The 8th International Conference of the African Materials Research Society

December 7th - 10th, 2015 Accra, Ghana

Theme: Transforming African Economies Through Innovative Materials Development

BOOK of ABSTRACTS

Venue: Mensvic Grand Hotel
East Legon-Accra, Ghana

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Message from the LOC Chairman

Dear Colleagues,

We welcome you to Ghana and the 8th International Conference of the Africa Materials Research Society! The theme of the conference was selected to show that materials development can be used to speed up the development of Africa's economy and the global community at large.

For the 8th AMRS conference to be possible we would like to express our sincere gratitude for the strong support of the Office of the Vice Chancellor of the University of Ghana, Metallex group of companies, Ghana Oil Company (Goil), National Petroleum Authority, Ministry of Petroleum, Minerals Commission, Radiation Protection Institute, MRS-Singapore, and EDIF. Holding this Conference in Accra, the "capital of Ghana" is very appropriate because Ghana is the gateway to Africa, the country at the center of the globe with the best hospitality.

Material research spans a very broad class of disciplines, and the resulting technologies impact many people and industries. During the Conference we will learn much from each other about recent development in the fields of materials science such as energy, electronics, health, environment and infrastructure. We have world leaders in fundamental science, in advanced technology and engineering, as well as others working on modest but very practical and effective solutions to everyday problems.

The Africa MRS in general and the Conference in particular, are deeply committed to education and capacity building, thus the Conference hopes to provide a unique platform for students to directly interact with national and international leaders. Enjoy, debate, learn!

Themes of the conference reflect the need of high relevance of utilizing Africa's natural resources for the development of the continent and the globe. The conference will cover presentations on:

- Materials for energy & sustainability
- Materials for life, health & the environment
- Metallurgy, foundry, processing & infrastructure
- Computational materials science
- Basic materials and Nano science
- Materials education and networking

Although Africa is rich in materials resources, it has not taken appropriate advantage of its resources to develop its regional economies to their fullest potential. Investing high in science, technology and education are critical components in the economic and social development. Therefore the goals of the conference are to bring scientist from the world to interact with African researchers/scientists to help educate next generation of African scientists. Also, this would bring about the introduction of new materials and processing techniques, increase partnerships between African universities and universities outside Africa. For those of us in Ghana, the conference is a wakeup call for academia to start and strengthen collaboration with material based industries. This will help industries to create R&Ds and more importantly on the job training of students graduating from universities.

Bringing lead scientists and students across the world to interact with African scientists and students is an opportunity to promote, share and exchange ideas in a wide range of fields in materials science and engineering.

I end by thanking our sponsors once again and to welcome all our international participants to Ghana. Enjoy the great and proverbial Ghanaian hospitality.

AKWAABA!!!

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Background to the Africa Materials Research Society and Conference

The formation of the Africa-MRS, has its origins in the August 2000 ‘US-Africa Materials Workshop’, held in Pretoria, South Africa. This Workshop, which was co-organized and sponsored by the United States National Science Foundation (NSF) and the South African National Research Foundation (NRF) sought to explore opportunities for collaboration between the USA and Africa with an overarching objective of developing materials research capacity in Africa. It brought together over 70 leading scientists, industry researchers and government representatives from the USA and 15 African countries, which, together, sculpted a forward-looking sustainable framework for driving materials research in Africa. Building on this initiative, two years later, on 12 December, 2002, the Africa-MRS was officially launched in Dakar. The Dakar meeting, which was attended by various world leading experts in the different facets of materials science, engineering and research, also became the 1st Africa-MRS International Conference. Subsequent biennial international Conferences where held in South Africa (2003), Morocco (2005), Tanzania (2007), Nigeria (2009), Zimbabwe (2011) and Addis Ababa, Ethiopia (2013). This year, the 8th Africa-MRS biennial Conference is being held in Accra, Ghana from 7th-10th of December, 2015.

Plenary

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Ɔkɔtɔ Nwo Anomaa – The Crab Does Not Give Birth to a Bird: Challenges and Opportunities in Materials Research in Africa

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In a previous Africa MRS meeting I asked a presenter the purpose behind their work on metal oxides. The response was that metal oxides are important materials in advanced batteries. When I enquired whether there was a battery industry in their country, the answer I received was: No. This paper raises the question: What scientific questions and issues should drive materials research in Africa? It is acknowledged that "science is science" and that there is no "African" science as opposed to "American", "Asian", or "European" science. It is argued, however, that researchers in developed countries are mostly motivated by challenges associated with their local problems. It is suggested that, likewise, Africans have a unique opportunity to contribute to world science by tackling challenges inherent in their local environment. This approach to scientific discovery is illustrated with examples related to interface, colloid, and nanoscience in hydrometallurgy and associated environmental systems: interaction of gold-cyanide complexes [$Au(CN)_2^-$] with activated carbon, a nanostructured material; "invisible" gold, nanogold, and Coulomb-blockage-related slow electron transfer; and interaction of arsenic ions [As(III), As(V)] with zero-valent iron [Fe^0].

Interface Science in Nanoelectronics and Energy Applications

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This presentation summarizes our atomic scale understanding of ultrathin films and interfaces in selected non-traditional materials of potential use in electronics and energy applications. We first review recent studies performed on films and interfaces that have been designed and synthesized by researchers in the Center for Sustainable Materials Chemistry (CSMC). These include results on HafSOx, AlPO, and nanolaminate structures for use in energy and nanoelectronics applications. For example, we present results that help us understand the basic photon and electron induced chemistry that occur with HafSOx, an inorganic resist that can help extend Moore's law by enabling sub-10nm lithography. Next we discuss new results that help us understand the structure and chemistry at the interface between noble metals and ionic liquids. Finally, we outline some unique tools that we (and colleagues) use to study surfaces, interfaces, ultrathin films, and nanostructures, focusing on high resolution variants of ion scattering, electron microscopy and ion beam microscopy. As one example, we review results using a new photoemission method to examine the local electrostatic potential in a dielectric.

NSF support is gratefully acknowledged.

Lubrication with Polymers on Surfaces

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Keywords: Lubrication Polymers, Rheology, Polymer Brushes

Nature lubricates with water, but water is an appallingly bad lubricant—by itself. Nature often overcomes this limitation by using molecules that adsorb to surfaces and contain highly hydrophilic side-chains (sugars) that render the surfaces slippery. Polymer brushes are man's attempt to imitate this mechanism, and when grafted on surfaces they have been shown, over the last couple of decades, to be highly effective in lubrication. Their effect on friction can be dramatic, especially in cases where contact pressures are relatively low (such as in the contact of soft surfaces). While some issues with wear remain, their application in both oil and aqueous environments opens new possibilities in a number of applications. Some of these are quite unexpected, such as their significant influence on the rheology of dense slurries—of significant potential impact on the construction industry, and, indirectly, on the environment.

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Precise Chemical, Physical, and Electronic Nanoscale Contacts

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The chemical, physical, and electronic connections that materials make to one another and to the outside world are critical. Just as the properties and applications of conventional semiconductor devices depend on these contacts, so do nanomaterials, many nanoscale measurements, and devices of the future. We discuss the important role that chemistry can play in making and optimizing precise contacts that preserve key transport and other properties. Initial nanoscale connections and measurements guide the path to future opportunities and challenges ahead. Band alignment and minimally disruptive connections are both targets and can be characterized in both experiment and theory.

Production and valorization of biochars from various biomasses and wastes

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Biochar is produced from pyro-gasification of various streams such as biomass, crops, contaminated wastes, plastic wastes. This process operates at high temperature under controlled amount of oxidants such as O2, CO2, and H2O to avoid complete combustion. At moderate temperature (< 700°C), pyrolysis oil is the main product. Above this temperature, syngas (a mixture of CO and H2) is produced. In all cases, biochar is generated as solid product. Biochar is mainly composed of carbon, but minerals of various contents are present depending on the initial composition of starting materials and experimental conditions. In general, biochar represents about 15-30 wt.% of the starting material and about 25% of the initial recoverable energy. Biochar can merely be landfilled as non-toxic waste. However, efforts are focused on the valorization of biochar in various challenging fields. This paper summarized our recent results pertaining to different research projects where our team on biochars is involved. The following aspects will be covered.

1-Production of biochar from various starting materials such as: raw wood, contaminated wood, mixture of wood and plastics, wastes from food industry or from wastewater treatment plants etc.

2- Engineering biochars with surface activation. The purpose is to improve the reactivity and to regenerate functional groups on the surface of biochar (inorganic or organic functional groups).

3- Engineering well-structured carbon (biochars)-based composites by thermo-conversion processes. As example, carbon nanotube/calcium phosphate composites have been obtained by catalytic decomposition of methane under controlled experimental conditions. Another example will concern blends elaborated from clay and biochar for thermal energy storage.

4- Characterization of these various biochars, composites and blends: the composition and different physico-chemical characteristics of biochars are determined using various analysis techniques such as CHNSO analyzer, TPX, XRF, ICP-AES, FTIR, XRD, Raman spectroscopy.

5- Valorization of biochar as catalysts, sorbents, carbon nanotubes and fibers, materials for Energy storage and sensors.

A feedback of 10 years research in the production, functionalization, characterization and utilization of biochars will be presented.

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Thermochemical production of solar fuels using redox active oxides

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Keywords: solar fuel, thermochemistry, solar concentration, ceria

Laboratories around the world are pursuing a variety of promising strategies for converting solar energy into a reliable energy source for on-demand utilization. We describe here a thermochemical approach for achieving this goal using solar heat as the energy source and redox active non-stoichiometric oxides as the reaction medium. Specifically, upon exposure to high temperatures and/or inert gas, the oxide undergoes reduction (without change in crystalline phase) to release oxygen. Upon exposure to H_2O (or CO_2), the oxide is reoxidized, releasing H2 (or CO). We compare the thermochemical fuel production behavior of a variety of oxides, including those of the fluorite structure-type (ceria and its derivatives) and those of the perovskite structure-type ($La_{1-x}Sr_xMnO_3$). A shared characteristic of the most promising materials is that bulk oxygen diffusion (chemical diffusion) is fast such that fuel production rates are limited either by surface reaction kinetics or, at high temperatures, gas-phase mass transfer rates. These insights guide the effort to discover advanced materials required for the realization of solar-driven thermochemical fuel production.

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Agro-materials and Agro-processing

Ameliorating the effects of phytochemicals substances on the setting of cement with rice bran in the production of particle boards using a natural accelerator

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Keywords: phytochemicals, setting, compatibility, accelerator.

The need to reduce or eradicate the exposure to chemicals leaching out of binders used in production of household appliances and other composite materials became expedient after several reports of formaldehyde toxicity. This research work evaluated the various means and alternatives that could be devised to improve the compatibility between rice bran and an appropriate binder such as cement known to have little or no hazardous effect. Polyphenolic phytochemicals referred to as inhibitory substances, present in rice bran hinders its compatibility with cement therefore inhibiting setting. Hot water pre-treatment method was employed in minimizing the effects of these inhibitory substances. A natural accelerator, cow horn, was employed in place of the synthetic calcium chloride commonly used in improving the compatibility of the residue with the cement binder. Fourier Transform Infra-Red analysis was employed to confirm the existence and the formation of additional bonds through the carboxyl C=O, C−O−C of ether, − OH and the C−O of alcohol functional groups in rice bran-cement bonded composites. Various concentrations of soluble metallic salts were utilized in ameliorating the effects of the left over phytochemical substances in addition to the metals existing both in the cement binders and agricultural residue through hydration.

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Analysis of Generated Biogas from Anaerobic Digestion of Piggery Dung.

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Key words: Anaerobic digestion, Biogas, Methane, Piggery dung.

The use of energy is paramount to human existence. Every activity globally revolves round it. Over the years, different sources of energy (petroleum fuels predominantly) have been utilized. Animal waste treatment on the farm is a phenomenon that has called for rapt research attention. Generated wastes on farm pollute the environment in diverse ways. Waste-to bio-energy treatments can provide livestock operators with multiple value-added, renewable energy products. The objective of this work is to generate methane (CH_4) gas from the anaerobic digestion of piggery dung. A retention time of 15 and 30 days and a mesophilic temperature range were selected. The generated biogas composition was methane (CH_4), carbondioxide (CO_2), hydrogen sulphide (H_2S) and ammonia (NH_3) using gas chromatography method. At 15 days retention time, 60% of (CH_4) was collected while CO_2 and traces of H_2S and NH_3 accounted for 40%. At 30 days retention time, 75% of CH_4, 20% of CO_2 was collected while traces of H_2S and NH_3 amounted to 5%. For on and off farm uses, biogas can be upgraded to biomethane by removing the impurities i.e CO_2, NH_3 and H_2S. The resuultant product biomethane (CH_4) can meet heating and power needs or serve as transportation fuels.

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Bringing African cities challenges to perspective: an overview of waste materials use in Tamale, Northern Ghana

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Keywords: wastewater, faecal sludge, shea slurry

Tamale is the largest city in Northern Ghana, with long tradition in organic waste use in agriculture. This comes as a result of combination of climatic conditions, such as long dry season, absence of adequate water supply, and general poverty, which drives citizens to look for cheap sources of nutrients as an input for urban and peri-urban agriculture, such as wastewater and faecal sludge from public toilets. Recent rapid expansion of the Tamale metropolitan area has brought new ideas for use and management of waste to the fore. Waste materials exploitation repertoire is expanding to include shea butter slurry as well as potential for biogas generation from abattoir and other sources (ex. public schools). City has been a host to series of collaborative research projects studying the wastewater use for vegetable production (FAO, IWMI, UDS) and its impacts on health, faecal sludge processing for safe use in agriculture (UDS, WHO, IDRC), production and use of biochar for agriculture and wastewater treatment (UrbanFood^{Plus}, RUAF, UDS, UG) and others, such as biological agents use in waste processing. Waste materials use is increasingly looked upon as an expanding area for production of energy, source of bio-fertilizer as well as business opportunity for small-scale entrepreneurs. This paper summarizes some of the recent examples of the waste materials utilization in Tamale and current direction of research.

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Chemical modification of *Celtis mildbraedii* (Esa Fufuo) a tropical hardwood species using acetic anhydride and propionic anhydride

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Keywords: Dimensional Stability; Chemical modification; wood.

Celtis mildbraedii (Esa fufuo) is a high density hardwood species and is abundant in the forest of Ghana. However Esa fufuo has a low dimensional stability as one of its disadvantages. In this study, *Celtis mildbraedii* (Esa fufuo) has been chemically modified with Acetic Anhydride (AA) and Propionic Anhydride (PA) to improve its dimensional stability. The percentage swelling coefficient, anti-shrink efficiency, water absorption co-efficiency and water repellent efficiency were used to analyze the effect of the modification on the dimensional stabilization of the wood. The dimensional stability of the modified samples was found to be superior to the unmodified samples. The average percentage swelling coefficient values of the modified and unmodified samples were AA = 5.086a, PA = 5.205b, De-ionized water = 7.284c. The average percentage water absorption values of the modified and unmodified samples were AA = 47.80a, PA = 48.01a, De-ionized water = 84.70b. The lower the percentage swelling coefficient and the percentage water absorption coefficient values the better the dimensional stabilization indicating AA modified samples were better dimensionally stabilized when using petcentage swelling coefficient followed by the PA modified samples and the DW samples the least. However by using percentage water absorption coefficiency there was no significant difference in dimensional stabilization between AA and PA modified samples.The higher the anti-shink efficiency and water repellent values the better the dimensional stabilization. The percentage anti-shrink efficiency of the AA modified samples was higher than that of the PA modified samples (AA = 43.92b, PA = 41.60a) indicating a superior dimensional stability for AA modified samples to that of PA. For the water repellent efficiency (AA = 76.74a, PA = 77.15a) indicating there was no significant difference between the AA and PA modified samples using the average water repellent efficiency values.

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Comparative green synthesis of nano silver particles from palm florescence, elephant ear seed pod and chanca piedria whole plant for agrochemical application

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Keywords: Chanca Piedra, Palm florescence, Elephant ear, Bio catalysts, Nano Particles

Nano particles were produced using extracts methanol and aqueous maceration of Palm florescence, elephant ear seedpod, and chanca piedria whole plant as well as boiled infusions of same plant materials as reducing and capping agents. Ultraviolet-Visible spectroscopic analysis was used to determine the complete reducing and capping process of the silver material and comparative reactive amounts of the individual bio catalysts were determined at the maximum wavelength of absorption. The presence of secondary metabolites in the plant materials were determined and were found to be; Saponin (water extract of Chanca P., Palm florescence and Elephant ear), Tannin (extracts of Chanca P. and aqueous extract of Palm florescence), Glycosides (extracts of Palm florescence and Elephant ear), Alkaloids (all the extracts except for the aqueous extract of palm florescence); Flavonoids, Steroids and Phenolics were contained in all extracts of the three sample materials. Fourier Transformed Infra Red (FTIR), spectroscopy was employed in identifying the functional groups present in the Nano material in other to identify and ascertain the purity of the particles produced. This process presents another environmental friendly process of producing Nanao particle for Agrochemical applications either as in a slow release nutrient matrix formulation or pesticide delivery vehicle for better econo-environmental application.

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Effect of soluble inorganic salts on the physico-chemical properties and degradation study of bio plastics from banana peel

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Keywords: biodegradability, physico-chemical properties, agricultural residues, bio-plastics.

Plastics have become a part and parcel of our daily lives. Basically, most packaging materials are produced from plastics, due to some of their unique properties such as their availability, inertness, ease of production, lightweight and low cost. Despite all these advantages, plastic packaging materials have become a major source of environmental pollution due to their non-biodegradability thus posing difficulties in disposing them.

This study is aimed at producing biodegradable bio-plastics with comparable properties as the synthetic ones from different cellulosic materials most especially, those from agricultural residues that are abundant and are usually considered as wastes. It is also aimed at studying the effect of doping the bio-plastics with soluble inorganic salts such as calcium chloride, on their physico-chemical properties and the rate of degradation in the presence of moisture. The bio-plastics were produced from different species of unripe banana and plantain peels at different acid concentrations.

Evidence of additional bond formation were observed through the carboxyl C=O, C−O−C of ether, − OH and the C−O of alcohol functional groups especially in the bio-plastics doped with Ca(II) salts. Evidence of the existence of other metals was revealed in the metal analyses with potassium and calcium having the highest percentages. The moisture absorption of the bio-plastics were found to increase with increasing acid concentration while the tensile strength and young modulus were decreased at a higher acid concentration in all the produced bio-plastics from all the species. Variation in trends was observed in the elongation at break in all the bio-plastics while the rate of biodegradation was increased in all the bio-plastics doped with CaCl2 salt.

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Plant design for the transformation of plantain into value-added products

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Keywords: Plantain, Lemon, Blanching, Plantain masher equipment, Economic Analysis

Plantain belongs to the genus Musa of the family *musaceae*. Nearly all edible plantain cultivar are derived from two wild species, *M. acuminate* and *M. balbisiana.* These wild species are classified on the basis of the proportion of the genetic constitution contributed by each parental source. Plantain (*Musa* spp.) is an important dietary source of carbohydrate in the humid tropical zones of Africa, Asia and South America (Robinson, 1996). Despite these many uses of plantain and the huge tonnages harvested each year, there are certain problems such as inaccessibility to production areas, far distances between production areas and customers, inadequate infrastructures for harvesting, negligence on the part of harvesters and handlers among others which are all factors that lead to high rate of post-harvest losses, it is therefore important subjecting plantain to processing methods that will help enhance and improve the value of the fruit and make it available all year round for better utilization. This plant design for the production of frozen plantain mash and fries includes research aimed at identifying the optimal blanching process and use of lemon to minimize browning of the frozen product. The design produced is for a cottage-size facility, producing 800kg/day of frozen plantain mash and 776.16kg/day of frozen plantain fries. Material and energy balances are produced based on the selected process and product and the production rate. The plantain masher is selected for the mashing operation is designed. An economic analysis is conducted to determine profitability and viability of the plant. The plant service life is estimated to be 20 years with an initial capital investment and working capital of GH₵ 4,485,261.493 and GH₵ 672,789.224 respectively. The net present value (NPV) of the project from the sensitivity analysis is GH₵ 3,415,407.494 and a payback period of 1.9 years. Again, the Discounted Payback Period yields a value of 3.22 years whereas the Rate of Return on Investment (ROI) is 53.2%. Also, the frozen plantain mash and fries with both sell at GH₵8. The above values indicate the project is a profitable venture and would even survive in times of economic crisis. Assumptions underlying the design include location of the plant covering an area of 8862.95m^2 at Dodowa, to serve a target market of Accra and its environs.

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Production and characterization of biochar from available processed timber (Teak, Gmelina, Obeche) wastes and mixed shavings, as effective CO2 sink, chromium contaminated soil ameliorant and nutrient slow release material.

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Keywords: Teak, Gmelina, Obeche, Mixed wood shaving, Biochar, Agrochemicals.

Using a modified rocket type pyrolysis drum, biochar was produced from Teak, Gmelina, Obeche and mixed wood shavings obtained from a local timber shade in Northbank Makurdi Benue State. To determine the suitability as source of reduced carbon compounds (organic molecules adsorbed to the particle's matrix) and colonizing soil bacteria substrate, the pore size of the material was ascertained by Methylene blue absorption test and the heavy metal content determined using Atomic absorption spectrophotometer. The leachate pH, relative Chromium absorption and desorption capacities were also determined. Results obtained show marked difference in physical properties but relatively the same efficiency in chromium absorptive capacity and leachate pH. This work presents a waste conversion package suitable as an Agrochemical input for enhanced crop production and ecosystem conditioning. The use of a sustainable biochar resource will ensure waste reduction, carbon sequestration. This will create an inventive recycling practice for a viable agri-business.

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Source separation and composting of household waste in the Ayuom farming community

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Keywords: Waste, Organic, Compost, Biochar

Waste generation cannot cease due to the existence of human activities. In most communities, organic waste represents the highest fraction of the waste generated. With the adverse effect of improper handling and disposal of waste, it has become important to produce compost out of the organic fraction to reduce the waste that would have been deposited in the landfill. The aim of this study was to produce compost from source separated waste. Identified household were given two dust bins each, one for the collection of organics and the other for inorganic waste.

Waste was collected weekly, further separated and then the organic fraction was formed into piles. During composting, the piles were monitored for temperature, C:N ratio, pH and moisture. Data collected for eight weeks were subjected to graphical interpretations, percentage, mean and t-test. The results showed 97% waste separation efficiency in the organic bins but that of the inorganic bin was 26.9%.

Compost produced had a mean NPK content of 0.06, 0.12 and 0.35 respectively but increased after 6weeks of incubation. From the study, the mean heavy metal content recorded for Nickel, Chromium, Mercury, Lead, Zinc and Cadmium fell within range as described in the ASCP Guidelines 2001.

After 6 weeks of incubation of compost : biochar mixture, the NPK content in all the ratios increased except for the 50% compost: 50% biochar and 25% compost : 75% biochar where the K content reduced.

Fertilizer requirements are reduced up to about 50% when compost is added to the soil, which in effect increases soil fertility and cat ion exchange capacity.

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Bioynthesis and Nonlinear optical characterization of copper hydroxide nanorods-like

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Keywords: Oxides, nanostructures, Transmission electron microscopy (TEM), X-ray diffraction, crystal structure

The present work reports the biosynthesis and nonlinear optical properties of Copper hydroxide nanorods (Cu(OH)2-NRs). Cu(OH)2-nanorods decorated spherical nanoparticles were synthesized from copper sulphate using saffron (Crocus sativus) extract at room temperature. Saffron extract acts as a reducing and stabilizing agent during synthesis process. X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), High Resolution-Transmission electron microscopy (HR-TEM) and Scanning electron microscopy (SEM) were initially used to characterize the synthesized nanorods. The morphological analysis showed the formation of uniform nanorods with an average length of 515 nm. The synthesized Cu(OH)2-NRs-like structure and crystalline nature was confirmed by the nanopowder X-ray diffraction patterns. The average crystallite size was found to be in the range of 13.25 nm. The nonlinear optical studies using a femtosecond laser at 800 nm, 80 fs pulses repetition reveal two-photon absorption behavior.

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Carbon Allotropes: novel material for the development of SASER

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Keywords: Carbon Allotropes, electron-phonon interaction, sound amplification, stimulated emission.

Carbon Allotropes are different molecular configurations that pure cabon can form. These are graphite, diamond, C60 fullerence, Nanotubes and Graphene to newly discovered Nanoribbons , Nanocone, Nanochain and many others. In this presentation, we studied the electron –phonon interaction in Carbon nanotube, Nanoribbon and graphene. The energy exchange between the electrons and phonons can lead to the following:

- electron giving energy to the phonons and thus amplifying the phonons whenever the drift velocity of the electrons exceed the velocity of sound
- Phonon giving energy to the electrons and therefore generating acoustoelectric current.

This presentation will focus on the first case and theoretically predict that these materials can be used for the development of SASER – Sound Amplification of Stimulated Emission of Radiation.

Characterization of nanostructures on the wings of *idea malabarica* (moore, 1877)

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Keywords: Idea malabarica (moore, 1877), Nanostructures, Reflectance.

Nature provides complex nanostructures superior to man-made technologies. These nanostructures can be bio-mimicked to produce devices and technologies with enhanced performances. Beetle, sea mouse, and butterfly wings are typical templates used by researchers in the biomimicry industry. Against the backdrop of these systems, using a number of characterization and optical techniques, we focus, on investigating the structural and optical properties of the wing scales of *Idea malabarica* (Moore, 1877) Fig.1. From our findings (Fig.2), the morphological structures observed on the black margins (Fig.2 (a &c) exhibit rectangular holes with ridge periodicity ~ 0.07 µm while the white with lemon background margins (Fig.2(d&f) shows alternating lamellae with periodicity of 0.02 µm. The optical examination deputes a fairly low reflectance value for black margins as compared to the white margins with lemon background. As such the wings of the *Idea malabrica* (Moore, 1877) serve as an excellent biomimicry material for solar absorber applications.

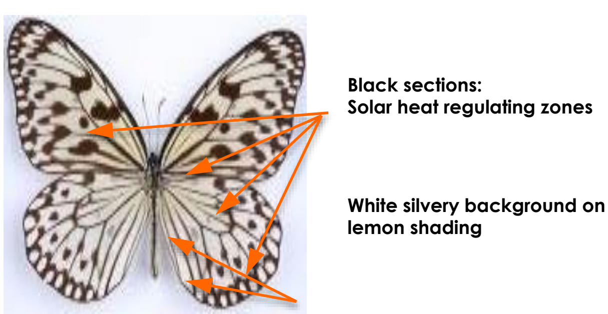

Fig. 1: The *idea malabarica* (moore, 1877).

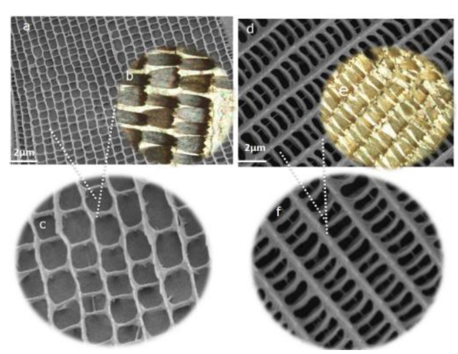

Fig.2: Structure from the SEM images

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Comparison studies on nano-particles coated with SiO_2 by water glass and hydro-reaction.

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Keywords: Nano-particle, Water glass, Hydro-reaction, Coating method

Nanoparticles coated by Silica (SiO_2) have found to be applicable in many advanced areas. This study deals with the preparation of nanoparticles coating with SiO_2 by water glass and hydrolysis reaction. First, the low temperature hydro-reactions were carried out at 30~100℃. Second, Silicon oxide-coated Nano compounds were obtained by the catalyzing synthesis. CeO_2 Nano-powders have been successfully synthesized by means of the hydro-thermal method, in a low temperature range of 100~200℃. In order to investigate the structure and morphology of the Nano-powders, scanning electron microscopy(SEM) and X-ray diffraction(XRD) were employed. The XRD results revealed the amorphous nature of silica nanoparticles. To analyze the quantity and properties of the compounds coated with Si oxide, transmission electron microscopy(TEM) in conjunction with electron dispersive spectroscopy was used. Additionally, the optical properties were investigated by SEM. Optimal conditions with a temperature range of 30~100℃, holding time of 10~20 minutes, PH = 10~12.5 were selected. Comparing the reaction pH level, it was revealed that the extinction of functional groups at pH=12~12.5 contributed to the growth and homogenization of the CeO_2 powders. Finally, it is suggested that the simple growth process is more favorable mechanism than the solution/aggregation process.

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Effects of reaction parameters variation on synthesis of magnetite

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Keywords: Magnetite synthesis, Parameter variation, EDXRF, XRD, XPS

The successful application of various nano-platforms in biomedical imaging and drug delivery is strictly depend on morphology, shapes and sizes of nanoparticles which is affected by some reaction parameters; concentration, reaction temperature, pH, mixing methods and reaction time. The primary objective of this present work is to investigate the effect of variation in reactant concentration on magnetite synthesis using a sol-gel method. Varied concentrations (gms) of Iron (III) nitrate ($Fe(NO_3)_3.9H_2O$) was dissolved in cm^3 of Ethylene glycol ($HOCH_2CH_2OH$) and stirred for 1hr.A brown homogenous solution was obtained and heated to 80^0C to form a brown gel. The gel was dried at 120^0C in an oven for 3hrs, and finally vacuum dried to obtain magnetite. The purity of synthesized Magnetite (Fe_3O_4) was investigated using Energy Dispersed X-ray Fluorimetry (EDXRF), X-Ray Photoelectron Spectroscopy (XPS). The surface area, melting point, morphology, crystal size, magnetic properties and particle size were analysed using Degas system (BET), Thermographic Analyzer (TGA), Scanning Electron Microscope (SEM), X-ray Diffractometer (XRD), Vibrating sample magnetometer (VSM) and ImageJ software. The study indicated that variation in concentrations of the reactant has no effect on the melting point and magnetic properties but it affected the particle sizes, crystal sizes, surface area and yield.

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Electrochemical capacitive properties of copper iodide thin film deposited by SILAR method

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Economical Successive Ionic Layer Adsorption and Reaction (SILAR) method was used to synthesize Copper Iodide (CuI) thin films deposited on amorphous glass and Stainless Steel (SS) substrates at room temperature. The resulting thin films were characterized for their structural, morphological and optical study by X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and UV-Vis Spectroscopy respectively. The energy band observed for the material is 2.70 and 2.98 eV for 20 and 30 cycles respectively. The electrochemical properties of this p-type semiconductor were characterized by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS). The CuI film on SS gave a specific capacitance of 598 $Fg^{-1}$with an excellent long-term cyclability and excellent reversible stability.

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Electrochemical properties of SILAR deposited copper-cobalt mixed oxides thin films

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We have used a simple, cost effective and scalable chemical method to deposit mixed oxides of copper and cobalt on indium tin oxide (ITO) and stainless steel (ss) substrates for pseudocapacitive applications. The nanoporous Cu-Co and Co-Cu mixed oxides show uniform surface morphology with average grain sizes of 118.7 ± 1.3 nm for Cu-Co and 188±5.4 nm for Co-Cu oxide films respectively.The electrochemical properties are characterized by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS). The Cu-Co oxide film on ITO gave very high specific and volumetric capacitances of 919 Fg^{-1} and 1201 Fcm^{-3} respectively. In addition to this, the Cu-Co oxide electrode shows superior rate capability and excellent long-term cyclability. While the ss offers less internal resistance, the stability of the films are better on ITO substrates. Our results indicate that the developed nanoporous electrodes give excellent properties for use as pseudocapacitive electrodes.

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Facile Synthesis of nanosheet like CuO Thin Film and its Potential Application as a High-Performance Pseudocapacitor Electrode

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Keywords: Copper oxide thin film, supercapacitors, specific capacitance, successive ionic layer adsorption and reaction, cyclic voltammetry.

We describe the chemical synthesis of binderless and surfactant free CuO thin films for pseudocapacitive applications. Nanosheet-like and nanorod-like CuO films are deposited on indium tin oxide (ITO) substrates using the successive ionic layer adsorption and reaction (SILAR) approach. The nanostructured CuO shows uniform surface morphology and uniform pore distribution with average grain sizes in the range 30 - 50 nm and pore size distributions (average pore size of 12.0 and 12.5 nm for 10 and for 40-cycles respectively), as estimated from AFM imaging. The electrochemical properties are characterized by cyclic voltammetry (CV), galvanostatic charge-discharge (GCD) and electrochemical impedance spectroscopy (EIS). The highest specific capacitance of 566.33 Fg^{-1} is obtained for as low as 10-cycle film at a scan rate of $5mVs^{-1}$. The long term stability tests by continuous GCD, indicates that there is no degradation after 1000 cycles with the film yielding 100% coulombic efficiency. This indicates a high stability of the synthesized CuO thin films. Hence, the developed nanostructured CuO thin film electrodes gives excellent properties for use as supercapacitors.

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Green synthesis of CO_3O_4 nanoparticles via aspalathus linearis: physical properties

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Keywords: Green chemistry; biosynthesis; cobalt oxide; nanoparticles; *Aspalathus linearis extract*.

Cobalt exhibits several possible oxidation states, including several types of coordinations. Consequently, cobalt oxides present a broad field for the creation of many frameworks in view of their stoichiometric and non-stoichiometric oxides, and mixed electronic valency of cobalt, and/or the presence of oxygen vacancies. This multi-electronic valence and rich coordination is proper to cobalt oxides in comparison to other 3d metal oxides. This provides cobalt the ability to be present in various spin states in its oxide forms: low, high, as well as intermediate spin. These probable spin states make the physics of the cobalt oxides attractive from a fundamental viewpoint and in spintronic applications. Being an antiferromagnetic p-type semiconductor, it is a multi-functional material with several practical applications such as heterogeneous catalysis, electrochromic sensors, pigments and dyes, energy storage, and anode materials in Li-ion rechargeable batteries. Several physical and chemical methodologies to synthesize nanocrystalline Co_3O_4 were used: thermal decomposition of cobalt oxalate, hydrothermal reaction, thermal decomposition of sol-gel derived oxalates, solution combustion method, microwave process, combustion route, among others. Hitherto, yet these physical/chemical methods are very effective, they are complex, and environmentally not generally friendly in view of the required energy balance and/or generated waste. In this contribution, we report for the first time, the use of the *Aspallathus linearis's* natural extract as an effective chelating agent for the facile and rapid bio-synthesis of pure Co3O4 single-phase nanoparticles at a low temperature. The fact that there was no use of inorganic/organic solvents neither surfactants nor high temperature makes this synthesis an effective green and eco-friendly process.

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Green Synthesis of Functional Metal Oxides via Aqueous Extracts of Callistemon viminalis

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Keywords: Green synthesis, metal oxides, nanopowders, raman spectroscopy, photoluminescence

We report the syntheses at room temperature of nanopowders of a variety of transition metal oxides using aqueous extracts from red flowers of the tree plant, *Callistemon viminalis*. The method is based on the action of organic constituents present in aqueous extracts (pH < 4) of *Callistemon viminalis*, as strong chelating agents. Apart from the metal-salt precursors used in the syntheses no other additives such as surfactants and non-aqueous solvents were employed. Annealing of the metal oxide-metal hydroxide-containing precipitates formed under 1h as well as the solutions obtained within the temperature range 300-500 °C, gave rise to nanostructured amorphous and crystalline forms of targeted metal oxides. This method of green synthesis using plant extracts offers a viable alternative to the use of expensive high vacuum technologies for producing metal oxide thin films and powders. The syntheses of a number of technologically relevant metal oxides, specifically Sm_2O_3 [1], Cr_2O_3[2], CdO, NiO and CuO is hereby reported. A variety of techniques amongst which are Scanning Electron Microscopy, High Resolution Transmission Electron Microscopy, Raman spectroscopy, Fourier Transform-Infrared spectroscopy, X-Ray Photoelectron Spectroscopy, X-Ray Diffraction analysis, and Photoluminescence spectroscopy were used to structurally and optically characterize the powders and thin films prepared. The results obtained show that the use of aqueous extracts of the plant *Calistemon viminalis* offers an easy, fast and environmentally friendly way of synthesizing nanostructured thin films and powders of an interesting number of functional metal oxides. Energy-storage applications of some selected synthesized oxides will be reported.

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Improved method of measuring the mechanical properties of shales by instrumented indentation

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Keywords: Shales, Mechanical testing, Core, Cuttings, Instrumented Indentation Testing (IIT)

Shales are usually chemically and mechanically unstable, making their extraction for macro-scale mechanical testing difficult and complex. In most cases, such mechanical property measurements are typically made on core samples that are expensive to extract and test using conventional mechanical testing methods. This, therefore, presents a need to engage an efficient and less expensive technique that will be particularly suited for testing small volumes of materials such as shale cuttings that are obtained from conventional drilling processes. In this paper, we clearly show how instrumented indentation testing (IIT) was used to measure the mechanical properties of shales obtained from different depths within the Niger-delta region of Nigeria. Through appropriate data analysis of the derived load-displacement loading and unloading curve obtained from the high precision indentation of the shales cuttings, we were able to determine some useful mechanical properties of these samples at the nano-scale.

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Influence of galvanic interaction on the leaching behavior of galena sphalerite ores in acidified hydrogen peroxide

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Keywords: Leaching, Galvanic Interaction, Dissolution and Passivation

The influence of galvanic interaction on the leaching behaviour of galena-sphalerite ore has been investigated using electrochemical techniques. Electrochemical measurements considered included open circuit potential (OCP), potentiodynamic polarisation and chronoamperometry. The as-received ores were pulverized and screened to particle sizes 150µm, 106µm, 75µm, and 53µm. Chemical compositions of the ore was determined using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), X-ray fluorescence and X-ray Diffractometer. Some of the identified metals were lead, zinc, copper and iron. Thereafter, electrochemical studies were conducted in 1 M H_2SO_4 with varying concentration of H_2O_2 as oxidant. The results show that the grains of the ore appeared inter-grown together with variation in chemical and mineralogical compositions within the particle sizes. The results from the electrochemical studies revealed that addition of H_2O_2 to H_2SO_4 enhanced the dissolution rate of the sulphide ores with dissolution rate increasing with increasing H_2O_2 concentration. The evolution of the open circuit potential in the investigated samples increased with increase in oxidant concentration suggesting that H_2O_2 oxidant had a strong influence on the surface reactivity of the sulphide ore. The dissolution potential also shifted to more positive values with increase in H_2O_2 concentration. Current density fluctuations were observed during chronoamperometry measurements which can be attributed to simultaneous dissolution and passivation of concentrates at the electrolyte-particle interface.

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Influence of Zn ion on the structural and spectral properties of CdS thin films

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Keywords: CdZnS, SEM, polycrystalline, band gap energy, solar cell

The effects of Zinc ion on the on structural, optical and surface properties of chemically deposited cadmium sulfide (CdS) thin films on glass substrates were investigated. While the scanning electron microscopy (SEM) showed that the CdS were made up of closely packed nano-particles with few holes, the XRD analysis revealed polycrystalline thin films in which the crystallite size decreased with increasing concentration of the Cd ion source. It was however observed that the presence of the Zn on the Cadmium sulfide shifted the reflection peaks of the CdS at very low concentrations of the Cd source. The Time of Flight (TOF) analysis was used to study the elemental compositions of the thin films. Increased concentrations of the Cadmium source relatively reduced the absorbance. However, the optical band gap energy decreased with increased concentration of the cadmium source. The thin films could be promising candidate for p–n junction in solar cell device

Investigating the material properties of ZnO:Li grown by SILAR technique

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Keywords: ZnO, SILAR, Dopant, Raman spectroscopy, Crystallite size,

Intrinsic and Lithium-doped zinc oxide thin films were grown on microscopic glass substrates by successive ionic layer deposition and adsorption reaction (SILAR). The thin films were characterized by Xray-Diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM) and UV-Vis spectroscopy to study the effects of the percentage composition of the Lithium dopant on the structure, morphology and optical properties of the flower–like clusters of the ZnO nanostructures. The XRD studies revealed that the ZnO thin films were crystallized in hexagonal wurtzite structures whose average crystallites sizes increased with the Li dopant level (74 nm, 104 nm and 132 nm). The raman spectroscopy also suports that the ZnO thin is of the wurtzite structure and are not oxygen-defficient. The transmittance of the the ZnO thin films significantly increased with the amount of the the dopant.The band gap also increased with the dopant level.

Investigation into the structure of zeolites synthesized from bauxite and kaolin using the hydrothermal method

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Keywords: Zeolites, synthesis, characterization, hydrothermal, crystallization.

The possibility of obtaining ultrapure zeolitic materials from local raw materials was investigated. Zeolites A, X and Y were successfully synthesized via the hydrothermal method. Bauxite and kaolin were locally acquired from Awaso and Anfoega in the Western and Volta Regions of Ghana respectively. Using X-ray diffraction (XRD), Scanning electron microscopy (SEM) and Fourier transform infra-red (FTIR) analytical techniques, both the starting materials and resultant zeolites were evaluated. Zeolite A showed a cubic crystal system with lattice parameter of 12.28 Å and space group $Pm\bar{3}m$. Zeolites X and Y also showed cubic systems with lattice parameters 25.07 Å and 24.76 Å with space groups $Fd\bar{3}$ and $Fd\bar{3}m$ respectively. The synthesized zeolites were of high crystallinity and comparable to that obtained from chemical reagents. However, the cost of production of the zeolites was vastly reduced allowing for further improvement and advancement in the research and application of zeolites in diverse areas.

Table 1. Elemental compositions of bauxite and kaolin

	SiO_2	Al_2O_3	K_2O	TiO_2	Fe_2O_3	Na_2O	MgO	Total
Bauxite wt.%	1.12	88.6	trace	1.3	9.0	-	-	100
Kaolin wt.%	69.58	20.54	5.59	0.95	1.08	0.28	1.98	100

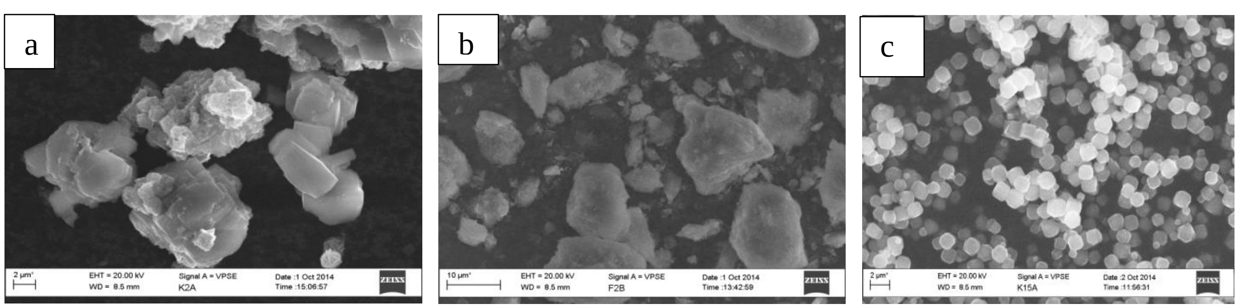

Figure 1: SEM images of (a) bauxite, (b) kaolin and (c) synthesized zeolite A

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Ion beam induced splitting of XRD and Raman peaks in InGaN/GaN epilayer system

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Keywords: InGaN/GaN epilayer system, Si irradiation, Ion beam induced XRD peak splitting, Ion beam induced Raman peak splitting

In this study, we investigated the effects of 10 MeV Si^+ ion beam irradiations on the structure of an InGaN/GaN epilayer system. The InGaN/GaN epilayers were irradiated at different Si^+ ion beam fluences ranging from 1×10^{14} to 1×10^{16} ions/cm^2 at room temperature. Characterisation of the epilayers by a combination of X-ray diffraction (XRD) and Raman spectroscopy shows new XRD and Raman peaks appearing, some peaks splitting and others shifting after ion beam irradiation. The appearance of multiple XRD peaks in an InGaN epilayer is sometimes attributed to phase segregation[1] and phase decomposition of the epilayer system.

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Iron Chlorophyll-a Biomimic Catalyst for the Green Synthesis of Polyaniline Nanostructures: Evaluation, Characterization and Optimization.

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Keywords: polyaniline nanostructures, enzymatic polymerization, bio-mimic catalyst, green synthesis, template assisted polymerization

Polyaniline PANI is one of the most widely studied and applied conductor-polymer. Its applications include diodes, anticorrosion, antistatic, solar cells and chemical sensor as active materials. PANI is usually produced by oxidative or electrochemical polymerization methods. The PANI produced in these methods often show inconsistent nanostructures, poor processibility and are insoluble in common solvents. The reaction usually involves the use of a number of environmentally unfriendly solvents and harsh inorganic acids. This has provided impetus to development of alternative methods that produce more consistent nanostructures, environmentally friendly and with lower overall energy demand. A sustainable enzymatic route for polymerization of aniline has been explored using the horseradish peroxidase enzyme. The enzyme however has limitations of instability and lose of catalytic activities in pH range where the best PANI is synthesized. To circumvent these disadvantages, synthetic biomimic catalysts have been prepared. In this work, we report on the synthesis, characterization and evaluation of the catalytic activities of a bio-catalyst that mimics the enzyme horseradish peroxidase. Chlorophyll-a was modified by de-metallation followed by chelation with iron to form iron-chlorophyll-a. The biomimic catalyst was evaluated in a polymerization system comprising aniline, hydrogen peroxide, sodium lauryl sulfate and hydrochloric acid. Spectroscopic evaluation using FTIR, UV/Vis and mass spectroscopy confirmed that iron-chlorophyll-a had been successfully synthesized. The iron-chlorophyll-a was found to catalyze the synthesis of PANI. The evolution of the reaction over time was monitored using a UV/Vis spectrophotometer in kinetics mode set at 650 nm wavelength for 6000 second. It was observed that the rate of polymerization increased with increasing concentration of catalyst and dependent on the aniline/initiator ratio. The ratio of 1:2.5 initiator to aniline was found to give the maximum yield at about 90 % w/w which is much higher than commonly attained using other methods. The morphology of the materials synthesized were evaluated by AFM and SEM which revealed nanostructures that were oval shaped. Electrical properties were evaluated using a four-point probe coupled to source meter. The materials were found to be conducting with an Ohmic behavior showing a conductivity of 0.14 S/cm.

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Low temperature hydrogen sensing in graphene oxide-doped tungsten trioxide thin films

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Key words: Tungsten trioxide, Graphene-oxide, Raman spectroscopy, Photoluminescence, Gas sensors

The method of Aqueous Chemical Growth was used to prepare nicro/nanostructured WO_3 porous thin films on plain glass microscope slides. The films were shown via scanning electron microscopy to largely consist of nanoplatelets, some of which were aligned perpendicular to the substrate surface while others existed as hierarchically organized microspherical structures. Transmission electron microscopy and X-Ray diffraction analysis showed the annealed films to exist predominantly in the monoclinic and hexagonal phases. When employed for hydrogen sensing the WO_3 thin films showed optimum sensitivities at 300 ºC with lowest sensing temperature occurring at 200 ºC. To reduce the H_2 sensing temperatures the WO_3 thin films were doped with graphene oxide using ACG. Raman spectroscopy (Fig. 1a) showed the inclusion of graphene oxide in the WO_3 thin films with peaks at 799.66 cm-1 and 702.61 cm-1 that could be attributed to short and long W-O-W bonds in the stretching mode. The D band peak at 1455 cm-1 could be ascribed to sp^3 carbons present in edge defects or the breakdown of translational symmetry in graphene oxide. The G band peak at 1519.86 cm-1, to first-order scattering of the E2g phonon mode in in-plane bound sp^2 carbons present in graphene oxide. The presence of graphene oxide saw the sensitivity of the WO_3 thin films increase by a factor of five (Fig.1b) while the minimum temperature for H_2 sensing was observed to reduce to 100 ºC. The undoped WO_3 thin films were shown to have a lower sensitivity to CO gas as opposed to H_2 within the 200-350 ºC range. This behaviour can be employed in the selective sensing of H_2 in the presence of CO, and should be further researched with regards to producing room temperature graphene oxide-WO_3 based sensors.

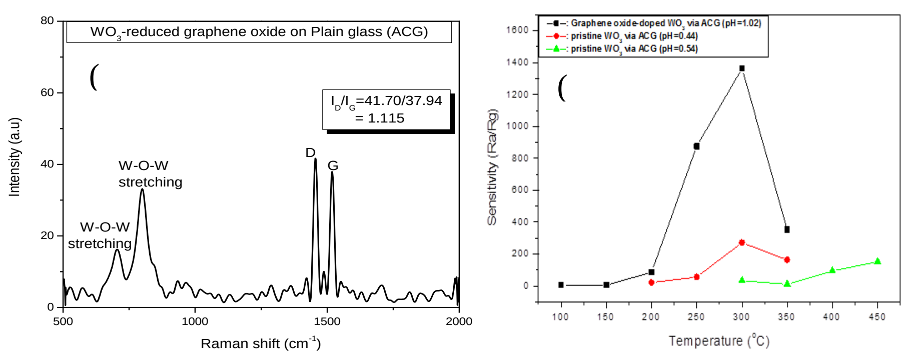

Figure 1 – (a) Raman of Graphene oxide-doped WO_3; (b) Comparison of sensitivities of graphene oxide-doped WO_3 and undoped WO_3 to H_2.

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Microwave induced synthesis of narrow ranged Ru particles supported on CNTs for selective CO methanation

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Keywords: Selective CO methanation, carbon nanotubes, microwave polyol, catalyst

Herein we report the purification of a H2-rich feed gas for a PEMFC using selective CO methanation over Ru nano catalysts supported on carbon nanotubes (CNTs). We have compared microwave and incipient wetness impregnation catalyst preparation methods. The CNTs were synthesized using a 5%Fe-Co/CaCO3 catalyst. The chemical vapor deposition (CVD) technique was used in the synthesis and the as-synthesized CNTs were purified and functionalized in 55% HNO3.1 A 1 g catalyst was prepared by wet impregnation to achieve 5% wt loading. Another 1 g of catalyst was prepared by microwave polyol synthesis. They were characterized using BET, XRD, Raman, TEM, chemisorption and TPR techniques. The RuO2 particles on the CNT support prepared by the different techniques were observed by TEM (Fig. 1). Small and uniformly dispersed RuO2 nanoparticles were noted for the microwave-assisted synthesized catalyst. For the impregnated catalyst, the particles observed were larger. This was mainly due to the short thermal induction period of the microwave energy, resulting in smaller, narrow ranged Ru crystallite and improved dispersion. Significantly higher catalytic activity for CO conversions was recorded for the catalyst synthesized by microwave-assisted method. The activity was attributed to high metallic surface with more exposed surface atoms and the high dispersion observed as revealed in the TEM (Fig.1) and confirmed with chemisorption.

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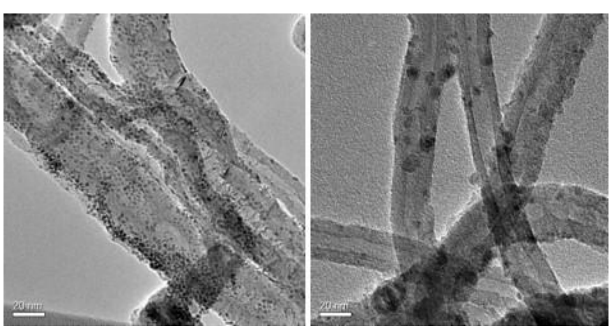

Fig. 1. TEM images of 5% loading of Ru prepared by (a) microwave (b) impregnation.

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Modification of ZnO nanoparticles using chlorogenic acid for various technological applications

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Key words: ZnO Nanoparticles,CGA, Fluorescence quenching, FTIR, TEM, DLS

Zinc oxide nanoparticles have tremendous scientific and industrial applications in solar cells, UV light-emitting devices, gas sensors, photocatalysis, and pharmaceutical and cosmetic industries. It has also medical applications due to high fluorescence nature of ZnO NPs for imaging of cancer cells and photodynamic therapy. In this this research the modfication of ZnO NPs bychlorogenic acid (CGA) were investigated using fluorescence quenching, UV-Vis Absorption Spectrscopy, Fourier Transform Infrared (FTIR), Raman Spectroscopy,Scanning Electron Microscopy (TEM) and Dynamic Light Scattering (DLS) techniques at different temperatures. The study results indicated the fluorescence quenching between ZnO NPs and CGA rationalized in terms of static quenching mechanism or the formation of non-fluorescent CGA-ZnO. From fluorescence quenching spectral analysis the binding constant (K_a), number of binding sites (n), and thermodynamic properties, were determined. The quenching constants (K_{sv}) and binding constant (K_a), decrease with increasing the temperature and their binding sites n are 2. The thermodynamic parameters determined using Van't Hoff equation indicated binding occurs spontaneously involving the hydrogen bond and van der Walls forces played the major role in the reaction of ZnO NPs with CGA. The FTIR, Raman, SEM and DLS measurements were also indicated the differences in thestructure, morphology and sizes of CGA, ZnO NPs and their corresponding CGA-ZnO due to modification ZnO NPs by CGA

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New Crystalline and Vitreous Compounds belonging to Na_2O-CaO/MnO-TiO_2-P_2O_5 system

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Keywords: Phosphates, Glass, Nasicon, DSC, XRD

Transition metal phosphates in both crystalline and vitreous forms are extensively studied for their potential application in heterogeneous catalysis, renewable energy, biomedical engineering, and environmental remediation. The study of Na_2O-CaO-TiO_2-P_2O_5 system showed that some compositions exist in both crystalline and glassy forms. The present work reports the synthesis and structural characterization of crystalline and vitreous compounds belonging to Na_2O-(1-x)CaO-xMnO-TiO_2-P_2O_5 system. The glasses were synthesized by the melting-quenching process at 1000°C. The crystalline compositions were prepared either by solid-state method at 750°C or by crystallization of the corresponding glasses at 650°C. Density of glasses was determined by the Archimedes method. The molar volume was calculated from the molecular weight and density. The density of the glasses increases and their molar volume decreases as manganese replaces calcium and x increases, indicating reticulation of the glass network, due to higher electric field strength of Mn2+ compared to Ca^{2+}. The glass transition, crystallisation and melting temperatures (Tg, Tc, Tm) were determined by DSC analysis. The values are around 480°C for Tg, 650°C for Tc and 800°C for Tm. Powder X-ray diffraction study shows that the crystalline compounds crystallize in R32 space group. Their structure belongs to the Nasicon type. It consists of a three dimensional network of PO_4 tetrahedra and AO_6 [A = Ti, Ca] octahedra sharing corners. The Na+ ions occupy the interstitial sites labelled M(1) and M(2). Raman spectroscopy study shows that the glasses contain -Ti-O-Ti-O-Ti- chains, indicating that the [TiO_6] octahedra are linked to each-other through corners, unlike the crystalline phases where they are connected to each-other via PO_4 tetrahedra. Electron paramagnetic resonance study shows that Mn^{2+} ions occupy octahedral sites in both crystalline and vitreous compounds.

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Optical properties of recycled polyethylene doped with carbon

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Keywords: Optical properties, Doping, Polyethylene, Absorbance

The ABSTRACT In this research, waste Polyethylene was doped with carbon and characterized for optical properties. The carbon amount in each of the doped material varies from 0-40% while the polyethylene was kept constant at 6ml volume. It was observed from the UV analysis that dopant concentrations of 0-10% absorb light in the UV range of 200nm- 900nm. In the dopant concentration of 20% absorbance was only recorded at the wavelengths of 200nm, 220nm, and 900nm, no absorbance was recorded on the conducting polyethylene of 30% dopant. However, the conducting polyethylene at 40% dopant only absorbed light at the wavelength range of 280nm to 320nm.

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PGM nano-particles & hybrid nano-composites by Gamma radiolysis/EISA

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Keywords: Mineral beneficiation, PGMs, Hybrid materials, EISA, Radiolysis.

The multi-functional Platinum Group Metals (PGMs) pure and hybrid nanostructures are based on a biomimicking approach. Marine organisms like diatoms and radiolaria provide materials scientists with many examples microstructures are formed by biomineralization a templated self-assembly process in which pre-organized organic surfaces regulate the nucleation, growth, morphology and orientation of inorganic crystals. Recently, various synthetic pathways that mimic aspects of biomineralization have been explored to produce patterned ceramic materials, among which the so called EISA and EISA templating processes. This research project focuses on the development of pure and hybrid advanced 1-, 2- and/or 3-dimensional PGMs nano-composites for multi-functional technological applications by a versatile novel hybrid nanotechnology-nuclear process: Radiolysis and Evaporation Induced Self Assembly (EISA). Figure 1 shows 0.1 M Pt solution of different concentration prepared from K_2PtCl_4. Figure 2 from our findings shows the effect of irradiation on Pt^{4+} solutions with different concentrations irradiated at a certain dose. On the image it is very easy to spot big black particles that are fairly agglomerated when the concentration is above $5x10^{-3}$ M. The UV-Vis spectrum of Pt of different concentrations shows a strong absorption peak at the wavelength 261 nm after irradiation, which indicates the presence of platinum nanoparticles. Furthermore, XRD and HRTEM images also confirmed the presence of the nanoparticles produced by Radiolysis.

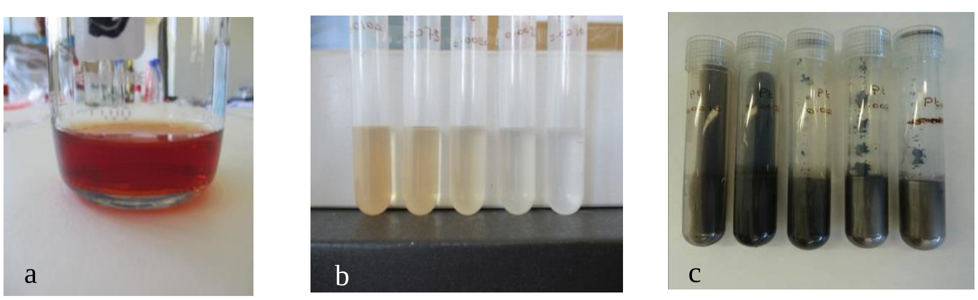

Figure 1: (a) Pt initial solution and (b) dilutions samples. Figure 2: Image of Pt samples after irradiation.

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Polyaniline-Biotinylated Antibody Biosensor for the Detection of Pseudomonas aeruginosa Bacteria

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Keywords: Biosensor, biochip, polyaniline fibres, conducting polymers, *Pseudomonas aeruginosa*

Although there are many diagnostic and detection platforms for detection of various bacteria, these often require large elaborate procedures and well trained expertise to execute. The turnaround time for results can sometimes be long. The development of portable and low power devices integrated biosensors is making available devices that can be used at the point-of-care. Such devices often can give immediate results. Rapid detection of bacterial pathogens is critical in the diagnosis of infectious disease. *Pseudomonas aeruginosa* is a nuisance bacteria that is also found in hospital environment that can cause fatality if there is a delay in detection. A biosensor based on polyaniline thin films and biotinylated anti-*Pseudomonas aeruginosa* polyclonal antibodies has been developed that enables the detection of *P. aeruginosa* bacteria. Thin films comprising polyaniline nano fibres were developed via in-situ polymerization on glass slides. FTIR and UV/Vis spectroscopy were used for functional group analysis and determination of optical properties. The effect of polymerization time and thermal treatment on morphology and electrical properties was investigated. The morphological characteristics were determined using AFM whilst electrical properties were determined using a four-point probe coupled to a source meter. Anti-*P. aeruginosa* biotinylated polyclonal antibodies were immobilized on avidin treated polyaniline thin films. Sensing characteristics of polyaniline films were evaluated in biosensor detection set-up. The set-up consisted of a helium-neon laser interfaced with a cadmium sulphide LDR detector connected to a circuit incorporating a multimeter. The changes in light intensity were observed to be directly proportional to the amount of bacteria bound by the antibodies which reflected in an increase in the resistance of the films. The resistance was found to increase linearly with increasing bacteria concentration. Bacteria concentrations in unknown samples were determined rapidly in under 5 minutes. The lower detection limit of the sensor was found to be 9.0×10^5 CFU/ml. Selectivity was demonstrated with the *E.coli* cross-reactivity test which showed no biosensor response in comparison to the response seen with the *P. aeruginosa* tests. We have successfully developed and tested a biochip that can be used in sensor devices for rapid determination of *P. aeruginosa* bacteria.

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Preparation, Characterization and Property Evaluation of Molecularly Imprinted Polyaniline Nanoparticles for Aldrin Detection

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Keywords: Molecularly imprinted polymers (MIPs), conducting Polymers (CPs), polyaniline nanoparticles, molecular recognition, re-binding

Molecularly imprinted polymers are a class of new functional materials that bring about selectivity to chemical sensors that is similar to that found in biological systems. The technique enables the creation of artificial recognition cavities within synthetic polymers that can be used in chemical sensors to detect specific analytes. Molecularly imprinted nanostructured materials of defined shape and size show remarkable properties that can be utilized in different fields of analytical chemistry. We report on the preparation, characterization and evaluation of molecularly imprinted polyaniline nanoparticles that can be used to selectively detect aldrin. Molecularly imprinted polyaniline (MI-PANI) nanoparticles were prepared by inverted emulsion polymerization using aldrin as template and aniline as a functional monomer. Materials prepared were characterized using FTIR, UV/Vis and NMR for structural elucidation. AFM and SEM were used for morphological characterization which revealed that the particles prepared were spherical in nature. Scanning electron microscopy further confirmed the shape and showed that the particles had diameters ranging from 250nm – 1.0 μm for MI-PANI compared to a size range of 60 – 100 nm for non-imprinted particles.Electrical properties were evaluated using a four-point probe coupled to a source meter. Non-imprinted materials showed an electrical conductivity of 4.149 S/cm that reduced to 0.546 S/cm in MI-PANI. The binding capacity of the imprinted nanoparticles was evaluated via re-binding adsorption experiments and the data fitted into the Langmuir adsorption mathematical model. K_D and B_{max} were calculated to be 0.6 ng/μL and 0.799 ng/μL respectively. The selectivity of imprinted nanoparticles was investigated by examining the adsorption characteristics of aldrin and DDT. The distribution co-efficient for DDT and aldrin were found to be 0.76 ng/ng and 1.31 μL/ng respectively indicating that MI-PANI exhibited much stronger binding affinity for aldrin than DDT.

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Preparation, Synthesis and property evaluation of Polyaniline-NiO nanocomposite thin films for detection of Formaldehyde.

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Keywords: Polyaniline, conducting polymers, NiO-PANI core-shell particles, volatile organic compounds, molecular sieve, band gap energy, morphology.

The current techniques developed for detecting gaseous formaldehyde (HCHO) requires elaborate procedures and are unable to give HCHO exposure data on a real-time basis. Instrumentation involved is often expensive and requires highly trained operators.Due to growing environmental concerns, the need for cheap selective gas sensors are becoming more valuable in any area where the measurement of concentrations of volatile organic compounds (VOCs) is required. HCHO is a VOC that is widely used in wood composites, adhesives, solvents and household materials. As a VOC, HCHO will continuously outgas from manufactured wood products and other household materials. It can be trapped inside buildings causing adverse health effects. Many polymer-based chemical sensors developed fail to distinguish between HCHO and acetaldehyde (CH_3CHO) especially in indoor air environments. Hence, the development of highly-selective HCHO gas sensor is significant in practical application. Polyaniline-15%NiO thin film was used as a transducer for detecting HCHO. The NiO nanoparticles were synthesized by sol-gel method. The functional groups and optical features of samples were characterized by, FTIR, Raman and UV-visible spectroscopic techniques. The surface morphology was investigated by AFM. Electrical property evaluation of the materials was done by use of a 4-point probe coupled to a source meter. From the UV-vis studies the band gap energy of NiO nanoparticles was found to be 4.06 eV giving the grain size of 25.1 nm. From XRD analysis the average grain size of NiO nanoparticles as determined by Scherrer formula was 25.0 nm. The SEM images of NiO nanoparticles were observed to consist discs that piled up to rods of agglomerated particles.The selectivity of the sensor was investigated by exposing the sensor to mixtures of HCHO and CH_3CHO vapours. The sensor showed selectivity towards HCHO with a minimum detection limit of 0.07 ppm. The sensor response time was within 30 seconds.

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RF sputtered Li-doped ZnO thin films: The effect of annealing temperature

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Keywords: Zinc Oxide, Thin films, Doping, Sputtering

RF magnetron sputtering technique was employed to deposit Li-doped ZnO thin films onto quartz substrate. The films were annealed at various annealing temperatures (RT to 800°C) under oxygen atmosphere. X-ray diffraction (XRD) analysis revealed that the deposited films had a hexagonal-wurtzite crystal structure with preferred orientation along the *c*-axis. As the annealing temperature increased from RT to 800 °C, the crystallite size of the films is becoming higher. From Atomic Force Microscopy (AFM), the root mean squares of the average surface roughnesses for the films annealed at various temperatures under oxygen atmosphere were obtained. The energy band gap of the films showed slight dependency on the annealing temperature. A Hall mobility of ~13.2 cm^2/V-s, concentration (n) of $\sim 7.6\times 101^{9} cm^{-3}$ and resistivity of ~112.7Ω-cm were obtained for the film annealed at800°C. The slight improvement in the electrical properties was attributed to the increase in the crystallite size. The results show that the annealing temperature plays a crucial role in the structural, morphological, optical and electrical properties.

Rhodium Nanoparticles green synthesis via natural plant Extract; The main physical properties

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Keywords: Rhodium Nanoparticles (Rh NPs); Green synthesis; Biosynthesis; Natural extract**.**

This contribution report on the synthesis of Rhodium nanoparticles (Rh NPs) synthesized for the 1st time by a completely green process using natural plant extract as an effective bio-oxidizing/bio-reducing agent as well as a capping compound. Their morphological, structural, and optical properties were investigated using various complementary surface/interface characterization techniques such as HR-TEM, HR-SEM, EDS, XRD, XPS and UV spectroscopy. The results confirm the formation of quais - monodisperse spherical Rh NPs in the range of 0.8-1.6 nm. The crystallographic phase of the annealed Rh NPs was face-centered cubic (fcc) phase structure with crystallites size around 3.5 nm. The chemical valence state and the optical properties for the prepared Rh NPs was investigated.

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Short-Period Superlattices in THz cavities

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Keywords: superlattice, tunneling, THz optical cavity

The effect of THz optical cavity on the resonant and non-resonant tunneling in short-period superlattices was observed. The MBE grown InAs/AlSb and GaAs/AlAs SLs consisted, respectively, of 60 and 100 periods sandwiched between heavily doped cap layer and the substrate. The doping level of the SLs was 5×10^{16} to 2×10^{17} cm^{-3}. Ion beam etching and conventional photolithography were used to fabricate the mesa structures. The metallic contacts to the structure had the form of a ring and formed a distributed cavity for a free-space wavelength of 110 to 160 μm. The ring resonator can support the excitation of so-called whispering gallery modes having sufficiently high quality factor Q. The electric field is directed across the SL layers and electromagnetic waves should propagate along the ring perimeter. Rectangular or triangular voltage pulses of 0.2 to 10 μs duration were applied to the sample. The measurements were performed mainly at room T. The periodic maxima were observed in current-voltage characteristics of resonator SL structures at the non-resonant tunneling [11] (at voltages outside the region of miniband transport, when the overlapping of ground confined states in the neighboring QWs disappeared). The distances between the maxima correlated with the energy difference of sequential resonances of the cavity. The equidistant maxima in I-V curves were explained by the Purcell effect – the enhancement of spontaneous emission rate for optical transitions between confined levels within QWs at resonant frequencies of the cavity. The effect of the optical cavity is observed also in the region of miniband transport at moving domain formation. A change of the cavity quality in this case led to a change in the shape of I-V curve. The reason for this change can be the high enough alternating field generated in the cavity, which shifts the operating point due to the rectification of ac field because of strong nonlinearity of the SL. This result points at the excitation of THz cavity by the negative resistance of SL with electric domains.

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Smallest spherical nanoparticles of molecule-based conductor: $TTFCl_{0,77}$

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Keywords: Molecule based conductor, Nanoparticles, neutral amphiphilic molecule.

Molecule-based conductors have been widely studied as single crystals (millimetric size) or crystalline powder. The decrease in crystallite size, in the nanometer range, allows envisaging totally different physical properties from those of "macroscopic" crystal. Spherical nanoparticles of molecular conductors are very rare. The spherical shape constitutes a "challenging" morphology for compounds which naturally grow as needles or wires due to their quasi-one-dimensional character. In this work, nano-objects of $TTFCl_{0,77}$ (Figure 1) are prepared by electrocrystallisation in the presence of two types of neutral amphiphilic molecules (amines or imines with a long carbon chain). In the case of amine, the dodecylamine lead to well dispersed spherical nanoparticles with size between 5 and 20 nm. In presence of a functionalized imine on a heterocycle, well-dispersed spherical particles have been prepared. The best results and the smallest nanoparticles were obtained using N-octylthiophenylimine (diameter below 12 nm).

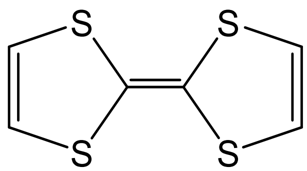

Figure 1: Molecular Formula of tetrathiafulvalene (TTF)

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Structural Modification and Band Gap Tailoring of Zinc Oxide Thin Films using Copper Impurities and its Photoelectrochemical Solar Cells applications

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Keywords: Cu impurities, Cu-doped ZnO, bandgap, surface morphology, chemical bath deposition

The doping effects of Cu impurities on structural, morphological and optical (band gap as well as absorbance and transmittance) properties of ZnO thin films have been investigated via chemical bath deposition (CBD) technique at 353 K bath temperature and a pH of 11.5 with post-deposition annealingat 673 K. The concentration of Cu in ZnO was varied between 1- 5 at.%. The synthesized Cu-doped ZnO (CZO) thin films were identified with hexagonal wurtzite structure, showing strong preferential growth of high intensity in the (002) crystal plane for3 at.% Cu concentration and sharply diminishing intensities for 1 and 5 at.%. A shift in angular peak position of 0.545^{o}in 2θ towards higher angle was observed for all CZO films.Crystallite sizes in the range of 8 to 32 nm were estimated in the (002) crystal plane.Optical studies indicates a red shift in the absorption band edge up to 450 nm upon Cudoping and high transmittance in the range of 60% to 90% was observed in the visible range of 400 nm to 800 nm for undoped and doped ZnO film samples. Optical energy band gap was found to vary from 3.03 eV for undopedZnO to 2.7 eV upon Cu doping. Scanning electron microscope images of the films revealed surface morphologies that varied from densely oriented nanodendrites to dense and vertically allignednanorods with high surface roughness. These morphologies are very suitable for photoelectrochemical solar cell, gas sensing and super capacitor applications. Surface wettability assessment of the films indicated that all the films were hydrophilic giving water contact angles in the range of 15.2-71.3^o. The water contact angles showed strong dependence on the concentration of Cu in ZnO and also decreased considerably upon annealing.

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Structures and Energetics of the Hydroxyl (OH) and Methyl (CH_3) adsorbed intermediates at Au(001) surface

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Keywords: Density functional theory calculations, Chemisorption, Gold.

The adsorption properties of the hydroxyl and methyl intermediates are calculated on the (100) facet of gold using periodic, self-consistent, density functional theory calculations (DFT-GGA) at different coverages: 0.25 ML, 0.50 ML, 0.75 ML and 1.00 ML for CH_3, and 0.25 ML and 0.50 ML for OH. For each species, we determine the optimal binding geometry and corresponding binding energy. It was found that OH was adsorbed on the top, bridge and hollow sites, while CH_3 was adsorbed only on the top site. For CH_3 radical, we found that the largest adsorption energy is at 0.25 ML (2.423 eV/CH_3) for a five-layers slab of Au(100) surface. The bridge site is also energetically the most preferred site for adsorbed OH on Au(100) surface for all coverages and for a four-layers (or five-layers) slab of Au(100).

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Study for Synthesis combined with composite sintered ring for use in vehicle engine part

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Keywords: Engine part, Sintering, Aluminum, Infiltration, Casting method

Auto industries have made attempts to reduce car weight. One of the ways is to reduce the weight of automobile parts. In this paper, a new synthesis method of making a highly functional sintered ring on an engine is proposed to replace cast iron rings which are currently being used. The ring will have better properties, in terms of its lower weight and better wear properties. The proposed synthesis method is to form a ring shape by sintering the mixture of iron and copper powders in a vacuum furnace, and to infiltrate the sintered ring with aluminum melt. The porosity in the rings will be around 40%~ 60%. The reaction between the melt and the sintered iron, during infiltration, will form new phases which will improve the interface properties between them. The microstructures will be analyzed and the new phases identified. A casting process that the ring and an engine block are cast as one body is also addressed. This process will make a ring with reduced thermal fatigue properties between the ring and the engine.

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Surface Acoustic Waves for Nuclear Magnetic Resonance Spectroscopy

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Keywords: NMR, Acoustics, Technique Development, Thin films, Nanoscience

Nuclear Magnetic Resonance (NMR) spectroscopy is a highly selective probe of local chemical environments, making it one of the most powerful tools for following processes and sensing on the nanoscale. However, owing to the very small differences in magnetic field-induced nuclear spin populations at room temperature, NMR is an inherently insensitive technique. Current NMR systems using inductor coils for radiofrequency excitation and detection further limit the sensitivity with their large resistive noise. This can complicate or even prohibit the acquisition of NMR spectra for small sample volumes or interfaces, which are integral to many nanoscale systems and processes – such as those in electrochemical devices. Current methodologies are aimed at bulk systems and are unsuitable for nanoscale surface measurements. This poster presents an NMR methodology based in the use of piezoelectromagnetic surface acoustic wave (SAW) devices. SAW devices comprise piezoelectric crystals coupled to electromagnetic resonators, thereby enabling acoustic excitation and detection of NMR signals in nanometre regions above the device surface through nuclear-acoustic coupling. This highly localised excitation/detection approach will enable the study of nanosystems, devices and surface chemistries, with a focus on electrochemical processes. SAW devices are limited only by thermal noise and thereby representing a drastic improvement in sensitivity over conventional NMR hardware.

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Synthesis and crystal structure of $NaMnCo_2H_2P_3O_{12}$

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Keywords: Hydroxyphosphate ,Single-crystal , Hydrothermal method, Structure resolution

A new hydroxyphosphate, $NaMnCo_2H_2P_3O_{12}$has been synthesized by hydrothermal method and its structure solved by single-crystal X-ray diffraction. The compound crystallizes in the monoclinic space group C2/c with the unit cell parameters a = 11.945(6) Å, b = 12.134(6) Å, c = 6.549(3) Å and β = 114.265(5)°, Z = 4, V = 865.4(7) Å^3. The structure parameters were refined to a final R_1/wR_2 = 0.0229 / 0.0547 for 1162 observed reflections. The structure of $NaMnCo_2H_2P_3O_{12}$ consists of a three dimensional (3D) framework built up from [MO_6] (M = Mn, Co) octahedra and isolated [PO_4] tetrahedra. The [MO_6] octahedra share edges and form infinite chains along the c axis (fig. 1). These chains are linked by corner-sharing PO_4tetrahedra. The framework defines two types of channels running along the [001] direction where sodium and hydrogen ions are located.

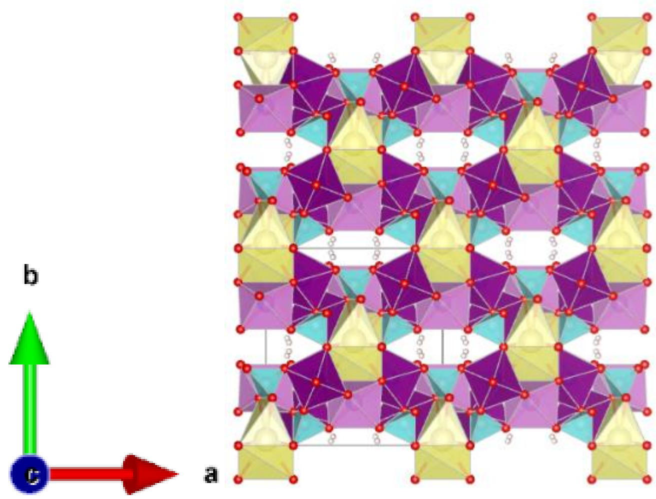

Figure 1.Projection of the structure of $NaMnCo_2H_2P_3O_{12}$ in (a, b) plane

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Synthesis and characterization of cassava bark nanoparticles

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Keywords: bark, cassava, characterization, nanoparticles, synthesis

Nanoparticles which have unique properties and have very wide range of applications. Synthesis and characterization of cassava bark nanoparticles (CBNPs) was carried out using ball milling at 36, 48, 60 and 72 hours. The morphology study was done using SEM and the Gwyddion software was used to determine the particle sizes from the SEM images. The particle sizes range for the un-milled cassava back (CB) was between 1.25 ± 0.06 to 19.92 ± 1.00 µm, while after milling for 36, 48, 60 and 72 hours the average particle size were 4.07 ± 0.20, 4.00 ± 0.20 µm, 80.90 ± 4.05 nm, 74.50 ± 3.73 respectively. 13.68 ± 0.68 nm was obtained by XRD using Scherrer equation after milling for 72hours and the XRD results reveal the presence of compounds such as SiO_2, $CaCO_3$ and $KAlSi_3O_8$. Furthermore, TEM was used to determine nanoparticles after milling for 72 hours and the particle size ranged from 9.73 ± 0.49 to 114.60 ± 5.73 for cassava back nanoparticles (CBNPs), EDX results showed trace element of Si, Ca, K, Fe, Al, O in the CB milled for 72hours.

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Synthesis and characterization of titanium dioxide

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Synthesis of titanium dioxide nanoparticles was done at room temperature (~22°C) by the use of sol-gel method. The titanium precursor used was Titanium tetrachloride ($TiCl_4$) which was added ethanol under a fume hood. After stirring for several hours, the gel as formed. The gel was aged and vibrated using the ultrasonicator. The sol-gel was dried and calcined at different temperatures. An anatase phase of titanium dioxide nanoparticles was formed after using the sol-gel method and different calcination temperatures. The synthesized titanium dioxide nanoparticles were validated by the use of X-Ray Diffraction analysis. The anatase phase of the titanium dioxide was confirmed present after the XRD patterns were compared to literature. From the characterization techniques used, the sizes of the nanoparticles was confirmed to exist between 1-100 nanometers.

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Synthesis and physicochemical characterization of Na_2O - MgO - P_2O_5 glasses

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Keywords: Phosphates, Glass, DSC, XRD, Raman

Phosphates glasses have potential in a variety of applications such as biomaterials for tissue regeneration, nuclear waste storage, and photonics. The present work reports the synthesis, structural characterization, chemical stability and thermo-chemical study of (50-x)Na_2O-xMgO-(50-x)P_2O_5 glasses, belonging to $NaPO_3$-$Mg(PO_3)_2$ meta-phosphate line of the ternary system, characterized by a constant O/P ratio = 3. The glass samples were prepared by the conventional melt quenching technique, in Pt crucible, in air, at 800 - 1000 °C depending on compositions. They were then poured in a graphite mould, at room temperature. The glasses are colourless. They have been characterized by density measurements, DSC, XRD, Infrared, Raman, chemical stability and by thermo-chemical study. Density measurements were made using standard Archimedes method. The molar volume was calculated from the molecular weight and density. The density increases slightly and the molar volume decreases as magnesium replaces sodium. This behavior is probably due to the conservation of the structure, formed by metaphosphate chains, as shown by Raman spectroscopy. The molar volume variation may be due to the substitution of a large ion Na^+ by a small one Mg^{2+} and also by replacing Na-O bonds by Mg-O bonds, which are more covalent. DSC was used to obtain the glass transition, crystallization and melting temperatures (T_g, T_c, T_m). The value of T_g increases when MgO replaces Na_2O, indicating an increase in the strenght of the glass network due to formation of covalent P-O-Mg linkages. Powder X-ray diffraction analysis of glasses heated at T_c shows the formation of only metaphosphates. Raman spectra don't show any significant change with an increase in MgO content, indicating conservation of metaphosphate chains in all glasses, similar to those observed in vitreous $NaPO_3$. The effect of MgO addition on the chemical stability was studied. The dissolution rate of the glasses in water decreases when MgO content increases, so the addition of MgO enhances the chemical stability. Thermo-chemical study shows that the dissolution phenomenon is endothermic for a lower MgO content and becomes exothermic when magnesium oxide is gradually incorporated.

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Temperature dependency on the synthesis of titanium dioxide particles from Ghana's Ilmenite Ore

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Keywords. Titanium dioxide, ilmenite, hydrolysis, x-ray diffraction.

This paper presents the study of the influence of temperature on the synthesis of Titanium Dioxide particles from ilmenite deposits in Ghana using the sulphate processing method. The ilmenite was ground to less than 100 µm and reacted with sulphuric acid to leach the titanium from the ilmenite sample. The resulting product was hydrolyzed to form titanyl sulphate and calcined at different temperatures. The calcined TiO_2 were characterized with X-Ray Diffractometry and the results showed evolution of sharp peaks as a function of calcination temperatures. For instance, temperatures between 600 and 700^{o}C produce the rutile phase of titanium dioxide. The implications of the results are further discussed to influence the selection of process parameters in the synthesis of TiO_2 from the locally available ilmenite ore deposits for industrial applications.

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Transport Phenomena in Carbon Materials at High Pressures

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Keywords: carbon materials, high pressures, transport phenomena

Temporal dynamics of impedance, d.c. conductivity and thermal e.m.f. of fullerite C60, single-wall carbon nanotubes (SWNT), graphite and graphene have been studied at pressures up to 50 GPa at room temperature. The transport phenomena were used as a tool for finding and interpretation of phase transitions arisen under high pressures. High pressures have been generated in the high pressure cell with synthetic carbonado-type diamond anvils. The anvils are good conductors and can be used as electric contacts making possible to measure temperature and pressure dependences of transport characteristics as well as their kinetics at changing pressure. The method used allows us to study the same sample at successive increasing and decreasing pressure and also to keep it loaded during a long time. Successive phase transitions of fullerite C60 appeared in the course of high pressure – high temperature (HPHT) treatment were accompanied by changes in resistance, which can be of quite different magnitude (from hundreds Ohm to hundreds MOhm) and of different temperature dependences. Critical pressures for the transitions depended on conditions and duration of preliminary HPHT treatment. This fact, as well as smeared character of the transitions is connected with long relaxation time, which was found to be about 140 min. The pressure-induced phase transition found in SWNT was attributed to a change in the shape of NT cross sections from round via elliptic to ribbon ones. The features of the phenomena studied found in graphite at the pressures of 15 to 20 GPa and at 30 GPa were ascribed to phase transitions at these pressures. The maximal values of resistivity relaxation times at changing pressure for graphite (~ 40 s) were observed near the phase transition points. The baric dependence of resistance for graphene has the similar form as that for graphite, while the resistance values of graphene are by almost one order of magnitude larger. The resistivity relaxation times after changing pressure for graphene turned out to be significantly larger than those for graphite. The relaxation times increased in the vicinity of phase transitions (15-20 GPa) up to ~10 min. The pressure dependences of thermal emf are similar for both graphene and graphite.

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ZnO sputter coating on SnO_2 nanowires

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Keywords: SnO_2, Nanowires, ZnO, Sputtering

The effects of thermal annealing on the structural and photoluminescence properties of SnO_2-ZnO core-shell nanowires were investigated. We observed that deposition process of ZnO by using an atomic layer deposition technique resulted in the SnO_2 core/ZnO shell structure. We have employed X-ray diffraction, scanning electron microscope, transmission electron microscope and photoluminescence (PL) spectroscopy to characterize both as-synthesized and ZnO-coated products. In particular, the as-prepared SnO_2-ZnO core-shell nanowires confirmed the presence of a smooth and continuous shell layer along the nanowire. The photoluminescence of the ZnO-coated products exhibited broad bands in the UV and green region, suggesting a possible contribution of the emission from the ZnO shell layers [Phys. Stat. Sol. (a) 205 (2008) 2002-2006].

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Computational Materials Science

A DFT/LDA study of pi-pi interaction in the case of PPV/SWCNTs and PPV/Graphene

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Keywords: DFT/LDA, Pi-Pi stacking, SWCNTs, Polyphenylene vinylene (PPV).

Interactions involving pi-pi species present a challenge both in experiment or theory. For theory, the complexity of these systems arises from the sort of methods actually employed to describe these non-covalent interactions with some authors totally describing these as solely van der Waals phenomenon whilst others consider it as a competition between many other forces of interaction [1]. Here, we show by using DFT/LDA (AIMPRO), one is able to describe correctly to some extent the interaction of these systems. We firstly considered the benzene-benzene dimer system followed by the interaction of the PPV with single-walled nanotubes of different chirality and diameter in comparison with PPV/graphene. We found that, there is a preferential orientation of the PPV which is slightly dependent on the binding energy calculated and this is driven by pi-stacking of PPV on these carbon materials (see figure 1), which is also confirmed by experiment [2].

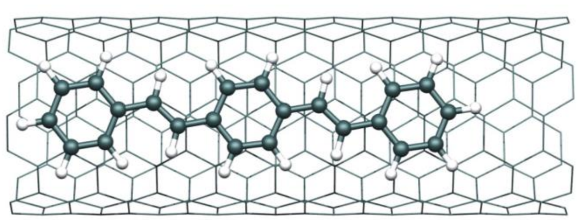

Figure 1. DFT model of PPV interacting with a (6,6) metallic nanotube in the most favorable orientation

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Bursting oscillations in the linear and nonlinear systems

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Keywords: Duffing oscillator, RLC circuit, electromechanical system, bursting oscillations

This works investigates the bursting oscillations in the systems. In first, the bursting oscillations in the linear and nonlinear systems are analyzed. It is found that the period, shape and amplitude depend on various control parameters. The experimental investigation using electronic components shows that the results are similar to these observed from numerical simulation. Secondly, the dynamical behaviors of mechanical system powered y bursting oscillations are performed numerically. The bursting oscillations have been found in the mechanical system. This work could pave the way for application in automation engineering and bio-engineering of artificial organs.

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Combined modeling and experimental approaches to innovative materials development in Africa

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Keywords: Modeling, Experiments, Innovative Materials Development, African Economies

The African continent is well endowed with lots of minerals and natural resources, yet most of its population (60-70%) live in rural communities and lack basic amenities such as affordable housing, transportation, and energy. For many of these rural communities, attainment of such needs by mean of modern facilities is long term and may never be achieved in the very near future. Alternatively, such basic needs may be addressed by means of innovative materials development via intrinsic and extrinsic modification of local raw materials. This paper highlights the importance of materials in the advancement of mankind and presents results of tests on some non-conventional composite materials and bamboo, in terms of their structures and crack-resistance behaviours. Data of experimental crack-resistance behaviour were compared with those of crack-bridging models and agreement between the two was very good. The objective is to show that by the use of *materials science* approach that combines modeling and experimental, innovative materials can be developed to meet basic needs of Africans, such as housing, energy and transportation. Education in *Materials Science and Engineering*, as well as, interdisciplinary approach to Materials Research is advocated. This is key to human capacity building and skills development necessary to integrate scientific and engineering efforts in innovation and development of materials towards the development and transformation of African economies.

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Comments on some transformation methods of PV solar cell's I-V Characteristics from their implicit forms to explicit ones

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Most of the times, an implicit form of the PV solar cell's I-V characteristic is used in the analysis of the electrical behavior of any circuit enclosing that electronic component. That analysis aims notably to determine the conductance at different points of the characteristic and then to extract component's model parameters such as the reverse saturation current (I_s), the ideality factor (n), the series and shunt resistances (R_s and R_{SH}, respectively). When numerical simulations are performed using the above mentioned form of the I-V characteristic, the process is quite slow. Explicit forms of that characteristic are in great demand, since simulations using them are about several tens fold faster than the previous ones. References on explicit forms of PV solar cell's I-V characteristics are rather scarce in the literature. The main objective of this presentation is an intercomparison of four selected techniques transforming those I-V characteristics from their implicit forms to explicit ones. Those techniques are namely: (i) the area's, (ii) the generalized area's, (iii) the trial function's and (iv) the Lambert W- function's methods, respectively. The analysis is conducted notably in terms of the device operating conditions, kind of solar cell's models and assumptions, related implicit forms of the I-V characteristics, derived explicit forms, outcomes' expressions, method's applications and further comments.

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Density functional theory study of surface relaxation, surface energy, work functions and effect of epitaxial growth of ruthenium on low miller indices of FCC nickel.

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Keywords: Relaxation; Workfunction; Electronic density of states; Density functional theory

Plane-wave density functional theory calculations with the Perdew-Zunger local density approximation (LDA) exchange-correlation functional and the Perdew-Burke-Ernzerhof (PBE) generalized gradient approximation (GGA) was used to study the bulk and electronic properties of nickel such as lattice constant, bulk modulus, cohesive energy, surface relaxation, surface energy and work function towards the use in nanoscale devices and catalytic application. Changes in these properties were noted as a function of increasing atomic layers. The results show that convergence of slab relaxations with respect to altering of inter layer spacing can be achieved with slab thickness that are greater than 8 atomic layers for a Ni-(100) surface and 6 atomic layers for a Ni-(110) surface structure. Ni-(111) surface structure experiences some oscillations on curve. The surface energy of the crystal reduces as a function of increasing slab thickness except in some peculiar cases or with a particular slab size where there are some anomalies which could be attributed to relativistic effects or quantum size effect (QSE). The work functions of low miller indices, (100), (110), (111), of fcc nickel crystal, computed using the finite slab approximation are observed to have a non-linear correlation with increasing atomic layers. Results of calculations of epitaxial growth of ruthenium *ad-atom* mono-layer deposition on fcc nickel showed that work function of the nickel slab is reduced and polarity is inducted on the nickel surface, enhancing electron mobility which is a characteristic property of materials as electrical contacts nanotechnological applications and a good catalyst according to the sabatier principle. This template could be used as a catalyst in Fischer-Tropsch Synthesis process well as in electronic components or systems as electrical contacts.

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Dental filling materials in the negative and near zero thermal expansion regime: *ab initio* study on ScF_3

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Keywords: Negative thermal expansion, Zero thermal expansion, Co-efficient of thermal expansion, dental filling

Computational prediction of novel materials for wide applications entails both numerical techniques and scientific intuition methods in combining elements in their formation. Cubic ScF_3 as a negative thermal expansion material has many applications that necessitate complimentary computational investigations for optimal use. There is hardly any experimental data on properties of ScF_3 at $T \leq 298.15K$ which now forms a basis of this research. This research intends to engage modern *ab initio* methods based on density functional theory (DFT) to study ScF_3 for acceptable prediction of the ground state configurations. The mechanical properties will be studied by calculating the Bulk modulus, the electronic properties will be calculated using the Bader topological analysis and the optical properties will be investigated by calculating the real and imaginary parts of the frequency dependant dielectric constant of ScF_3. Phase transition will be confirmed by molecular dynamic simulations and pair distribution function analysis while the Negative Thermal expansion property will be simulated in VASP using *ab initio* Born-Oppenheimer molecular dynamics. It is possible to obtain a near Zero thermal Expansion material by forming a composite with ScF_3 thus narrowing the gap between the NTE and the ZTE families. The Composite may be used for more innovative functionality such as making Cement and Ceramics, Electronic packaging industries, Fibre optics gratings, mirror substrates and more importantly dental filling materials. This research focuses on materials for dental filling since the current dental amalgams are made from Mercury which can potentially cause bronchitis and pneumonia. Current fillings tend to expand at different rates to that of the tooth hence causing tooth ache.

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Direct and indirect phase transition of refractory compounds

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We have performed first principles calculations to analyze the electronic structures and relative structural stability and pressure induced phase transformation of refractory compounds (transition metal carbides) from NaCl-type (B1) to CsCl-type (B2) via zinc blend phase using plane wave pseudopotential approach in the framework of generalized gradient approximation (GGA) for the exchange and correlation functional. The ground state properties, equilibrium lattice constant, bulk moduli and band structures are determined for the stoichiometry of the compounds and compared with known experimental and theoretical values. We find that, the phase transition pressure for the indirect phase transition from B1to B2 via zinc blend structure is about 17-fold for TiC, 12-fold for both ZrC and HfC respectively when compared with the direct phase transition. The band dispersion and electronic density of states for B1 and B2 phases were explored and found to indicate metallic character in contrast with the zinc blend phase, which has an opening in the band gap region suggesting a semiconducting behaviour.

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Doping effects on electronic structure and thermoelectric transport properties of cadmium oxide: First- principle calculations.

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Key words: Thermoelectric, figure of merit, doping.

Energy harvesting requires clean and highly efficient energy conversion technologies. Thermoelectricity is one such technology that achieves thermal-to-electric conversion and vice versa. Using density functional theory based on Quantum ESPRESSO and different exchange–correlation functionals, we computed thermal conductivity of both undoped and doped CdO with 3*d* transition elements. We predict manganese and zinc doped CdO has lower thermal conductivity and high figure of merit. We also report our results on the effects of doping on the elastic constants, bulk modulus, band structure and density of states of CdO.

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Dynamical processes effects on stratospheric ozone variations in Nigeria

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Keywords: ozone variations; dynamical processes; harmattan wind; ETSP; and climatic variability

The effects of zonal wind on stratospheric ozone variation over Nigeria have been studied. The areas covered in this study include; Sokoto, Maiduguri, Abuja, Ikeja, Port-Harcourt and Enugu in Nigeria, from 1997 to 2005. Zonal wind was computed from the iso-velocity map using a programme written with MATLAB software and thereafter, AAM and LOD were calculated using the equations adopted. The mean monthly variations of AAM and LOD at pressure levels of 20 and 30 mb in the atmosphere depict a definite pattern of maximum amplitude between July and August, and minimum amplitude between December and March. This is also the trend observed in the seasonal variation of O_3 column data in the low latitude. The mean monthly maximum O_3 concentrations was found to be 284.52 Du (Sokoto) occurring in July while, an average monthly minimum O_3 concentration was found to be 234.867 Du (Enugu) occurring in January. It has been established in this study that, the variation in atmospheric angular momentum (AAM) caused by variation of the universal time or length of day (LOD) transfer ozone (O_3) by means of zonal wind from the upper troposphere to the lower stratosphere in the stations understudy. The strong effect of the pressure levels of the atmosphere on O_3 variation could be attributed to its effect on the AAM and LOD. Variation in the LOD is significant in the tropics, suggesting that, the effects of the extra-tropical suction pump (ETSP) action is not the only driver responsible for O_3 transportation from the tropics to extra-tropical zones. Consequently, these findings lead to a deduction that weather pattern alteration observed due to these changes could lead to climate change.

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Effect of Nickel Monolayer Deposition on the Structural and Electronic Properties of the Low Miller Indices of (bcc) Iron: A DFT Study

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Keywords: Relaxation; Reconstruction; Workfunction; Electronic density of states; Density functional theory

Nickel and iron are active metal sites in the enzyme carbon-monoxide dehydrogenase (CODH) which reduces CO_2 to CO at ambient temperature and pressure. We investigated the thermodynamically preferred (surface and interstitial) sites for Ni monolayer deposition on Fe (100), (110) and (111) surfaces and the impact of deposition on the structural and electronic properties of the surfaces using the spin-polarized density functional theory-generalized gradient approximation (DFT-GGA) method. We also considered the effect of dipole correction and surface coverage on the ease of adsorption and workfunction. The workfunction of the clean Fe surfaces is found to be of the order (100) ~ (111) < (110) i.e. 3.80 eV ~ 3.84 eV < 4.76 eV respectively, including dipole correction to compensate for any false surface dipole is detrimental to the experimental workfunction trend of (100) < (110). The adsorption energies show that Ni adsorption is thermodynamically favored on the (100) and (111) surfaces and not the (110) surface with absolute value increase in the order (111) [-0.38 eV] < (100) [-0.28 eV] < (110) [0.57 eV]. The interaction of Ni with Fe is strongest on stepped Fe (111) facet and weakest on the most closed packed Fe (110) facet. Ni deposition reduces workfunction on only the (110) surface which implies enhanced electrochemical reactivity which has negative effect on corrosion resistance on that facet. Structurally, there is expansion of the first interlayer spacing (d_{12}) of all the Fe surfaces upon deposition which is not affected by coverage. These findings improve our understanding of deposited catalytic Fe surfaces and has important implication for developing improved Fe electro-catalysts for CO_2 activation and reduction.

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Electronic properties of the intrinsic isolated point defects in bulk TiO_2: an *ab initio* DFT+U Study

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Keywords: Titanium dioxide, Anatase, Band gap, Intrinsic point defects.

This study investigates the effects of the intrinsic point defects on the electronic band structure properties of bulk titanium dioxides anatase phase using the ab initio DFT+U method. Ab initio calculations were done using Quantum Espresso code, while GGA-PBE and plane wave based norm conserving pseudo-potentials were used. The calculated lattice parameters for the pristine super-cells were found to be in good agreement with other published studies differing by by about 2.5%. An indirect band gap of 3.01eV was observed for pristine supercell along the Γ to Z, high symmetry point. On introduction of isolated intrinsic point defects within the perfect super-cells, both bond length and angles were altered. In particular, the apical bond length changed from 1.956Å to values ranging between (1.783–1.831)Å while the equatorial bond length changed from 2.049Å to (2.112–2.212)Å. The Ti-O bond angle changed from the values of 103.87° and 152.32° to a new range of values (93.63-149.88)° and (156.74-176.11)° respectively. The electronic band structures were equally altered. Both Schottky and Frenkel defects introduced defect levels whose location depended on the defect type. Oxygen vacancy and titanium interstitial introduced n-type conductivity while oxygen interstitial and titanium vacancy introduced p-type conductivity in anatase. Frenkel defects introduced almost metal-like properties by almost "closing" the energy band-gap. The calculated defect formation energies (DFEs) showed that the formation of oxygen interstitials is the most favored due to its lowest value of DFE. As such, this study confirms that intrinsic point defects in anatase contribute to improved structure-electro properties of this material of interest for various industrial applications.

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Energy band structure studies of AlSb AND GaSb

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Keywords: Full-potential Linearized Augmented Plane Wave Method (FP-LAPW), Density Functional Theory, Generalized Gradient Approximation

The electronic and structural properties of zinc-blende AlSb and GaSb are calculated using the full-potential linearized augmented plane wave method. The exchange-correlation potential was calculated within the generalized gradient approximation using the Perdew-Burke-Ernzerhof scheme. Ground state properties obtained include equilibrium lattice constant, bulk modulus and its pressure derivative. The values obtained are presented and discussed in context with the available theoretical and experimental values with reasonable agreement.

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First-principles calculations of mechanical properties of Niobium Carbide and Niobium Nitride in the Rocksalt and Zincblende crystal structures

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Keywords: Hard materials, Transition metal carbides and nitrides, Elastic constants, Bulk and shear modulus, First-principles calculations

Transition metal carbides and nitrides have attracted a lot of attention in the research field due to their fascinating mechanical properties. This work focused on the bulk moduli, shear moduli and the elastic constants of niobium carbide and niobium nitride due to an earlier study, which found them harder than other 4d TMNCs. Theoretical calculations were performed using first-principles total energy calculations by applying the plane-wave pseudopotential density functional theory (DFT). The Generalized Gradient Approximation using Perdew-Burke-Ernzerhof method was used in this work to describe the exchange-correlation energy as implemented in the Quantum Espresso computer code. The results obtained were compared with other previous studies. Using the GGA calculations, it was found that the bulk modulus and C11 values for NbC and NbN in the RS structure were in good agreement with the experimental values and varied by 0.81% and 0.7434%, respectively, for NbN in RS. The results of C44 and C12 show variation in NbC and NbN. This study established that NbC and NbN exhibit high values of elastic constants and shear modulus when compared to experimental values which tend to describe their response under an external strain that may act on them. These results suggest that the two TMCNs are suitable for applications in ultra-hard metals and related industries. Keywords: Hard materials, Transition metal carbides and nitrides, Elastic constants, Bulk and shear modulus, First-principles calculations

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First-principles Density Functional Theory Study of Arsenic Immobilization by Al(III)-modified zeolite Clinoptilolite.

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Keywords: Clinoptilolite; Adsorption; Density Functional Theory (DFT), Arsenic species, Quantum-ESPRESSO

Clinoptilolite has been identified as a candidate for arsenic removal from water, but the exact adsorption sites, their relative stabilities and the characteristics of the environment where the arsenic is located within the zeolite framework still remains elusive. We also considered the effect of Si/Al ratio on the adsorption potentials of Al(III)-modified natural zeolite clinoptilolite. We present first-principles density functional theory calculations of arsenic acid $AsO(OH)_3$ and arsenous acid $As(OH)_3$ adsorption by Al(III)-modified natural zeolite clinoptilolite (CL) under vacuum and hydrated conditions. Density functional theory (DFT) calculations within the generalized gradient approximation (GGA) were carried out using the plane-wave pseudopotential PWscf code in the Quantum-ESPRESSO package using ultrasoft pseudopotentials with the PBE functional. The adsorption energies for both arsenic and arsenous acids on dehydrated CL zeolite (Si/Al = 1.7 - 8) at all the adsorption sites are favorable (7 – 252 kJ/mol, exothermic) except at the 8 MR in the (100) plane (site 3) for $AsO(OH)_3$ at Si/Al ratio of 5 and the site locate between the 8MR in the (001) plane and the 8 MR in the (100) plane (site 4) for $AsO(OH)_3$ at Si/Al ratio of 6 and 8. However, in the hydrated CL, the exothermicity is maintained only in the 8 MR in the (001) plane (site 2) and site 4 with increase in the extent of exothermicity (32 - 161 kJ/mol). The unfavorableness of the adsorption in the hydrated systems increases with increasing water molecules added. We attribute thus to the water molecules filling the pores in the zeolite, therefore leaving no space for the adsorbates to fit in. The strength of binding of the arsenic species is shown to depend sensitively on the Si/Al ratio in the Al(III)-modified CL zeolite, decreasing as the Si/Al ratio increases. The calculated high adsorption energies indicated a great potential for Al(III)-modified clinoptilolite for arsenic immobilization. This preliminary work improves our understanding of the role that Al(III)-modified clinoptilolite zeolite may play in the remediation of Arsenic contaminated sites and may help the development of reliable forcefields that can be employed in classical MD simulations to simulate complex systems

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Investigations of electronic and phonon mediated superconductivity of Rb and K doped graphene

Gebrekirstos Gebreamlak Berhe

Addis Ababa University, 2013

We performed ab-initio calculations on a novel class of superconductors, which comprise of alkali doped graphene. Pristine graphene is doped with the potassium and rubidium atoms. We theoretically studied lattice dynamics by performing density functional perturbation theory based simulations for studying doping effects on graphene's phonon modes. Spectra of electronic and phonon density of states are compared in between undoped graphene and potassium and rubidium doped graphene. Besides, the study of electron-phonon interactions is also performed and the significant amount of electronphonon coupling is found to be present among the potassium and rubidium doped graphene. That is attributed as one of the reasons for as-found induced superconductivity at certain crystal symmetry points of interest in Brillouin zone of this material, specifically, at the (Γ and k-points. The higher values of electron-phonon couplings of 0.3679 and 0.1907 correspondingly for the potassium and rubidium doped graphene are found to be responsible for the superconductivity. Nevertheless, during our calculations the el-ph coupling strengths for pristine graphene is always found to be zero at various special points. In addition, the prospects of the phenomena of superconductivity amongst the alkali doped graphene are discussed in detail.

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Quantum mechanical *ab initio* calculations of the structural, electronic and optical properties of bulk gold nitrides

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Keywords: Gold nitride, DFT, GW, optical properties

In the present work, the atomic and the electronic structures of Au3N, AuN and AuN2 are investigated using first-principles density-functional theory (DFT). We studied cohesive energy vs. volume data for a wide range of possible structures of these nitrides. Obtained data was fitted to a Birch-Murnaghan third-order equation of state (EOS) so as to identify the most likely candidates for the true crystal structure in this subset of the infinite parameter space, and to determine their equilibrium structural parameters. The analysis of the electronic properties was achieved by the calculations of the band structure and the total and partial density of states (DOS). Some possible pressure-induced structural phase transitions have been pointed out. Further, we carried out GW0 calculations within the random-phase approximation (RPA) to the dielectric tensor to investigate the optical spectra of the experimentally suggested modification: Au3N(D09). Within the accuracy of the employed methods, the obtained structural parameters and electronic properties show acceptable agreement with some of the available previous calculations. Among the studied modifications, we determined metallic and semiconducting phases. According to the fact that the experientally produced gold nitride phases are metallic, our DFT-GGA and GW calculations confirmed that D09 structure cannot be the true candidate for the Au3N stoichiometry that has been suggested by experimentalists. However, we found that the triclinic Au3N(TRI1b) modification possesses the leaset tendency to dissociate back into its constituent components Au and N2. We also found that Au3N(TRI1b) is relatively sensitive to external pressure and tends to increase its bulk modulus upon application of external pressure. From experiment, previous ab initio calculations, and from the present work, one may conclude that if Au3N is the true stoichiometry, it must have a metallic character only at low crystal symmetries.

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Radiation Damage Effects in Miniature Neutron Source Reactor Fuel Cladding: Ghana Research Reactor 1

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KEYWORDS: Monte Carlo Transport Code, MCNPX, Specter Code.

Irradiation of miniature neutron source reactor support structures with neutron particles from fission of uranium-235 in the reactor core, can alter the mechanical properties of the support materials. Damage to materials caused by neutron irradiation is an inherently multi-scale phenomenon. Macroscopic properties, such as brittleness, creep behaviour, hardness and plasticity, of structural reactor materials may change due to microstructural effects of radiation. This work will use simulation of series of codes as a guide to predict possible changes in the material properties in the reactor over time. Having simulated the radiation effects on the fuel cladding will help address safety concerns in the operation of the reactor. Monte Carlo Transport Code (MCNPX) will be used to model the interaction of neutrons emitted from the fuel pellets in the reactor core with the aluminium cladding. Parameters (i.e. neutron flux, the energy deposited in the material and neutron energy per source neutrons) calculated using the MCNPX code is transferred unto a subsequent models (SPECTER code) to calculate the rate of displacements per atom (i.e. DPA) and the average primary knock-on atom (PKA) energy. A DPA between 103 and 21 was determined in the aluminium cladding. The maximum 103 DPA value was determined when the reactor was assumed to operate for five hours a week since it first operation and the 21 DPA was when the reactor was assumed to operate at one hour a week till now. An average PKA energy of 0.13MeV was determined in the cladding material. The DPA and PKA values are further used (although not discussed in this paper) to determine the long term radiation induced effects within the material.

Soy based nanoemulsion of Griseofulvin: Formulation antifungal, stability and toxicity assessment

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Keywords: Nanoemulsion, Griseofulvin, Antifungal activity, Toxicity, Stability

Griseofulvin, a fungistatic agent with poor aqueous solubility and bioavailability was formulated as a nanoemulsion using a simple homogenization technique, soya bean oil, soya lecithin and distilled water. Highest concentration of the drug in the lipid was achieved by optimization. The nanoemulsion was characterized by determining the particle size and size distribution, and antifungal activity against *Candida albicans*, *Aspergillus niger*, and *Trichophyton rubrum. In vivo* antifungal activity was determined with *A. niger* by establishing systemic mycosis on male Wister rats. Commercial brand (a suspension) of the drug at 10 mcg/g and 0.77 mcg/g of the nanoemulsion was administered orally. The percentage parasitemia by microbial count was determined. The nanoemulsion was characterized by electrical conductivity, pH, toxicity and stability parameters. Effects of the nanoemulsion on the haematopoietic system, liver as well as histopathology were examined. Stability study of the nanoemulsion was also performed. The optimized formulae had oil to surfactant ratio of 7:3. The drug concentration of the nanoemulsion was 0.48 µg/ml. The *in vitro* antifungal activity showed that the nanoemulsion was more active against all three organisms at a much lower dose (0.48 µg/ml) than the commercial preparation (25 mg/ml). *In vivo* antifungal activity showed that the nanoemulsion produced a significantly reduced parasitemia compared to the commercial suspension. The stability parameters including average drop size of 150.3 ± 2.23 nm, pH of 6.30 ± 0.00, conductivity of 84.00 ms/cm ± 0.58 and viscosity of 0.89 cP ± 5.05 did not differ significantly after 90 days. Griseofulvin nanoemulsion is a potential new formulation of griseofulvin with improved activity and lower toxicity than the available commercial suspension.

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The effect of nitrogen doping on the structural, electronic and optical properties of hexagonal and cubic $Ge_2Sb_2Te_5$: an *ab initio* study

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Keywords: $Ge_2Sb_2Te_5$, nitrogen doping, optical conductivity, reflectivity contrast, PCRAM.

$Ge_2Sb_2Te_5$ (GST) has been successfully applied in optical phase change memory and is being considered for application in non-volatile electronic memory (PCRAM). Although pure GST has shown enhanced properties in terms of thermal stability and speed of transition, numerous efforts have been directed towards improving further its physical properties with the aim of obtaining optimal performance. For example, the issue of a large writing current needs to be addressed if meaningful commercialization PCRAM is to be achieved. Also, a main driving force for the search in new materials is to decrease the wavelength of the laser used for writing, reading and erasing bits. By reducing the wavelength, the size of the written bits are decreased and the storage capacity is increased. The effect of nitrogen doping on the structural, electronic and optical properties of hexagonal and cubic $Ge_2Sb_2Te_5$ (GST) has been investigated from first principles. The nitrogen content was set to 10 and 25 at. %. It was found that the hexagonal phase becomes more stable while the cubic phase becomes more unstable with increasing nitrogen content. A difference in reflectivity of about 8% was calculated for pure hexagonal and cubic phases. Pure GST was found to have a higher reflectivity contrast in the infrared spectral range whereas nitrogen doped GST had a higher reflectivity contrast, which increases with rising nitrogen content, in the ultraviolet region. The optical conductivity of both phases was found to decrease with increasing nitrogen content, in agreement with experiment and other theoretical studies.

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The Role of Stress-Assisted Dissolution of Topical Silica Layer on the Fatigue Failure in Silicon MEMS Structures

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Keywords: Crack nucleation, fatigue, silicon micro-electro-mechanical-systems (MEMS), SiO_2 layers, stress-assisted dissolution.

This paper presents an analytical and computational model for the study of fatigue crack nucleation in silicon micro-electro-mechanical systems (MEMS) structures. A finite element analysis is performed to study the role of stress-assisted dissolution on the formation and growth of cracks in the topical SiO_2 layer on the silicon MEMS structures. The possible formation and growth of cracks by such dissolution was elucidated and compared with measured surface profiles from prior work. The measured surface topologies obtained using Atomic Force Microscopy (AFM) is also compared with predictions from linear perturbation analysis of the stability of surface topology that evolves during stress-assisted dissolution of the silica layer. The implications of the results are then elucidated for the design of reliable Si-MEMS Structures.

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Use of BP based algorithms to predict yarn tensile strength

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Keywords: Cotton, Ring Spinning; Tensile, Backpropagation (BP), Differential Evolution (DE); Particle Swam Optimization (PSO)

Although gradient based backpropagation (BP) training algorithms have been widely used in Artificial Neural Networks (ANN) models for the prediction of cotton yarn properties, they still suffer from serious drawbacks which include lower learning speed and tendency to converge to local minima. The design of hybrid algorithms has been suggested as one of the approaches which can be used to solve the above mentioned problem. This paper will concentrated on the use of hybrid models designed from Levenberg-Marquardt Backpropagation algorithm (LMBP) and Differential Evolution, christened (LMBP-DE) and LMBP and Particle Swam Optimization (PSO), christened LMBP-PSO. Ring spun cotton yarn strength was predicted using the designed models. The performance of models trained using LMBP was also evaluated for comparison performance. The results obtained in this research work indicated that in terms of speed (training time) and performance (mse value) the hybrid algorithms performed better than the LMBP algorithm. LMBP also showed a higher CV of mse values which could imply that it was more prone to getting stuck in local, minima than the hybrid algorithms.

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Materials Education and Networking

AMSEN – Past, present and future

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DST-NRF Centre of Excellence in Strong Materials, University of the Witwatersrand, Johannesburg, South Africa

Keywords: Networking, Education

The African Materials Science and Engineering Network (AMSEN) is funded by the Carnegie Corporation of New York, and started operation in 2009. The six AMSEN Nodes are: University of the Witwatersrand, South Africa; University of Nairobi, Kenya; University of Namibia; Federal University of Technology, Akure, Nigeria; University of Botswana, and since 2014, the University of Ghana. There are also "satellite" institutions which have benefited: Jomo Kenyatta University of Agriculture and Technology in Kenya, Tshwane University of Technology in South Africa and recently, the Cape Peninsula University of Technology, also in South Africa, which has widened the networking. Nine PhD and six MSc students have graduated across all the Nodes, with more in the pipeline. Over 60 journal papers have been published, with many conference contributions. With very few exceptions, the students are co-supervised across the Nodes. The AMSEN Workshops, usually held every other year, have been hugely beneficial for networking, because this is the only time that almost everyone can get together, and share ideas. The Nodes report on their work, and all the students present in a formal conference-type setting, with a proceedings volume. Much of the direction for the development of the training workshops of AMSEN came from the 1st AMSEN Workshop. Training within AMSEN uses AMSEN's own resources, as well as those of the home universities and also external contacts. The graduates have either gone back to work in their home institutions, or have gone on to further work in the field. Many of the supervising staff have also been promoted, because AMSEN has also allowed them to progress, by funding the students, providing running costs, some equipment and also facilitating exposure of their research work. Therefore, AMSEN has really helped to develop the next generation of academic researchers in Africa, and is looking for ways to continue.

New frontiers for African Materials Science and Engineering

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This paper presents a perspective of the role that materials science and engineering can play in the development of Africa. Following a review of the materials and energy resources of Africa, the talk highlights the opportunities for the development of new materials that address the basic needs of Africa in the areas of health, energy and the environment. In the area of health, low cost nano-science approaches are presented for the detection and treatment of disease. Selected examples are presented for the detection and treatment of cancer and cardiovascular disease, which are two of the biggest killers of people in Africa. New and emerging approaches to energy harvesting and storage are also elucidated. These include: low cost solar cells; light emitting devices; thin film batteries/super-capacitors, and bamboo wind turbines. The paper then presents new ways of using our basic understanding of mechanical properties in the design of a new generation of sustainable, environmentally-friendly building materials that recycle waste materials into wealth and wellbeing. The paper concludes with some suggestions of how the African/global materials community can work together with the African Materials Research Society (AMRS) to make materials science and engineering the engine for African development.

Technical education – The key to sustainable technological development

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Keywords: Technical education, sustainable development, economic development, skilled manpower, industrialization, technological development

Technical education has been identified as one of the most effective human resource development that needs to be embraced for rapid industrialization and sustainable technological development of any nation. Technical education has been an integral part of national development in many societies because of its impact on productivity and economic development. This paper discusses the dearth of skilled technical manpower in Nigeria and its effect on the technological development of the nation. It advocates for a comprehensive revitalization of technical education in Nigeria to promote workforce partnership needed to develop innovative approaches or replicate models that operationally demonstrate how a demand-technological the society needs. Efforts and ways by both the government and individuals to train and produce the required manpower for the achievement of vision 20, 2020 objectives were also suggested by the authors.

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The role/importance of engineering materials utilization in present day world

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Materials had been in use since time immemorial. Our world is all about materials, which is why Materials Science and Engineering are taking prominence and centre-stage position in many developed and developing countries. Over the years there have been changes in man's choice of materials for his engineering activities. The ages and times/period of man's activities on earth are sometimes usually referred to by age and period when such materials were in vogue like the Stone Age, the Iron Age and the current Silicon age, etc. However, the challenges of current world are constantly fuelling the discovery and development of new kinds of materials with the desired properties and the right cost to meet the challenges of the current day world. This article is, therefore, aimed at reviewing the advances made in engineering materials, their classification and the role/importance engineering materials in current day world vis-a-vis their properties and areas of application.

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A technoprenuers and energy sustainability through biomass gasification

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Keywords: Technopreneurship, Gasification, Biomass, Innovation, R&D

About 81% percentage of the world population does not have access to electric energy in quantity significant enough to positively impact their life and support economic development. To argument for this energy shortfall generators powered by petroleum are used but the cost of these petroleum fuels limits their widespread use. In these countries a lot of organic waste (biomass) is been generated from agricultural activities which is the mainstay of these developing countries. These wastes could be a source of wealth especially in sustainable energy projects such as gas and electricity generation. These can be an opportunity for technopreneurs to fill the energy gap of these countries. The gasification of carbon-containing materials to produce combustible gas is an established technology. This was popular in the years before petroleum fuel became the cheapest fuel for energy generation. However recent concerns of environmental sustainability have refocused attention back to gasification. This is where technopreneurs in these countries can key into owing to the fact that biomass gasification designs are available. They only need to choose the appropriate design that suit the specific need of their society with the aim of channelling R&D to it and bring such designs to fruition .This will solve the power problem and convert waste to wealth and conserve the environment. This paper seeks highlight the gains of biomass gasification, as technopreneurs go beyond studies and reviews to practical application of electricity generation through biomass gasification.

Activated carbon derived from ginger bagasse for high performance supercapacitor

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Keywords: Biomass, Activated carbon, Supercapacitor, Energy storage, $ZnCl_2$ activation

The contribution of the developing countries in resolving the energy crisis will be more efficient by taking advantage of readily available and abundant raw materials that could be converted in refined products using low-cost and environmental friendly processes. The African continent has abundant biomass, especially waste generated from different extraction processes that could be used as precursors for the manufacture of activation carbon, for example. As a proof of the concept, ginger bagasse was considered as source of activated carbon for supercapacitor application. Two synthesis routes were explored: the direct activation with $ZnCl_2$ and the hydrothermal treatment of the ginger bagasse in HCl followed by activation in $ZnCl_2$. The symmetric cells made from the obtained activated carbons operate in a wide potential window of 1.6 V in 6 M KOH aqueous electrolyte. The activated carbon synthesized from the direct method shows higher electrochemical performance with a specific capacitance of 70 F g^{-1} compared to 60 F g^{-1} at a current density of 1 A g^{-1} for the hydrothermal treated ginger bagasse. Both cells exhibit excellent stability after 120 h of floating. Explicitly, the cell made from the direct activation process stabilised very quickly at 90 F g^{-1} after 30 h while its counterpart shows a continuous increase in specific capacitance from 60 F g^{-1} to 90 F g^{-1} with increasing time up to 120 h. These two stability behaviours will be explained in term of the different functional groups that could arise from the two synthesis processes. The results obtained show the potential of the use of biomass for the low cost production of activated carbon for supercapacitor application.

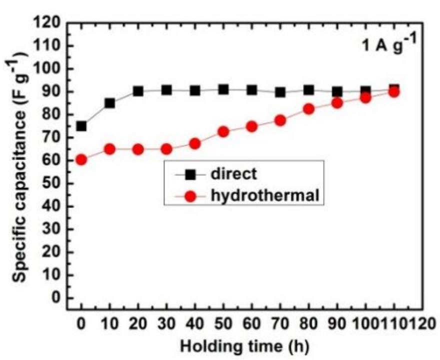

Figure 1: floating for 120 h for symmetric supercapacitor cells derived for ginger bagasse

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Bending of pre-buckled organic solar cells

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KEYWORDS: Buckling, flexible organic solar cells, finite element modeling, design

This paper explores the extent to which the pre-buckling of layers (in thin film multilayered structures) can be harnessed to make flexible electronic structures for organic electronic devices. The deformation of buckle profiles, with a range of nano- and micro-scale wavelengths, is modeled using finite element simulations of the bending of layered structures that are relevant to flexible organic solar cells. The introduction of the pre-buckled profiles is shown to increase the range of deformation that applied to model structures, prior to onset of significant stresses and strains. The implications of the work are discussed for the design of robust flexible organic solar cells.

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Bio-flocculants from the extracts of ashed leaves of African almond tree and seed pods of bride of Barbados as harvesters of micro algae from fish pond waste water fro biofuel production

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Keywords: bioflocculants, pride of Babadoos, African Almond, Pawpaw, Banana, palm frond,bioash

Harvesting of microalgae from ponds and other aquatic media have been the costliest aspect in the establishment of an algae economy. Attempts have been made by scientist world over at developing cheap, feasible and ecofriendly methods for solving this problem. This paper presents another attempt using waste and natural materials in harvesting algae cultures from waste aquatic media. Leaves of African almond tree and seed pods of bride of Barbados tree were collected and burnt in an open system. The ash generated were soaked in calculated amount of distilled water (pH 7.0), for 24Hrs. The filtrate obtained was used in the flocculation and sedimentation investigation at different concentrations and volumes. The results obtained showed that at the same volume of water (1Ltr), filtrate pH values were Pawpaw leaves (10.7), Banana leaves (10.8), Banana stem cutting (11) and Palm frond (10.9). The concentration of the extracts and volume used has a direct relationship with the precipitation rate and sediment height as measured with a meter rule. There was observed difference in product colour and density with the later expressing the nature of material flocculation rate in relation to flocculants concentration. The species present in the aquatic medium were identified using standard method of identification of micro-organism.

Cadmium Zinc Telluride Ternary Semiconductor Compound Thin Films for Energy Applications

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Keywords: CdZnTe thin films, closed space sublimation, conductivity, current, resistance.

The research paper is based on the growth of CdZnTe thin films by thermal evaporation technique using layers method. Deposition parameters are optimized like for growth of CdTe semiconductor material layer on glass substrate. After depositing the CdTe layer, a thin layer of ZnTe is deposited on already CdTe layer for the formation of ternary IIB-VIA semiconductor compound CdZnTe thin films by the same technique. After annealing, these CdZnTe thin films samples are characterized structurally, optically and electrically. The CdZnTe thin films with band gap energy of 1.45–1.75 eV are of current interest because of their promising applications as the top device of a two-cell tandem structure in high-efficiency thin-film solar cells and of X-ray and gamma ray detectors. Thin films of CdTe with thickness of 1-3 microns can convert sunlight energy into electrical energy. Electrical results show that conductivity of CdZnTe thin films varies from 4.66 x10^{-06} $(\Omega\text{-cm})^{-1}$ to 8.20 x10^{-11} $(\Omega\text{-cm})^{-1}$. Due to its direct energy bandgap nature, it is ideal for efficient thin film based solar cells. The effects of radiations on the CdZnTe thin films can explore a new pathway for researcher.

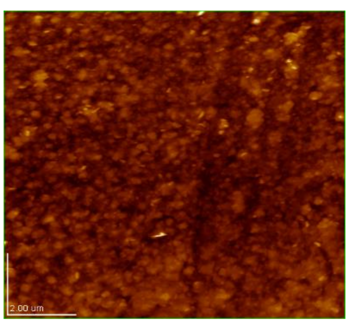

Fig. 1

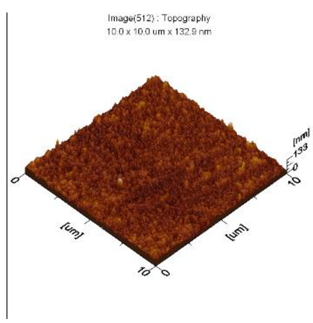

Fig. 2

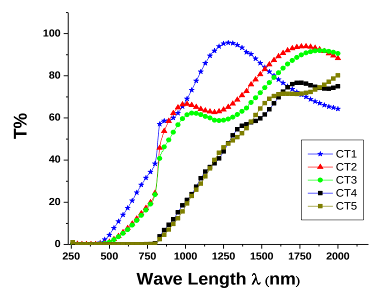

Fig. 3

Fig. 1: Two dimensional and three dimensional AFM images of CZT-1 sample

Fig. 2: Transmission pattern of CdTe thin films as a function of wave length

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Capacity Loss and Electrolyte Decomposition in a Silicon Electrode Lithium Ion Battery Systems

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Keywords: Solid Electrolyte Interphase (SEI), Electrode, Electrolyte, Lithium ion battery, Silicon

The solid-electrolyte interphase (SEI) passivating layer that grows on all battery electrodes during cycling is critical to the long-term capacity retention of lithium ion batteries. Yet it is inherently difficult to study because of its nanoscale thickness, amorphous composite structure, and air sensitivity. Innovative experimental strategies therefore offer new understanding of this important interface. Here we employ ^{1}H, ^{7}Li, ^{19}F, and ^{13}C solid-state nuclear magnetic resonance (ssNMR) to gain insight into the decomposition products in the SEI formed on Si electrodes, the uncontrolled growth of the SEI representing a major failure mechanism that prevents their practical use in lithium ion batteries. The capacity loss of the system is measured as a function of voltage, demonstrating how the low voltage plateau of the Si electrochemistry underlies SEI formation in these systems. The voltage dependent formation of the SEI is confirmed using ^{1}H ssNMR. Using selective ^{13}C labelling, we detect decomposition products of electrolyte solvents ethylene carbonate (EC) and dimethyl carbonate (DMC) independently. EC decomposition products are present in higher concentrations and are dominated by oligomer species. Lithium semicarbonates, lithium fluoride, and lithium carbonate products are also seen. Ab-initio calculations have been carried out to aid in the assignment of NMR shifts. ssNMR applied to both rinsed and unrinsed electrodes show organics are easily rinsed away suggesting they are located on the outer layer of the SEI.

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Carbon materials derived from renewable pine biomass for high voltage supercapacitor electrode in neutral aqueous electrolyte

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Keywords: Biomass, pine cones, microporous carbon, aqueous electrolyte, supercapacitors.

As the world demand for energy continue to increase at a rapid rate, it is critical to improve on the sustainable technologies which produce, convert and store energy efficiently and adequately. Electrode materials are key to improving performance in a number of important energy storage technologies such as supercapacitors and batteries. Supercapacitors are nowadays attractive and play a dominant role in energy storage applications as they can supply higher power density than batteries and higher energy density than conventional capacitors. Biomass materials are potential sources of carbon materials for supercapacitors and have become attractive because they are readily available, abundant, low-cost, pose no threat to the environment and meet the requirement for green and sustainable carbon sources for developments of electrode materials for next generation of supercapacitors. Herein, we explore the synthesis of high surface area carbon from coniferous pines by hydrothermal treatment followed by physical activation and carbonization, and have investigated its potential properties for supercapacitor application. The symmetric device fabricated from this carbon material could achieve a wide operational voltage of 2 V in neutral aqueous electrolyte exhibiting good charge propagation with a specific capacitance of 137 F g^{-1}, energy density of 19 Wh kg^{-1} and long cyclability with 10,000 cycles. The results obtained show that the carbon material produced exhibits very good electrochemical performance and can be easily regenerated

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Coloration of sulphuric acid anodized aluminum plates and its emissivity

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Keywords: - coloured anodic films, brightened aluminum, sulfuric acid anodized aluminum, and emissivity.

Coloured anodic films were produced on eight brightened aluminum sample plates by anodization process in sulfuric acid at 18 – 20 °C for different anodization times of 5 - 40 minutes. The sample plates where brightened in a brightening mixture of phosphoric acid, nitric acid, and copper nitrate solutions at 80 °C. The anodized brightened plates were coloured by immersion in lead acetate and potassium permanganate solutions respectively at 18 – 20 °C. . Emissivity of the sample plates was determined after brightening, anodization and after colouration processes respectively. The thickness of the anodic films was determined by gravimetric method. The coloured sulfuric acid anodized aluminum plates produced hard coloured anodic films with interference colours ranging from dark – brown yellow, yellow and yellow – light brown on the samples with high emissivity values depending on the anodizing time. The coloured anodized aluminum plates with emissivity values of 0.82 – 0.83 obtained for deposition times of 30 to 40 minutes could find applications in high temperature control coatings, services, space applications and production of aluminum roofing sheets to limit radiant heat transfer.

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Comparative Synthesis of Mesoporous $MgO-MoO_3$-SBA-15 catalyst as Surfactant Template for Catalytic Production of Biodiesel

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Keywords: Biodiesel, Mesoporous, Heterogenous Catalyst, SBA-15, Transesterification

The need to increase the percentage of renewables in the global energy mix has resulted in the search of suitable production methods for renewable energy resources. Biodiesel as a renewable energy source is produced by transesterification in the presence of a catalyst. In this work, mesoporous surfactant template silica catalysts have been investigated using different crystallization processes (oven dry, air dry and microwave). The heterogeneous catalyst synthesizedwere characterized using confocal optical microscope, X–Ray diffraction and Fourier Transform Infrared Spectroscopy. The results indicate a successful synthesis of the catalyst after impregnation of $Mg(NO_3)_2$ and $(NH_4)_6Mo_7O_{24}$ precursors into the SBA-15 silica template. The extent of crystallization and pore distribution characteristics indicates that the crystallization process was process dependent with the oven dried process methodology showing the most optimal process module for the catalyst development.

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Design and optimization of Graphite/$LiNi_{0.6}Co_{0.2}Mn_{0.2}O_2$ Lithium Ion Cells

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Keywords: Lithium ion battery, Simulation, Optimization, Experiment

Li-ion batteries as an energy storage material have been established as a leading and a promising candidate for automotive and aerospace applications. But To meet the mileage requirements of electric vehicles, the energy density of Li-ion batteries needs to be enhanced by controlling the porosity and thickness of electrodes. Changes in electrode thickness and porosity affect the rate performance of Li-ion batteries. Hence Graphite/ LiNi0.6Co0.2Mn0.2O2 Li-ion cells with different cathode thicknesses and porosities are examined using mathematical model in order to study its performance and aid in its optimization and understanding the transport processes in the liquid electrolyte and the porous electrodes. Ragone plots are generated for the various cell designs using the model where the specific energy and average specific power are evaluated. The cell are optimized for discharge times ranging from 10 h to 2 min in order to map the maximum performance of this chemistry under wide operating range. The study allows us to ascertain the ability of this chemistry to be used in a particular application. The solid phase Li-ion diffusion coefficient decreased with an increase in current rate. The salt concentration gradient increased with an increase in cathode thickness and porosity at high rate. Based on the experimental data and simulation results from this study, it can be concluded that both solution and solid phase diffusion limitation are the major limiting factors during high rate discharges in thick and less porous electrodes. The low-rate specific energy calculated for the experimental cells ranges from 94 to 186 Wh kg-1 with this mass based on the composite electrodes, electrolytes, separator and current collectors. The optimized designs derived in this work are expected to be starting point for battery manufacturers and to help decrease the time to commercialization.

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Effect of artificial muscle made from nylon 6 monofilament on the healing efficiency of smart composite

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Keywords: Smart Composites, Ionomers, Artificial Muscle, Self-healing

Smart composite characterized by self - healing ability has continued to receive a lot of attention since the last decade, and this has led to the prodigious employment of smart polymeric materials in order to attain self-healing properties. This study involves the fabrication and demonstration of a new grid stiffened self-healing smart composite structure made from ionomer (Surlyn®), carbon fiber that can withstand damage from a three point bending test, and an artificial muscle manufactured from a commercial nylon 6 monofilament. An external stimulus in the form of voltage difference on this ionomeric composite caused the carbon fiber embedded in the polymer matrix to exacerbate the resistive heating of the polymer matrix. This resulted in the melting of the ionomer matrix around the damaged area, and the precipitating of the embedded artificial muscles to actuate and contribute to the improved effective healing of the crack area. This experimental investigation showed that a single edge notch crack imparted damage to the beam can be healed even at constrained boundary conditions upon resistive heating while undergoing a close – then-heal approach. A higher healing efficiency and reduced flexural recovery stress were observed during heal-then-close cycles 1 through 4 of the tested samples. SEM and DSC techniques were employed to observe the nature of the resulted healed crack and to characterize the thermal properties.

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Electromagnetic coupling between absorbers and scatterers for improving absorption in polymer:fullerene thin-films

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Keywords: energy materials, absorption, scattering, organic photovoltaics, plasmonics

Coupled harmonic oscillators are prevalent in many physical systems, ranging from coupled mechanical oscillators (e.g., two pendula connected by a spring), atoms or molecules inside a cavity, vibrational modes of molecules, as well as light-matter interactions. The latter include a vast array of intriguing optical phenomena, including surface plasmon polaritons (coupled light-plasmon quasi-particles), electromagnetically-induced transparency, and Fano resonances. When oscillators are coupled, energy can be efficiently transferred between them. It is thus of interest to investigate the coupling mechanisms between absorbers and scatterers to determine nanophotonic designs for organic photovoltaics in order to maximize absorption within the organic active layer. Here, we report a previously unidentified electromagnetic coupling phenomenon called, "absorption-induced scattering" that occurs ubiquitously for absorbers in the presence of scatterers. We show through finite-difference time-domain simulations and dark-field spectroscopy measurements that the origin of this phenomenon is electromagnetic coupling between the optical transitions of absorber materials and scattering modes, regardless of whether the scattering modes are localized, collective, or plasmonic in origin. The general requirements for absorption-induced scattering to occur are: 1) the presence of a scattering object and an absorber material; 2) spectral overlap between the optical transitions of the absorber and the scattering modes; and 3) close proximity between the scattering object and absorber. Scattering arising from plasmonic modes is shown to increase the intensity of absorption-induced scattering, in particular when the plasmonic mode spectrally overlaps the absorption band edge of the absorber. Additionally, we show through a combination of integrating sphere reflectance measurements and electromagnetic simulations that absorption-induced scattering can give rise to greatly enhanced absorption.

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Encapsulation of Organic Light Emitting Diodes and Red-Shift of its Electroluminescence Spectra

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Keywords: Polydimethyl siloxane, encapsulation, red-shift, degradation, OLEDs.

This paper presents the use of a cost effective method for the encapsulation of organic light emitting diodes. Environmental interactions with the organic layers of these devices within moisture and oxygen rich environments limit their applications. We have therefore explored the use of polydimethyl siloxane (PDMS) as an excellent and cost effective encapsulation layer to overcome these challenges. The results from sensitivity, storage, humidity and mechanical tests presented here show that the structural integrity and mechanical robustness of the devices are maintained after encapsulation. The current-voltage characteristics of encapsulated devices showed better performances than the bare devices. A red-shift of the electroluminescence spectra of the device was noticed after encapsulation with PDMS. Finite element simulations with COMSOL Multiphysics also delineated a similar red-shift, thereby validating the experimental results. The results from the encapsulation procedure indicate effectiveness against degrading environmental conditions. This reproducible stamping technique therefore meets the encapsulation requirements of low temperature processing, inherent flexibility, device compatibility and mechanical robustness at low costs.

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Energy materials and devices for Africa's development: The Pan-African Materials Institute initiatives

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In this paper we report some initiatives being taken by the Energy Focus Resarch Group of the Pan-African Materials Institute (PAMI) in the areas of Organic Light Emitting Devices (OLEDs), Organic Photovoltaics (OPVs), Silicon heterojunction (HJ) solar cell devices and Flexible Electronics, towards the mitigation of the energy crisis in Africa. Preliminary theoretical and experimental investigations of OLED, OPV, Silicon HJ have been carried out and the devices fabricated on both rigid and flexible substrates. We report turn-ON voltages below 2V for ITO/MoO3/MEH:PPV/Al OLED while efficiencies of 4% and 16% have been achieved for ITO/PEDOT:PSS/P3HT:PCBM/Al OPV and ITO/p a-Si:H/i epitaxial- Si/n c-Si/n+ µc-Si/Al single junction Silicon hetorojunction devices respectively. Some degradation mechanisms in organic electronic devices are being investigated and simple yet effective fabrication methods are also being proposed. Futhermore, structural, morphological, electrical and optical properties of Indium Tin Oxide (ITO) and Zinc Oxide (ZnO) with thin metallic interlayer Transparent Conducting Oxides (TCO) have also been optimized for low temperature applications. We report optical transmittance of over 85% in the visible spectrum and electrical resistivity lower than 10-3 Wcm for an ITO 100 nm thick deposited by RF sputtering technique, in an entirely low temperature process. An effective alkaline texture process has also been developed for Silicon substrate with potential applications in inorganic electronics.

Examining the control of methane leakage from Natural Gas Production in the United Kingdom: A Model for Ghana

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Keywords: Methane leakage; Natural gas production; Model; Environment; Climate change

Natural gas has been considered a cleaner fossil fuel compared to oil and coal for many years, however one setback to its clean reputation is methane leakage. This has been of great concern both to industry and academia. The United Kingdom (UK) has made great strides in reducing its methane leakage and is therefore selected as a model country for discussion. The purpose of this paper is to assess the strategies of UK in its methane leakage control and subsequently develop a novel gas monitoring model for Ghana, an upcoming gas producer.

Methane leakage does not only undermine air quality but also represents a loss of revenue .Ghana could therefore avoid these undesirable consequences by adopting proactive strategies as evolved in this paper using a SWOT analysis. Statistical significance of UK's methane leakage between two decades (1990-2000 and 2000-2011), as well as estimated commercial value of methane lost is also presented to demonstrate the relevance for methane leakage control measures.

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Fabrication and characterization of porous TiO_2/Nb_2O_5 composite film electrodes for application in dye-sensitized solar cells

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Keywords: Titanium dioxide (TiO_2) niobium(v) oxide (N_2O_5), electrophoretic deposition (EPD), dye-sensitized solar cells,(DSSC)

Porous and nanocrystalline composite films were deposited by electrophoretic deposition technique (EPD) from nanoparticles of titanium dioxide (TiO_2) and niobium (v) oxide (Nb_2O_5). The TiO_2/Nb_2O_5 composites photoanodes were fabricated to exploit the advantages of Nb_2O_5 like its high electron transport rate, higher stability and higher conduction band energy than TiO_2. These hybrid photoelectrode (photoanode) composed of TiO_2 and Nb_2O_5 were fabricated on a FTO coated glass substrate using electrophoretic deposition (EPD) technique. The colloidal suspension utilized in EPD cell consisted of mixture of TiO_2 and Nb_2O_5 nanopowders and 2-propanol in a Pyrex glass. The optimization of process-related EPD parameters yielded particle concentration of 0.25g/L, applied voltage of 35V, and deposition time of 90s. XRD graphs showed both Nb_2O_5 and TiO_2 nanoparticles present in the composite films in the ratio 1 to 1.78 which confirmed both type of nanoparticles deposited on the EPD cathode upon application of an electric field. The SEM micrographs of the composite electrode thin films showed that porous films of high quality with well controlled morphology were deposited using the EPD technique. Cells fabricated with optimum EPD parameters yielded a V_{OC} = 0.8V, J_{SC}=10.96mA/cm^2, FF=0.538, and η=4.72%. Conversion efficiency in composite based dye-sensitized solar cells increased slightly compared to values obtained in cells based on single material. The formation of core-shell structures and thus energy barrier is proposed to explain the improvement in solar cell parameters.

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Failure of Wrinkled and Micro-Buckled Stretchable Organic Solar Cells

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Keywords: stretchable electronics, adhesion, organic solar cells, failure mechanisms

This paper presents the effects of failure mechanisms of stretchable organic solar cells. Wrinkling and micro-buckling strategies are used to enhance the stretchability of organic films. The failure mechanisms are observed using scanning electron microscopy before the interfacial fracture energies in the multilayered devices are computed using finite element simulations. The pre-strain limit for subsequent stretching (on wrinkled or micro-buckled surfaces) of stretchable organic solar cells is then predicted using the computed interfacial fracture energies. The optical transmittance spectra of anodic layer of the devices are measured. The failure mechanisms are then used to explain the degradation of the optical transmittance and I-V curves of stretchable organic solar cells.

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Feasibility study on wind-photovoltaic hybrid system for rural secondary schools. The case of Mamaclementina Foundation Secondary School-Makambako, Tanzania

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Keywords: Hybrid system, HORMER Software

This study aimed at combining wind and solar energy for generating electricity to meet school demand in rural secondary schools. Most of the schools are far from electricity grid and the use of diesel generator has high running cost and time consuming. In this work wind and solar pattern suitable for generating electricity have been established. Also the design analysis of wind – photovoltaic hybrid system for generating power to meet school demand has been made. Data used were collected through questionnaires, interviews, measurement and field survey. Respondents were head of school, teachers, laboratory technician, and students. Survey was made to government institution, agency, NGOs and private organization in order to obtain wind and solar data, and also materials used for solar and wind energy generation. The data analysis and modelling of the hybrid system was done by Hybrid Optimization Model for Electric Renewables (HOMER) software. Based on data analysis the load demand for basic needs of school was found to be 27.229 Kwh per day for a school of 420 students. The design analysis revealed that this demand can be met by solar generator of 5 Kw, wind generator of 3 Kw and 12 batteries of 350 ah each. However further study is recommended for comparing the cost of wind - photovoltaic hybrid system with grid utility and diesel generator.

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Figure of Merit for spectrally selective reflector surfaces

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Keywords: Spectrally selective reflector, Transparent conducting film, Figure of Merit.

Spectrally selective reflector (SSR) surface is a radiation filter whose ideal integrated reflectance is unity below the band gap of the absorber. Above the band gap, reflectance is ideally zero. SSRs can be fabricated by coating reflecting layers with transparent conducting films. It is useful to have a Figure of Merit (FoM) to characterize the performance of the device. In this work, a FoM of SSR has been derived by utilizing the heat balance equation. We show that the FoM depends on reflectivity of transparent conducting film above and below the band gap edge and that for an ideal SSR, FoM approaches 0.8. For a non-selective reflecting surface, the FoM tends to unity.

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Formability Characterization of Aluminium AA6082-O Sheet Metal by Erichsen Cupping Test

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Keywords: Formability, Erichsen Cupping test, AA6082-O

Aluminium alloy AA6082 is easy to machine, heat-treatable and optimized to be the strongest alloy in the 6000 aluminium alloy series. These properties have seen it replace AA6061 in many applications of skin sheet or structural sheet materials. Aluminium alloy AA6082 is a relatively new alloy hence several studies are being done to evaluate the formability. However, little information is available on formability characteristics of aluminium alloy AA6082-O sheet metal. The main objective of this study was to determine the deep drawability of AA6082-O sheet metal. The deep drawability was experimentally investigated by carrying out Erichsen Cupping tests carrying on 60 mm x 60 mm flat sheet specimens of two different gauge thicknesses (1.0 mm and 2.0 mm), using a WP 300 Universal Material Tester with a loading capacity of 20 kN. The resultant forming limit curve (FLC) level of the forming limit diagrams (FLDs) from the Erichsen Cupping test was found to be higher for 2.0 mm thick sheet than 1.0 mm thick sheet. Based on the FLDs it was concluded that the alloy formability is largely affected by the sheet thickness and the rolling direction. The formability increases with increasing sheet thickness, but the alloy exhibits planar anisotropy ($\Delta r < 0$) as evidenced by some test samples earing. The alloy fractures with little or no observable necking, but the general stress-strain behaviour is typical of that of the aluminium 6000 alloy series.

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From waste to resource: analyzing the fuel properties of biomass (maize cob) and its blend with coal

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Rotten Agricultural wastes (biomass) emit methane and leachates. Bush burning by farmers to clear the land generates CO_2 and other local pollutants. It follows therefore that improper management of agricultural waste products (biomass), contributes towards climate change, contamination of water and soil and local air pollution. But this waste (biomass) is of high value with respect to material and energy recovery. The thrust of this paper therefore, is on the ignition and combustion behavior of the biomass-maize-cob and its blends under typical conditions. $Ca(OH)_2$ was used as a desulphurising agent before briquetting. Ultimate and proximate analyses of the biomass and the blends were carried out using (ASTM D-3172-89, ASTM D-3176-3178). The ultimate analysis showed the presence of Ca, Mg, Al, Na, Fe, S, Pb etc. Result of the burning and viability tests show that maize cob blended with coal burn faster, smoke less and less ash residue than without blends.

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Ghana energy challenge and the way forward

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Ghana is facing acute energy challenge currently, which is mainly attributed to shortages of fuel supply, faulty plant's parts, low level of water in the hydro dams and many operational setbacks. These problems have persisted for a very long period and have a direct adverse impact on our socio-economic activities, as well as health and environmental state. Energy is a key ingredient in the economic stability of the nation, as its absence create huge deficit in employment and many other essentials needed for the development of the country. This paper seeks to analyze these challenges and offer comprehensive solutions to halt the growing trend of energy poverty in the country. First of all, the paper considers the four main factors that affect the appropriate selection of fuel for energy, as well as the technology to be employed. These factors are the security of fuel supply, Emission from the fuel/plant, cost of fuel/plant, and NIMBY (Not in My Back Yard) syndrome. It is evident that careful considerations and thought are not given to these factors in selecting our fuels and technologies which have had a gruesome impact on our supply of power to households and industries. Lack of proper monitoring and payment system is also seen as a major factor in our current energy predicaments. In this presentation the current technologies and fuels employed in power generation plants in the country are thoroughly reviewed. New power plant technologies such as carbon capture and storage (CCS) technologies, which are noted as the antidote to carbon mission from fossil fuel plant, are highlighted. Moreover, the importance of widening our energy mix by including all fossil fuels (i.e. coal, oil and gas) and boosting our security of supply by diversifying the source of these fuels are clearly elucidated. Finally this presentation makes appropriate recommendation for the suite of power technologies to be adopted, and the role of government and independent power producers (IPP) in tackling the energy challenge the country is currently facing. With the vast renewable energy resources available in the country, recommendation is also made for the appropriate utilization of these resources and how it could contribute to curtailing the energy poverty currently experienced in the country.

Graphene Based Dye sensitized Solar Cells

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Keywords: (Graphene, Chemical Vapour Deposition, Photosensitizer, Inkjet printing, DSSCs)

Dye-sensitized solar cells (DSSCs) are an attractive alternative to conventional silicon-based solar cells, largely due to its simple fabrication process and cost/performance advantages. Indeed, the dissolution of platinum counter electrode in the I_3^-/I^- electrolyte, cost and requirement for high temperature treatment are drawbacks of the well-established platinum-based DSSCs. These drawbacks can potentially be addressed by graphene based dye sensitized solar cells. Graphene is a promising candidate for platinum substitution in DSSCs due to its high exchange current density, low charge-transfer resistance and high specific surface area. Large area graphene films with varying growth time thickness were synthesised by CVD on copper foil and transferred to other substrates for characterisation and photovoltaic applications. STM, Raman spectroscopy and imaging show films with high crystallinity, low defect density, I_{2D}/I_G ratio of 0.52-2.26 and the presence of continuous graphene sheets with optical transparency of 75.7%-96.8%. The use of CVD graphene sheets as counter electrode in DSSCs was explored. Studies on DSSCs based on graphene ink counter electrodes are also presented. The ink is produced via sonication induced liquid phase exfoliation of pristine graphite flakes. This ink can then be formulated for printing technologies such as inkjet and screen-printing. The repeatability of the printing process is demonstrated through an array of 9 printed electrodes, with ~5% standard deviation in sheet resistance. Our results show that inkjet printable graphene ink, without any chemical functionalization, offers a flexible and scalable fabrication route, while costing only a fraction of the platinum counter electrodes in DSSCs.

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Graphene foam based 3D porous carbon for high-performance supercapcitors

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KEYWORDS: Porous carbon; Supercapacitor; Equivalent circuit; Electrochemical performance.

As a result of the depletion of fossil fuels and the issue of greenhouse gas emissions, cleaner sources of energy have been explored, such as solar and wind energies. Furthermore, new technologies for minimizing CO_2 emissions are developing rapidly and need to be augmented by highly reliable energy storage devices such as supercapacitors or electrical double-layer capacitors (EDLCs). The EDLCs have unique properties that are related to the primary charge storage harvesting mechanism, which relies on electrosorption of ions from an electrolyte onto a porous electrode [1]. Carbon materials are the materials of choice for EDLCs applications and their advantages as electrode materials were reported in previous work [2,3]. In this work we report on the hydrothermal synthesis of three-dimensional porous carbons with high specific surface area (SSA) based on graphene foam with two different polymers, namely polyvinylpyrrolidone (PVP) and polyvinyl alcohol (PVA). The hydrothermal treatment resulted in a hydrogel which was further treated with potassium hydroxide (KOH) for activation; this was followed by carbonization to create a porous network of graphitic carbons. The effect of activation on the morphology and the SSA of the three-dimensional PVA-GF-PVP carbons produced, designated as 3D-PGP, were systematically studied. The electrochemical characteristics of the 3D-PGP exhibited superior supercapacitive performance with specific capacitance of 188 F g^{-1}, coupled with high energy and power densities. Moreover, no capacitance loss after 10,000 cycles was observed, owing to the unique structure and large surface area (3000 m^2/g) of the active material. The outstanding performance of this material as electrode for supercapacitor shows great potential for its application in high-performance energy-related applications.

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Highly transparent and conductive n-Zn1-xGaxO thin films by homemade chemical spray pyrolysis

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Keywords: ZnO, Thin films, Gallium doping, Spray pyrolysis technique, Electrical characterisation

In this study both undoped and Ga doped ZnO thin films were deposited on borosilicate glass substrates via a simple but effective spray pyrolysis technique. Thin films were characterised by X-ray diffractometer, UV-vis spectrophotometer and Four point probe set-up. Evolutions of the structural, morphological and optical properties were studied as a function of increasing Ga doping concentration from 2at.% to 7at.%. XRD results revealed that the films are polycrystalline with hexagonal wurtzite crystal structure. Increased Ga doping concentrations decreased crystallite size from 74 to 19nm whilst the dislocation density and lattice strain increased. All films exhibited high transmittance of about 85% in the entire visible spectrum. Band gap values shifted to higher values with increased Ga doping. Lowest resistivity of $1.47\times10^{-4}\,\Omega$cm was obtained at 3at.% Ga doping concentration.

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Inhibiting Interfacial Recombination Events in Dye-Sensitized Solar Cells Using Self-Assembled Bilayers

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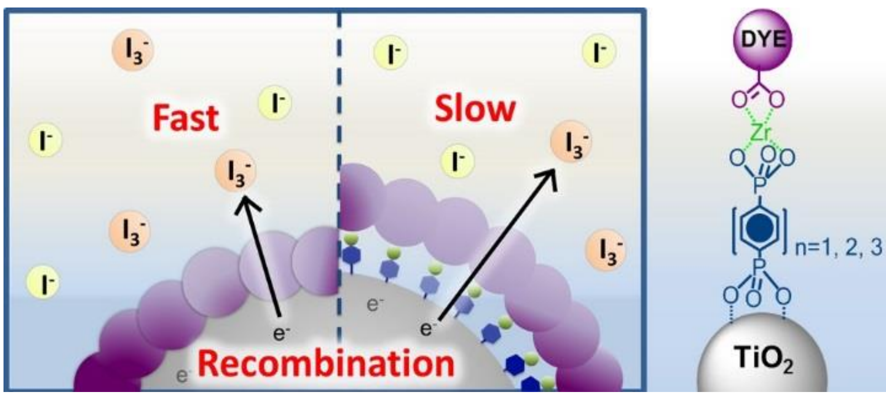
Keywords: Self-assembled, bilayer, dye-sensitized, recombination, open circuit voltage



The efficiencies of Dye Sensitized Solar Cells (DSSCs) and Dye-Sensitized Photoelectrosynthesis Cells (DSPECs) are mainly determined by electron transfer processes at the TiO_2-dye-electrolyte interface. Recombination of injected electron with redox mediator at this interface is one critical factor responsible for the low performance of these devices. Self-assembled Bilayer is introduced in this work as an effective method of slowing down the rate of these processes in DSSC devices. The Bilayer architecture is composed of a symmetric bridge molecule, a linking metal ion and the sensitizer molecule. The length of the bridge molecules were varied in this study. Spectroelectrochemical characterization measurements such as I-V, IPCE and EIS were performed on DSSCs and a decreasing rate of the recombination process with increasing bridge length was seen. This was indicated in the increased open circuit voltage as well as increased lifetime and diffusion length in TiO_2.length showing that the bilayer is an effective strategy in inhibiting these recombination events. The increase in voltage is however outweighed by the decrease in photocurrent, resulting in an overall decrease in device performance.

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Isolation and characterization of plant pigments as potential sensitizers in solar cells

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Keywords: Dye-sensitized solar cells, UV-Vis spectroscopy, Absorbance

Most Dye Sensitized Solar Cells (DSSC) incorporates synthetic dyes to convert photons from the sun into electrical energy; however, these cells are expensive and environmentally unfriendly. This work was based on four natural photosynthetic pigments extracted from the Neem tree (*Azadirachta Indica*) and the Baobab tree (*Adansonia*), which would be used as sensitizers in DSSCs. Most research has shown that plant pigments are very good sensitizers and with the proper combinations, they can be used as very efficient sensitizers in dye sensitized solar cells. Most of the characterization was based on the absorption spectra of the pigments and the results demonstrated a positive correlation between the spectral absorption of the natural pigments based on different concentrations and the spectral absorption of the natural pigments over a wavelength of 210nm – 540nm. At a wavelength of 500nm, the pigments absorbed most photons between concentrations of (70%water/30%ethanol) to (20%water/80%ethanol) with absorbance between 0.7A - 3.0A but after fractionation it was observed that the absorption spectra of the pigments varied between 220nm to 340nm recording an average maximum absorbance of 5.3129A. The composition and the purity of the pigments were confirmed using thin layer chromatography.

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Laser nanostructured Co and Ni nanorods-AL_2O_3 cermets for enhanced & flexible solar selective absorbers applications

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Keywords: Solar absorbers; Spectral selectivity; Photothermal conversion; Nanocylinders; Electrodeposition

We report on the structural and optical properties of laser surface structured Co nanocylinders-Al_2O_3 cermets on flexible Aluminium substrate for enhanced solar selective absorbers applications. This new family of solar selective absorbers coating consisting of Co nanocylinders embedded into nanoporous alumina template which were produced by standard electrodeposition and thereafter submitted to femtosecond laser surface structuring. While their structural and chemical properties were investigated by X-ray diffraction, scanning electron microscopy, energy dispersive spectrometry and atomic force microscopy, their optical characteristics were investigated by specular & diffuse reflectance. The optimized samples exhibit an elevated optical absorptance $\alpha(\lambda)$ above 98% and an emittance $\varepsilon(\lambda)$ ~0.03 in the spectral range of 200-1100nm. This set of values was suggested to be related to several surface and volume phenomena such as light trapping, plasmon surface effect as well as angular dependence of light reflection induced by the ultrafast laser multi-scale structuring.

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Membrane Materials for CO_2 Capture: a short overview

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Investigations have revealed that Greenhouse Gases (GHG), such as carbon dioxide (CO_2), is the cause of global climate change and other related environmental disasters. In sub-Saharan Africa, country whose generation of electricity is predominantly dependent coal-fired power plant technology will emit large quantity of CO_2 to the atmosphere. Therefore, there is an urgent need to mitigate CO_2 emissions in such country, and carbon capture and storage (CCS) is amongst the possible options to address the issue. Amongst the promising CCS techniques in use are absorption and adsorption. Absorption is a mature technology with about 100% efficiency for CO_2 capture, but it is cost intensive due to large quantities of energy required for desorption and regeneration of the solvent, and the environmental unfriendliness of the spent solvent [1]. Therefore alternatively CCS techniques such as adsorption and membrane system have been proposed due to less energy requirement when compared to absorption and the materials employed may be environmentally friendly. These advantages show that with membrane-based CO_2 separation system, lower operational costs may be achieved and application in CCS may be carried out economically. However, new membrane materials displaying high selectivity and flux huge for CO_2 capture are required to make membrane-based CO2 capture competitive to absorption. In addition, membrane system also has drawbacks, which include poor membrane reproducibility, scale-up difficulty and high cost of the membrane supports [2]. Against this background, this piece presents a short overview of membrane materials applicable in CO_2 capture with a view to provoking thought of researchers on CO_2 capture. Information from the overview could provide a platform upon which several research and development, targeting development of robust and high selective membrane materials for CO_2 capture, could be built. Presence of membrane materials with high selectivity and flux to CO_2 could fast-track the development of robust and energy-efficient membrane-based technologies retrofittable to the existing coal-fired power plants for CO_2 capture.

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Microwave Synthesized Pyrite Thin Films

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Keywords. Iron pyrite, solar cells, microwave irradiation, x-ray diffraction.

Iron pyrite (FeS_2) is an earth abundant material with a good potential for yielding low cost solar cells that can be produced in a sustainable and environmentally friendly manner. In this work, iron pyrite was synthesized using a wet chemical synthesis process assisted by microwave irradiation. Microwave irradiation led to pyrite formation within a few minutes and irradiation at a power level of 800 W for 10 min yielded a cubic phase as revealed by x-ray diffraction. Thin pyrite films prepared from the synthesis product and the results of studies on their optical and electronic properties will be presented.

Theme: Materials for energy and sustainability.

Middle management influence on formulation and implementation of strategic initiatives: An analysis and report on Tullow Oil Ghana

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Keywords: Middle managers, Sensemaking, Strategic agency

Tullow Oil Plc is one of the incredible success stories of oil and gas exploration in recent years. The company has grown from its humble beginnings in Ireland into one of the world's most successful E&P players, with a specialist focus on frontier and underexplored areas. It has achieved this success by pursuing an exploration-led growth strategy, which it complements with strategic acquisitions of mature and producing assets. This report argues that Tullow has achieved this success through the ability to formulate the right strategies and effectively implement them. It goes on to argue that in order to do this, middle managers at Tullow have to influence the formulation and implementation of strategic initiatives. In order to establish how middle managers influence strategy at Tullow, this report studies the strategic roles middle managers play at Tullow Oil Ghana, one of the group's business units. The reports utilizes a deductive approach to analyze primary data, obtained through a pilot study drawing on preliminary questionnaires and interviews, to determine how middle managers at Tullow Oil Ghana influence the formulation and implementation of strategic initiatives. The report concludes that middle managers make use of their experience, expertise and interactions with various stakeholders to gain an understanding of what is happening in Tullow Oil Ghana and its environment. They then make use of interactions with their senior management and their subordinates, through the appropriate forums, to influence the formulation and implementation of strategic initiatives respectively. This report seeks to establish the kind of strategic influence middle managers exert at Tullow Oil Plc. It also investigates to determine the contextual factors that enable or inhibit the ability of middle managers to exert strategic influence. It also establishes how middle managers influence the formulation and implementation of strategic initiatives at Tullow Oil Ghana.

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Optical Transmittance of ZnO/Al/ZnO Electrodes: Models and Experiments

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Keywords: Multilayers; numerical simulations; optical transmittance; resistivity; solar cells.

This paper presents the effects of thicknesses on the electro-optical properties of aluminum (Al) nanolayers embedded in zinc oxide (ZnO) for transparent electrode applications. Numerical modeling was used to study the transmittances (Ts) of ZnO/Al/ZnO (ZAZ) film stacks with Al thicknesses between ~ 1 and 100 nm. Multilayers with mid-Al layer thicknesses between ~ 1 and 10 nm are shown to have average Ts between ~ 75 and 90%, which decreased further with increasing mid-layer Al thicknesses. The simulations are comparable with experimental measurements in multilayers produced using the predicted mid-layer Al thicknesses. The electrical properties are presented for ZAZ multilayers with optimum Al thicknesses. The results show that the best multilayers have the highest Haacke figure of merit of 4.72 $m\Omega^{-1}$ and sheet resistances as low as ~ 7.25 Ω/sq. These are shown to be comparable to the performance characteristics of indium tin oxide (ITO) anodes that are used currently in organic solar cells and light emitting devices.

Opto-electrical Properties of poly (3- hexylthiophene-2, 5- diyl) (P3HT), [6, 6] phenyl-C61- butyric acid methyl ester (PCBM) and Squariane Systems

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Keywords: P3HT, PCBM, blend ratio, thin films, conducting polymers,

Ternary systems comprising P3HT:PCBM and varying amounts of squarylium III (SQ3) were prepared and deposited by spin coating to obtain nano-size thin films. The films produced were subsequently annealed at 140 °C for 10 min. Absorption spectra and electrical measurements were used to evaluate the effects of thermal annealing and dye loading on the different blends. The films were characterized for their surface morphology and film thickness using atomic force microscopy. Photo-conversion efficiencies were determined following current density – voltage measurements under dark and illumination conditions enabling determination of various solar cell parameters. A significant increase in the maximum peak absorbance, from 0.31 to 0.36 a.u. was observed by incorporating SQ3 molecules at 13 % w/w loading. The absorption range was also observed to broaden (400 – 700 nm) extending to the near infra-red. The V_{oc}, I_{sc} and *FF* in the control P3HT:PCBM were 0.53 V, 0.78 mA and 1.3 % which change to 0.64 V, 9.68 mA and 3.9 % in P3HT:SQ3:PCBM blends. The inclusion of SQ3 dye molecules resulted in enhanced light harvesting capacity due to widening of the absorption range. This consequentially resulted in an increase in photogenerated excitons and I_{sc}. Increase in V_{oc} is ascribed to the elevation of HOMO of P3HT due to increase in disorder arising from inclusion SQ3. The rise is HOMO is attributed to increased interchain orbital delocalization. The HOMO of SQ3 is reported to be located between the HOMO and LUMO of levels of P3HT and PCBM. It has been further suggested that incorporation of SQ molecules introduce a second exciton generation system and charge transfer mechanism. Photoinduced charge transfer is not only favourable between P3HT and PCBM but also between SQ3 and PCBM. Thus, the synergistic effect of improved light harvesting characteristics with additional exciton generation and charge transfer mechanism resulted in an increase in photoconversion efficiency.

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Organic binders to enhance fuel efficiency of charcoal stoves (*jikos*) and in water filters

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Key words: Plant-derived binder, thermal shock, thermal conductivity.

This work presents experimental and theoretical study of the effect of a plant derived bidder (*corchirus olitorius*) on the thermal shock resistance and thermal conductivity of kaolinite-based refractories. Shock-induced crack growth, thermal conductivity and mechanical strength is studied in sintered structures produced from powders with varying binder concentrations. The underlying microstructures are elucidated via scanning electron microscope (SEM). The implications of this work are discussed for the design of strong and long lasting ceramic stove linings for the energy saving and efficient stoves for rural and urban area households in developing countries where wood/charcoal is the main source of energy. Another implication is the design of stronger ceramic water filter membranes used for water purification.

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Potential of producing solar grade silicon nanoparticles from selected agro-wastes in Nigeria

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Keywords: energy, photovoltaic, silicon, agricultural wastes, thermochemical method.

Recent publication by the U. S. Energy Information Administration (EIA), showed that Nigeria generates around 3,080 MW of electricity while the actual demand is estimated at 10,000 MW. The 2012 total energy consumption profile of Nigeria showed that about 99% of the energy consumed was derived from fossil fuels which contribute to greenhouse gases emission. Electricity, if readily available at low cost, can easily replace the fossil fuels which pose adverse effect on the citizen and climate. Solar photovoltaic is identified as an effective renewable energy source that has proven to be a promising candidate for provision of clean and sustainable electricity. Silicon is the leading terrestrial PV materials for making solar cell due to its high efficiency but comes with high production cost. This paper presents the possibility of producing low cost solar grade silicon with low energy input, from selected agricultural wastes in Nigeria, using sol-gel and metallothermic reduction methods. XRD and SEM/EDS analyses of proximate analysis products of three agricultural wastes showed the presence of amorphous silica which can be reduced metallothermically. Sourcing for agro-wastes and their conversion to PV material could serve as means of generating income to interested unskilled youths and farmers. Production and deployment of cheap solar cells from the extracted silicon could provide remarkable employment opportunities for unemployed graduates. The improvement of electricity generation will close the generation gap, offering electricity to isolated communities not connected to the national grid, consequently improving the GDP and energy profile of the country, and lastly increase the citizens' life expectancies.

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Potential of Raffia Palm (Raffia Farinifera) as feed for integrated biorefinaries

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Raffia palms are native to tropical Africa and constitute an important ecosystem. Some of the socio-economic and cultural importance of the raffia palm in communities in West and Central Africa include: source of fibre used in the agricultural, art and craft sectors, food (sap), symbols during traditional ceremonies, source of traditional building material and toothpick, fuel and source of traditional African pharmacopoeia. The stem of the raffia palm is harvested in a controlled manner throughout the life of the palm, thus representing a potential source of renewable biomass. Biomass is receiving ever-increasing interest as a more sustainable alternative to fossil-fuel derived fuel, chemical feedstock and materials and is the source of feedstock for an emerging bio-economy. Proximate analysis for lignin, cellulose and mineral content of the stems from 3 varieties of raffia palm in Cameroon was carried out using the klaxon, modified Jayme-Wise and atomic absorption spectroscopy, respectively. Fibre surface was also observed by scanning electron microscopy. The results showed that the amount of lignin ranges from 22-42% and this is comparable to the lignin from soft and hard wood which ranges from 18-45% and contents varied between of 31- 41 %. No silica bodies were observed. The lignin and cellulose values compare well with agricultural waste from oil palm production. The potassium and ash contents of the raffia palm are significantly lower than for that in all parts of the oil palm (frond. Lignin from raffia palm was determined using. Lignin is receiving increasing interest as feedstock for sustainable chemicals, biomaterials and bio-energy. Raffia palm is cultivation is already widely practised over different eco-climatic zones of West and Central Africa. Raffia palm plantations are relatively fast growing, very accessible and the harvesting of stem does not require heavy equipment or investments. The existing uses of the raffia palm and the results of this preliminary study indicate that raffia palm deserves more investigation as a source of feedstock for the emerging bio-economy.

Preparation and characterization of doped zinc oxide thin films for solar cell applications

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Keywords: Zinc oxide, Thin films, Pyrolysis, Solar cell

A key component of optoelectronic devices such as solar cells, touch panels and light emitting diodes (LEDs) and is the transparent conducting oxide (TCO). Some common materials used in the fabrication of TCO include Tin-doped Indium Oxide (ITO), fluorine doped tin oxide (FTO) and doped-zinc oxide (ZnO). Zinc Oxide (ZnO) is an attractive material for TCO because it is cheaper, readily available and non-toxic. The direct band gap of ZnO is approximately 3.3eV. The wide band gap gives ZnO a high visible transparency. Radio frequency (rf) magnetron sputtering, molecular beam epitaxy (MBE), pulsed laser deposition (PLD) and chemical vapor deposition (CVD) techniques have been used to grow ZnO films with good structural, optical and electrical properties. These techniques are expensive to use and mostly require vacuum conditions for deposition. Spray pyrolysis is a common and simple means of forming ZnO films on substrates. The aim of this work is to produce and characterize gallium/indium/aluminum and fluorine doped transparent ZnO thin films using the spray pyrolysis technique. A precursor solution of zinc acetate ($Zn(CH_3CO_2)\cdot 2H_2O$), acetic acid, de-ionized water and ethanol was prepared for the purpose of spraying. To prevent the formation of zinc hydroxide precipitate which turns the solution milky, acetic acid is added. The amount of acetic acid added was varied to study its effect on the transparency and structure of the thin film. All films were deposited on soda-lime glass substrates at a temperature of 400°C. The ZnO films had optical transmittance values above 80%. X-ray diffraction measurement also revealed the undoped ZnO films grown on glass substrate had (002) preferred orientation.

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Pressure Effects on Surface Contacts in Perovskite Solar Cells: From Analytical/Computational Models to Multi-scale Experiments

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Keywords: Perovskite solar cells, analytical/computational modelling, ellipsometry, atomic force microscopy, adhesion and contacts,

This paper presents the results of a combined experimental, theoretical and computational study of the effects of pressure on the contacts between layers that are relevant to perovskite solar cells. These include structures consisting of planar hetero-junction solar cell layers deposited on fluorine tin oxide (FTO) and indium tin oxide (ITO) substrates. The models consider the contacts around impurities that are present at the interfaces between layers. These are modelled using analytical and finite element models that consider the effects of layer/dust particle elastic moduli, adhesion energies and the separation between dust particles. The models are used to study the effects of layer dimensions on the adhesion and contacts between individual bi-material pairs that are fabricated using spin coating and deposition techniques. Ellipsometry measurements of layer thickness and atomic force microscopy measurements of surface roughness/adhesion energies are incorporated into the models to provide insights how surface roughness and layer/dust particle elastic properties contribute to surface contacts that are relevant to device performance and fabrication. Finally, computational simulations of perovskite solar cell performance are presented. These include results obtained from the solution of semiconductor equations along the solar cell structure in one dimension (1D) via the SCAPS software. The structures that are simulated include planar heterojunction and mesoporous configurations with planar contacts and functionally graded interfaces with full and partial surface contacts.

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Pressure-induced microstructural changes in conjugated polymer photovoltaic cells

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Keywords: Pressure-induced, microstructure, X-ray scattering, photoluminescence, polymer chain alignment

This paper presents the evidence of the effects of pressure on the polymer chain alignment in poly (3-hexylthiophene) and [6,6]-phenyl C61-butyric acid methyl ester (P3HT:PCBM) blends that are used in bulk heterojunction photovoltaic cells. The polymer chain alignment was analyzed using grazing incidence wide angles X-ray scattering (GIWAXS). The current-voltage characteristics of the resulting bulk heterojunction photovoltaic cells are also shown to change significantly with changes in the microstructure of the P3HT:PCBM active layer. The implications of the results are also discussed for the microstructural design of bulk heterojunction organic photovoltaic cells.

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Proton Exchange Membrane Fuel Cell Deployable Domestic Power Plant (PEMFC-DDPP)

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The demand for electrical power to fulfill Ghana's energy needs keeps rising, and the quest for cheap and sustainable renewable energy continues unabated. The development of Proton Exchange Membrane Fuel Cell Deployable Domestic Power Plant (PEMFC-DDPP) is envisaged to provide power supply either to replace or supplement domestic energy demand. The proposed PEMFC-DDPP should be capable to deliver variable power source form a fraction of watt to approximate 1Mega watts of power using adaptive system components of a fuel cell power plant. The PEMFC-DDPP unit is made up of three main systems: 1) Electrolyzer - a device the split water into its constituent element of hydrogen and oxygen, 2) PEM Fuel Cell Unit - an electrochemical device that converts chemical energy direct into electrical energy, and 3) Fuel Cell Power Conditioner - a device that converts dc to dc and inverts dc to ac. In practice hydrogen and oxygen are the sources of fuel for Proton Exchange Membrane Fuel Cell. The production of hydrogen and oxygen would be performed by an Electrolyzer, using dc current from a deployable solar panel and backup rechargeable batteries. The Electrolyzer utilizes the principles of electrolysis in chemistry to split water (H2O) into hydrogen and Oxygen. The gases are either stored in segregated canister or directly feed the fuel cell stacks which employ proton exchange membrane (PEM) technology. The direct current (DC) output of the fuel cell is then connected to a fuel cell power conditioner, a circuitry which incorporates dc-to-dc converter and dc-to-ac inverter employing pulse wave modulation techniques. This paper presents an overview of how to generate free energy from water. The development of Proton Exchange Membrane Fuel Cell Deployable Domestic Power Plant (PEMFC-DDPP) is envisaged to be a part of the solution to Ghana's electricity load shedding "Dumsor" challenges.

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Purity-Performance relationship of anthocyanidins as organic sensitizer in solar cells

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Keywords: Terminalia Catappa, Anthocyanins, Solar cell, Device Stability, Efficiency.

This study reports a comparative analysis between crude and purified extracts obtained from withered leaves of *Terminalia catappa* (*T. catappa*) on the one hand, and pure chemical compounds of anthocyanidins as organic sensitizers in solar cells. The samples were characterized by Ultraviolet-Visible (UV-Vis), Fourier-Transform Infra-red (FT-IR) spectroscopic and Gas Chromatography Flame Ionization Detector (GC-FID) techniques. Solar Cells fabricated with Mesoporous thin film TiO2 sensitized with the extracts and pure compounds were then characterised. The prominent transitions in the U-V spectra were found to be the $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ and wavelengths shifts of the absorption (around 350 – 380 nm) with a characteristic decrease in the absorption between the *T. catappa* crude (TCE) and *T. catappa* purified (TCP) extracts. The FT-IR spectra of the purified sample have bathochromic (red) shifts on the hydroxyl group and hypsochromic (blue) shifts on the benzene ring. The GC-FID chromatograms and spectra revealed the presence of six anthocyanidins and their amounts in mg per 100 g of the sample. The results showed that delphinidin was most abundant, and its quantity increases with purity of the samples, while others decreased with purity in both samples. The photovoltaic performances increase with purity. The efficiency of the solar cells fabricated with the pure cyanidin, purified extract and crude extract were 2.27, 0.746 and 0.336 respectively. This exploratory study suggests that purity of cyanidin constituents used in the solar cell fabrication determines effective efficiency and stability.

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Pyrolysis of waste plastics to liquid fuel

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Keywords: plastics, waste, liquid fuel, kerosene, petrol, diesel, pyrolysis, HDPE, reactor.

Thermal degradation of waste plastics in an oxygen-free atmosphere has been regarded as a promising method that can convert waste plastics into hydrocarbons that can be used either as fuel or as sources of chemicals. In this work, high-density polyethylene (HDPE) waste plastics was chosen as the material for thermal treatment (pyrolysis). A cylindrical stainless steel reactor was locally built and used to convert waste HDPE into liquid hydrocarbon fuel through pyrolysis. At temperature range of 150°C - 450ºC various liquid fuels such as kerosene, petrol, and diesel are obtained. The temperature of the pyrolysis reactor is increased slowly to the desired temperature and kept constant till the process is completed. The liquid fractions obtained were analysed for chemical composition using FTIR. The physical properties of the fuels were also determined using American Society for Testing and Materials (ASTM) test methods. The chemical analysis indicates that the liquid fuel obtained has more alkanes. There were some peaks corresponding to aromatics which are all single bonded compounds. One of the fuel samples tested gave the following results: density; 792kg/m^3, evaporation; 24mls, residue; 1.8%vol, flash point 51.1 ºC, copper corrosion (3hrs at 100 ºC); 1a and evaporation at 24% volume. These results when compared to that of classical kerosene indicated that the liquid obtained has properties similar to that of kerosene. Further chemical and physical tests conducted on the liquid fuel proved to be kerosene.

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Sensitization of mesoporous oxide semiconductors with metal-free Indoline dyes

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Photoelectrochemical cells (PECs) based on dye-sensitized (DS) nanocrystalline films of oxide semiconductors TiO_2, SnO_2 and ZnO have been extensively studied as potential low-cost alternatives to the conventional silicon-based photovoltaic devices. In these solar cells, ultrafast electron injection from a photoexcited dye into the conduction band of the semiconductor and the subsequent dye regeneration and hole transportation to the counter electrode are responsible for the efficient generation of electricity. Ruthenium-based complex dyes such as Ruthenium 535 bis-TBA (N-719,Solaronix), extensively used in TiO_2-based DS cells, exhibit higher photovoltaic performance in terms of efficiency and stability. But these dyes contain Ru which is rare and expensive and its synthesis route is cumbersome. Metal-free dyes such as indoline D358, D205, D149 and D102 contain no rare metal and possess highest occupied molecular orbital (HOMO) and lowest unoccupied molecular orbital (LUMO) positions similar to those of the Ru-based dyes and have molecular extinction coefficients higher than that of the Ru-based dyes. In the presentation we will look at the preparation of porous ZnO and SnO2, the sensitization of these oxide semiconductors with indoline dyes and the evaluation of the photovoltaic performance under AM 1.5 simulated sunlight.

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Simonkolleite-graphene foam composites and their superior electrochemical performance

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Keywords: simonkolleite sheets, graphene foam, composites, supercapacitor

In the developing field of energy storage technology, the design and fabrication of efficient energy storage devices with high energy and power densities are of growing concern today. Numerous scientists have engaged in active research to develop robust and reliable energy storage systems which will match the increasing demand for energy in a variety of applications from energy storage systems in portable hand-held devices to back-up systems in hybrid electric motor vehicles. Supercapacitors (SCs) with high power densities and long cycle life as compared to much common hybrid batteries in use today are promising candidates for such applications. However, they are also characterized with low energy densities in comparison to batteries which create a drawback for their wide applications. Simonkolleite-graphene foam (SimonK/GF) composite has been synthesized by a facile solvothermal and environmentally friendly technique with excellent electrochemical properties. The obtained product was initially analyzed by scanning electron microscopy (SEM), Brunauer–Emmett–Teller (BET), X-ray diffraction (XRD), Fourier Transform Infrared Resonance (FTIR) Spectroscopy and Cyclic Voltammetry (CV) techniques. The microscopy results reveal hexagonal sheets interlaced with each other and adjacent graphene sheets. The existence of graphene foam in the simonK/GF composite is further confirmed from the structural and the optical characteristics obtained from XRD and FTIR respectively. The BET results obtained indicate an improvement in the surface area due to the addition of graphene foam to a value of 39.58 m^2 g^{-1}. The N_2 adsorption/desorption also shows the presence of active mesopores required for charge transport. As a promising electrode material for supercapacitors, the composite shows a high specific capacitance value of 1094 F/g at 1 A/g with a coulombic efficiency of 100% after 1000 cycles. These results show a potential for adoption of this composite in energy storage applications.

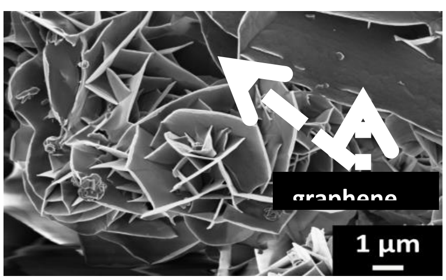

Figure. 1: SEM Image of simonkolleite-graphene foam composite foam (GF)

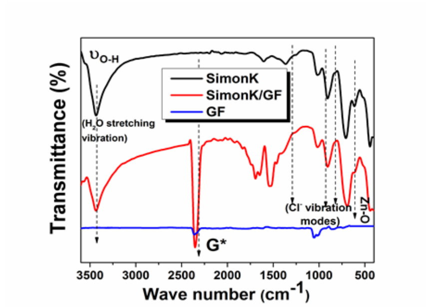

Figure 2: FTIR spectra of SimonK, grapheme simonkolleite-graphene foam (SimonK/GF)

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Singlet Fission for Tandem Solar Cells

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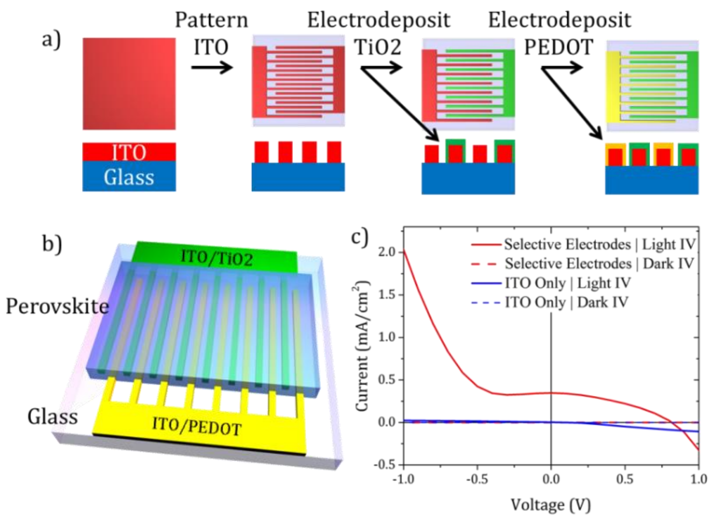
Keywords: Singlet Fission, Triplet, Perovskite, Solar Cell

Singlet exciton fission can provide the means to overcome the efficiency limit of single-junction solar cells by converting a high-energy singlet exciton into a pair of lower-energy triplet excitons. In previous research, we have demonstrated that an organic singlet fission material, such as pentacene, can be combined with a low-bandgap inorganic semiconductor to produce photocurrent from both materials in a working solar cell[1,2]. All devices demonstrated so far, however, are based on relatively inefficient technologies such as semiconductor quantum dots. For the design of efficient solar cell architectures which benefit from singlet fission, a change must be considered from the classical paradigm of a free carrier-oriented device design to a triplet exciton-oriented design. Here we demonstrate a fabrication route to achieve an interdigitated back contact perovskite solar cell, and how we could combine such architecture with a singlet fission chromophore to achieve a triplet-logic device with a theoretical efficiency higher than the Shockley-Queisser limit for a single junction.



Figures:

(a) Sketch of device fabrication. A flat film of ITO is patterned into interdigitated contacts in a one-step photolitography process, followed by electrodeposition of both TiO_2 and PEDOT on the corresponding electrodes.
(b) The full device with a spin-coated film of perovskite semiconductor.
(c) IV characteristics of a perovskite interdigitated back-contact solar cell, with and without selective electrodes.

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Solar energy applications for rural development

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Keywords: Energy, conventional, non-conventional, socio-economic, solar energy technology, and rural development.

Energy has a major impact on every aspect of the socio-economic development of a nation. It is the pivot on which the economic, social and welfare development of any nation revolves. Energy is also the motive force behind sustained technological development of the nation. The conventional energy sources have limited availability and are associated with environmental problems. The limited availability of conventional energy sources and the associated environmental problems could be overcome by using the non-conventional energy sources to augment the applications of conventional energy sources. Renewable energy technology could be employed to alleviate the already over-stretched ecosystem and supply the energy necessary for rapid development, especially in the rural areas by encouraging the establishment of cottage industries and stemming the rural urban drift. Solar energy is a non-conventional energy source and basic fuel for all earthly processes. The energy is renewable, freely available and the applications are environment friendly. Most rural dwellers live in communities that have difficult terrains, no good roads, electricity grids and no easy access to conventional energy sources but have high quality and abundant supply of solar radiation. The effective harnessing of solar radiation, using solar energy technology, to augment energy supply from conventional energy sources would enhance the availability of energy for socio-economic activity. This would lead to significant improvement of standard of living of people. This will also reduce migration of the people from rural to urban communities, and enhance rural development.

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Solution Processed Aluminum Oxide Thin-Film Dielectrics: Insights into Structure and Properties

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Keywords: Semiconductors, Thin-films, Inorganic Clusters, Structural Characterization

Aluminum oxide films prepared from CSMC cluster precursors are envisioned for applications as high-k dielectrics and other end uses. Their structural characterization is complicated by the lack of long-range order—which prevents structure-performance relationships to be readily determined. Here we report on a wide range of characterization techniques, namely 27Al solid-state NMR, FTIR, XRD, and TPD to inform us of changes in the film morphology with annealing temperature. These structures are then correlated with performance metrics, such as the measurement of the dielectric constant of the material.

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Structural and optical characterization of tin oxide codoped with aluminum and sulphur

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Keywords: Spray Pyrolysis, Tin Oxide, Transparent conductors, Co-doping

Thin films of Tin oxide co-doped with 28%Aluminum and varied concentration of Sulphur were prepared on $1 \times 1\ m^2$ glass substrates at 470^0C by spray pyrolysis technique. Films were produced from 2.0 M solution of hydrous tin chloride dissolved in ethanol with a few milliliters of hydrochloric acid, 1.5M aqueous Aluminum chloride and 2.0M aqueous solution of Ammonium Sulphide. Effects of Sulphur concentration on structural and optical properties of transparent tin oxide thin films were investigated in the Sulphur content range 0.0-50.0 % with a fixed 28%Al content. Structural and optical characterization of films was measured with Siemens D5000 X-ray diffractometer and Perkin-Elmer Lambda 900 double beam spectrophotometer respectively. Dispersion analysis based on a model of Drude and Kim terms was used to simulate the experimental transmittance and reflectance data. Films with thickness lying in the range 171nm-247nm were analyzed. Polycrystalline structures without any second phases were observed with preferential orientations along the (110), (101), (200) and (211) planes. Average grain size as determined from the (110) peaks lay in the range 19.2nm-47.7 nm. Optical band gaps lay in the range 3.93-4.02eV. It was observed that co-doping lowered the grain size significantly and increased transparency of the oxide.

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Study of some materials as buffer layer in $CuSbS_2$ solar cell using SCAPS-1D

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Keywords: Solar cell, buffer layer, $CuSbS_2$, Efficiency

This study involves the study of thin film materials as buffer in $CuSbS_2$ solar cells. The materials considered were CdS, InS, ZnSe and ZnS. Firstly, the CdS thin film was used to optimize the $CuSbS_2$ solar cell using SCAPS-1D. A base model using CdS was developed, simulated and an efficiency of 3.13% was obtained. Thereafter, the CdS buffer layer was substituted with InS, ZnSe and ZnS respectively. Efficiencies of 0.26% (InS), 1.72% (ZnSe) and 14.36% (ZnS) were obtained with these materials respectively. In conclusion, ZnS thin film is a viable buffer material for $CuSbS_2$ solar cell due to its output performance and non-toxicity.

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Surface passivation effects on CO_2 sensitivity of spray pyrolysis deposited Pd-F:SnO_2 thin film gas sensor

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Keywords: Gas sensor, passivation, CO_2, spray pyrolysis, SnO_2, co-doping

Different thin films samples made of SnO_2, F:SnO_2, Pd: SnO_2 and and co-doped Pd-F: SnO_2 were deposited at a substrate temperature of 450^oC using optimized doping concentrations of F and Pd, thereafter the samples were annealed and passivated in a tube furnace at 450^oC. Optical and electrical methods were used in characterizing the thin film samples: The band gap energy for all samples was extracted from optical data using a proprietary software, Scout™ 98. The calculated band gap energy were found to be 4.1135eV for Pd:SnO_2 and 3.8014eV for F:SnO_2 being the highest and the lowest calculated band gap energies, respectively. The wide band gap energy has been attributed to the incorporation of Pd ions in crystal lattice of SnO_2 thin film for Pd:SnO_2 while for F:SnO_2 has been due to incorporation of F^- ions in the crystal lattice of SnO_2 which gives rise to donor levels in the SnO_2 band gap. This causes the conduction band to lengthen resulting to a reduction in the band gap energy value. The electrical resistivity was done by measuring the sheet resistance of the SnO_2, Pd:SnO_2, F:SnO_2 and Pd-F:SnO_2 thin films. The undoped SnO_2 thin film had the highest sheet resistivity of 0.5992 Ωcm while F:SnO_2 had the lowest sheet resistivity of 0.0075 Ωcm. The low resistivity of F:SnO_2 results from substitution incorporation of F- ions in the crystal lattice of SnO_2 thin films, instead of O^- ions which lead to an increase in free carrier concentration. The Pd-F:SnO_2 gas sensor device was tested for CO_2 gas sensing ability using a lab assembled gas sensing unit. The performance of the gas sensor device was observed that: the as prepared device was more sensitive to CO_2 gas than those subjected to annealing and passivation. The decrease in the sensitivity of the annealed Pd-F: SnO_2 gas sensor is attributed to decrease in grain boundary potential resulting from grain growth. This causes a decrement in adsorption properties of CO^- and O^- species by the annealed Pd-F: SnO_2 thin film. The sensitivity of passivated Pd-F: SnO_2 gas sensor was found to be the lowest. The low sensitivity is due to the effects of nitration and decrement in grain boundary potential resulting from grain growth, nevertheless, the sensitivity of the passivated Pd-F: SnO_2 thin film was found to be within the range for gas sensing applications.

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Synthesis and characterisation of poly(vinylcarbazole)-polyaniline-nickel conducting polymer blend nanocomposites for opto-electronic applications.

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Keywords: Nanocomposites, *in-situ* polymerisation, conjugated polymers, Polymer blends, devices

In this study, PVK/PANI conducting polymer blends incorporating nickel nanoparticles to form PVK/PANI/Ni nanocomposites systems of different concentrations has been chemically synthesized. The optical response, morphology, crystal structure, chemical composition and electrical characteristics (sheet resistance) of the synthesized nickel nanoparticles, PVK/PANI blend, and PVK/PANI/Ni nanocomposites were investigated with a view to developing new nanomaterials that could be utilized as part of active materials in a multilayered organic electronic device. Nickel nanoparticles concentrations of 5%, 10%, and 15% were chemically incorporated into PVK/PANI via *in-situ* polymerization to obtain PVK/PANI/Ni nanocomposites systems The fabricated nanomaterials showed characteristics that are promising for use in organic opto-electronic devices.

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Synthesis and characterization of tin oxide nanoparticle for energy applications

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Keywords: Tin Oxide, Hydrothermal, Microscopy, Optical Properties, Microstructure

Tin oxide (SnO_2), a transparent conducting oxide and a wide band gap n-type semiconductor, has been used in many applications such as gas sensors, electrodes in solid-state ionic devices, solar cells, etc., due to its unique properties such as chemically inert, mechanically hard, and thermally heat resistance. Tin oxide can be synthesized using a variety of techniques such as sol-gel, hydrothermal method, precipitation, carbothermal reduction and polymeric precursor. In this preliminary work, the reverse micelle microemulsion and hydrothermal techniques, have been employed to synthesize tin oxide nanoparticles with much focus on varying the synthesizing parameters to determine their effect on the tin oxide nanoparticles. We elucidate the synthesis process and mechanism for the nanoparticles formation. The microstructure, morphological and optical properties of the as-prepared nanoparticles have been characterised via X-ray Diffraction (XRD), FTIR/Raman Spectroscopy, Scanning Electron Microscopy (SEM) and UV-Vis spectroscopy. The rutile structured nanoparticles have average crystallite size of 6.73nm and 7.62nm and optical energy band gap of about 3.4eV.

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The South African perspective in the vision of the global technology development of hydrogen fuel cells

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Keywords: (South African HFCT Strategy, Global HFCT Development, (PEM) fuel cell system)

The South African hydrogen fuel cell technology (HFCT) initiatives is a national strategy response to the globally emerging HFCT sector. Among the currently developing renewable technologies, hydrogen fuel cell technology may be one of the most promising. As a part of this general thrust, the South African Department of Science and Technology is encouraging and funding the development of fuel cell technology. If successful within the sustainability and financial constraints, a well-developed hydrogen fuel cell technology for South Africa and the region, can decrease strain on the national economy, and cut down the country's carbon footprint from coal-fired power generation. There is also the potential to improve the lifestyle and the economy in the remoter parts of the nation and the region by enabling on-site generation of electricity. The outline entails and locates to the global project scale, stage of development, and know-how of the South African HFCT initiatives in the context of its project and achievements made concrete up to date and the endeavour towards its goals. The country being known as the wealthiest on platinum group metals, key elements to HFCT system efficiency, mainly the most effective proton exchange membrane (PEM) fuel cell system.

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Theoretical and experimental study of the electronic and optical properties of transition metal doped zinc oxide

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Pure and transition metal (TM)-doped ZnO crystals have been synthesized using a wet-chemical process with ZnCl2 as precursor. The chlorides of Fe, Ni and Mn were used in doping at 2, 4, 6 and 8 mol % and KOH was used as precipitant. Crystal phase characterization was carried out with X-ray powder diffraction which confirmed the formation of ZnO at lower doping concentrations for all the samples. At 6 % and 8 % Fe-doping, Xray diffraction showed other peaks indicating the formation of other crystalline phases long shifting of peak positions to lower 2θ angles. Ni doped ZnO did not show the formation of other crystalline phases and the shifting of the 2θ peaks to lower angles was not observed in samples doped beyond 2 %. The appearance of other crystalline phases in Mn doped ZnO was only observed in 8 % mol doping. There was no consistent down shifting of the 2θ peaks to lower angles beyond 2 % mol doping in all samples. The band-gap was determined from the absorption edge of the UV absorption spectrum. Fe-doped ZnO showed an increase in band-gap from 3.30 - 3.36 eV. Mn-doped ZnO showed an increase in band-gap from 3.30-3.33 eV from 0 % -6 % samples and a decrease to 3.30 eV in the 8% mol doped ZnO whereas Ni-doped ZnO showed an initial decrease in the band-gap from 3.30 to 3.26 eV, followed by an increase in band-gap to 3.35 eV for the 6 % doping. This research work seeks to examine the correspondence between the results from experimental and abinitio computation for the electronic and structural changes caused by TM-doping in ZnO. Preliminary work on the ab-initio computation has started but there are no results so far.

Update on recent research activities for new applications of phosphates

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Keywords: Phosphate synthesis, hydroxyapatite, Energy storage, Calcium carbonate waste

This presentation will review results obtained by the phosphate group at the School of mining in Albi during the past dozen years. Most of the research was made in collaboration with the Solvay headquarters in Brussels, Belgium. Solvay is a world leader in production of sodium bicarbonate, and part of this production is used for neutralizing acid gas emissions from incineration facilities (the Neutrec process). Yet the Solvay process leaves large amounts of basic residual brines and calcium carbonates which are stored on site where the production activities occur These waste minerals have accumulated over the years and led to the need to recycle them in some sort of beneficial re-use. The basic brines can be neutralized with atmospheric or waste CO2 to form precipitated calcium carbonates. We have examined the calcium carbonates present and found that they can be converted to calcium phosphates by reaction with phosphoric acid. The resulting minerals have good capacity to capture heavy metal ions in solution or gas phase and can be combined with the Neutrec process to purify industrial gas emissions. They can also be introduced in wastewater treatments to reduce the biological burden by adsorption of organics and toxic metals. An extension of this research to soil remediation demonstrated that phosphate introduction in heavy metal bearing dredging residues stabilizes the toxic elements by drastic reduction in solubility. The same occurs in treatment of MSWI fly ash. We will discuss the mechanism leading to these results and also present some work done on lithium iron phosphate species used in storage batteries for cars. The work demonstrates that phosphates are of use for agriculture and also other advanced environmental technnologies.

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Variable Dc Output Feedback Phase Controlled Power Conversion

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Keywords: silicon-controlled-rectifier, light-activated-silicon-controlled-rectifier, silicon-controlled-switch, gate-turnoff-switch, feedback

Several household appliances and energy storage devices such as electrochemical cells (batteries) utilize direct current (DC) power supplies input. Thus, alternating current (AC) from the mains often have to be converted to DC. Conversion losses up to forty percent are usually encountered using traditional linear power supply. We present here the use of the four-layer *pnpn* semiconductor devices commonly referred to as thyristors for switch mode power supply. By examining available commercial samples with respect to their material structure and current-voltage characteristics, we establish important parameters affecting its controlled rectification. By varying these parameters in software based simulations, we establish the trends in the behaviour. Based on these trends, we propose a design for an AC to DC converter with variable DC output and a current control feedback to monitor output and boost efficiency. Simulation of this design indicates the possibility of a new mechanism for achieving sustainable energy with rechargeable batteries (energy storage devices) or solar cells by regulated power, static switching and phase control charging.

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A Ghanaian archeological clay enhances fungal growth *in-vitro*

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Archeological clay was excavated in context and characterized using X-ray diffraction (XRD), Fourier Transformed Infra Red Spctroscopy, BET and inductively coupled plasma--optical emission spectroscopy (ICP-OES) techniques. The XRD analyses revealed an orthorhombic chamosite structure with Lattice parameters a =15.11 A, b= 7.92 A and c=7.21A. The ICP analyses revealed varied concentrations of Fe, Mg, Cr, Pb Ca, Zn, and Ni. The pore structures of the chamosite were well characterized by BET. Medical practices in prehistoric times used materials such as clay soil and plants parts to cure various ailmnets including chronic and infectiuos diseases. In this study we tested the usefulnes of the clay in antimicribial activity. The clay promoted fungal growth in vitro using a broad spectrum of fungal pathogens, and even abrogating the antifungal activites of the most potent commercially available drugs. The results suggest the potential application of this clay material in tissue engineering to prepare scaffold materials for tissue growth.

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A Preliminary Study of Phase Transformation in Sintering of Mechanically Activated Mullite-Cordierite Composite Precursors

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Key words: cordierite, mullite, phase transformation, mechanical activation, x-ray diffraction

A cordierite precursor mixture of kaolin, talc, aluminium hydroxide, alumina and a secondary silica source (silica gel) was studied with respect to the influence of wet milling intensity per unit time on phase transformation pathways. The effects of mechanical action and milling times were investigated at 1150°C for 2hrs. This resulted in the development of significant mechanically assisted phase transformations specifically related to formation of mullite in the most highly activated materials. Mullite transformation to pre-cordierite mineralogy and the formation of silicate were also found to be dependent on the degrees and methods of mechanical processing.

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Anatomical properties of blighia sapida

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Keywords: anatomical properties, *Blighia sapida*, scanning electron microscope

Wood anatomical structure of various tree species help identify the wood. The characteristics and composition of these structures affect its utilisation. In this work we studied the anatomical properties of *Blighia sapida* a lesser-known Ghanaian hardwood species using the light microscope and scanning electron microscope (SEM). Anatomical features studied were fiber length, double fiber wall thickness, fiber proportion, vessel diameter and proportion, rays and axial parenchyma proportions. We observed that the use of SEM in studying the anatomical or ultra-structural aspects of wood gives a clearer understanding of the features and structures found in wood. Anatomical features such as presence of crystals and absence of axial parenchyma in *Blighia sapida* were better understood.

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Anti-hyperglycaemic effect of Terminalia catappa Linn. (Combretaceae) Stem bark extract

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Keywords: *Terminalia catappa*, extract, fractions, diabetes, optimal activity

This present study was designed to investigate the effect of methanol stem bark extract and fractions (n-hexane, ethyl acetate, butanol and water) of *Terminalia catappa* on glucose level, liver enzymes (AST, ALT and ALP), and blood parameters (PCV, Hb, WBC and RBC) in streptozotocin, alloxan and alloxan-nicotinamide induced diabetic Wister rats. The dried pulverized stem bark was subjected to macroscopic, microscopic and analytical standards. The crude extract (CE) was screened for its anti-hyperglycaemic effect at different doses (125mg/kg, 250mg/kg, 500mg/kg) and fractionated into n-hexane fraction (HF), ethyl acetate fraction (EF), butanol fraction (BF) and water fraction (WF). The crude extract and the fractions were screened for anti-hyperglycaemic activity with the most effective dose being 500mg/kg. The crude extract and the fractions significantly ($p<0.01$) reduced the blood glucose levels when compared with control. The potency/activity of the extract and fractions increased in the order WF>BF>CE>EF>HF; with the WF and BF at 500mg/kg exhibiting reduction comparable to that obtained with 500mg/kg metformin. The extract and fractions significantly ($p<0.01$) decreased AST and ALT, but increased ALP levels. It also significantly increased PCV, Hb, RBC, but there was no significance in WBC count. Acute toxicity test on the CE established an oral LD_{50} of >5000mg/kg in rats, as well as sub acute toxicity. Phytochemical analysis of the extract and the fractions showed the presence of various bioactive substances such as alkaloids, tannins, flavonoids, saponins, terpenoids, steroids, cardiac glycosides, carbohydrates, proteins and anthraquinones. The results of the present study showed that the stem bark of *Terminalia catappa* Linn. possess anti-hyperglycaemic activity. The bioactive fractions can be formulated into effective drug delivery systems for optimal activity

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Antihypertensive Effects of the Fruit of *Haematostaphis barteri* Hook

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Keywords: *Haematostaphis barteri* Antihypertensive, median lethal dose (LD_{50}) traditional medicine.

Haematostaphis barteri is a tree widely distributed in Eastern Nigeria. The plant is used in traditional medicine for the treatment of ulcers, as tonic and as anthelmintic. The fruit is used for high blood pressure. Acute toxicity and antihypertensive studies of the methanol extract and its n-butanol fraction from the fruit revealed an *intraperitoneol* median lethal dose (LD_{50}) of 4330.1 mg/kg and 3807.9mg/kg for methanol extract and butanol fraction respectively. A single administration (at the dose of 1 mg/kg, 10 mg/kg and 100 mg/kg produced a dose dependent hypotensive effect on both extract and n-butanol fraction. These effects may be attributed to angiotensin conversion enzyme inhibition, vasodilator and vasoprotective activities which were reported for phytoconstituents such as anthocyanins and other flavonoids present in the fruit. The result therefore supports the claims by traditional medical practitioners that the fruit could be beneficial in the management of hypertension.

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Antioxidant, Anti-bacterial and Cytotoxic Activities of Ethyl acetate and Methanolic extracts of *Cryptolepis oblongifolia* (Meins) Schltr

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Key word: *Cryptolepis oblongifolia*, Inflammation, cytotoxic, and antioxidant

Cryptolepis oblongifolia (Periplocaceae): is a shrub indigenous to West Africa. Traditionally, it is used in treatment of stomach aches, intestinal diorders, amoebiasis and inflammations. The aim of this research was to established scavenging activity of Ethyl acetate and methanolic extracts of *Cryptolepis oblongifolia* on 2, 2 – diphenyl -1- picrylhydrazyl (DPPH), Ferric ion reducing antioxidant power (FRAP), [2, 20 azino – bis (3- ethyl benzothiozoline -6- sulfonic acid) diammonium salt (ABTS)], Antimicrobial activities, total phenolic/flavanoids and cytotoxic activities of the extracts were assessed. Extracts were obtained by meceration, a broth serial micro dilution method was used to determine the minimum inhibitory concentration (MIC) against Gram-positive and Gram- negative bacteria and mycobacterium species. The antioxidant activity was determine using free radical scavenging assays, and the 3- (4, 5 – dimethythiazolyl -2-) -2, 5 diphenyl tetrazolium bromide reduction assay was used for cytotoxicity. Both the extracts of *C. oblongifolia* shows considerable to weak antimicrobial activity (MICs ranging from 32 to 1024 µg/ml) were obtained, significant value ($P < 0.05$) free radical scavenging activity (IC50 ranging from 43.76 ± 0.7 to 515 ± 0.7), cytotoxicity on Vero cells were LC_{50} 39.07 ± 4.2 and 716.86 to 114.80 µg/ml. Our finding support the use of *C. oblongifolia* roots in treatment of inflammation related conditions in traditional medicine

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Application of TiO_2 Nanoparticles as Catalyst in the Photo degradation of Dye Contaminated Water

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Keywords: Nanocrystalline TiO_2, Rhodamine B dye, Photodegradation

Water contamination from the disposal of dye pollutants into the ecosystem has numerous adverse effects such as: aesthetic pollution, eutrophication and perturbations in aquatic life. Methods to mitigate these effects including physical and biological methods have been reported. On technique that has great potential is the photo-degradation using semiconductor nanoparticle catalyst. In this work, we have explored the synthesis of porous TiO_2 nanostructured powders using the sol gel and hydrothermal techniques. The as-prepared nanoparticles were characterized using X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), *Brunauer–Emmett–Teller* (*BET*) surface area analysis and Thermogravimetry (TG) for their microstructure, morphology, porosity and thermal properties. The TiO_2 nanoparticles in Rhodamine B dye solution was exposed to UV-light source for different time durations and the optical properties were measured using the UV-Vis spectrometer. The effects of the synthesized TiO_2 catalyst on the photo-degradation of Rhodamine B dye are also presented. The results demonstrate that the rhodamine dye was successfully degraded with time. The implications of the results are further discussed to influence the use of TiO_2 as catalyst in the photodegradation of dye pollutants in contaminated water sources.

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Assessing the extracts of ashed fruit calyx of borsassus aethiopum (Fan Palm), whole seed of teak tree and castor plant leaf as potential bio flocculants for harvesting micro alga from waste fish pond water for biofuel production

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Keywords: Algae economy, Bio flocculants, Plant ash, Sedimentation,

Harvesting of microalgae from ponds and other aquatic media have been the costliest aspect in the establishment of an algae economy. Attempts have been made by scientist world over at developing cheap, feasible and ecofriendly methods for solving this problem. This paper presents another attempt using waste and natural materials in harvesting algae cultures from waste aquatic media. Fruit Calyx of *Borsassus Aethiopum* (Fan Palm), Whole Seed of Teak Tree and Castor Plant Leaf were collected and burnt in an open system. The ash generated were soaked in calculated amount of distilled water (pH 7.0), for 24Hrs. The filtrate obtained was used in the flocculation and sedimentation investigation at different concentrations and volumes. The results obtained showed that at the same volume of water (1Ltr), filtrate pH values were, Fruit Calyx of *Borsassus Aethiopum* (9.9), Whole Seed of Teak Tree (10.1) and Castor Plant Leaf (10.6). The concentration of the extracts and volume used has a direct relationship with the precipitation rate and sediment height as measured with a meter rule. There was observed difference in product colour and density with the later expressing the nature of material flocculation rate in relation to flocculants concentration. The species present in the aquatic medium were also identified using standard method of identification of micro-organism.

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Assessment of Paediatric Dispersible Paracetamol Tablet Containing Lentinus tuber regium Based Co-Processed Filler-Binder-Superdisintegrant

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Keywords: Paediatric, dispersible, paracetamol, *Lentinus tuber regium*, co-processed, filler-binder-superdisintegarnt.

Paracetamol (PCM), enlisted in World Health Organization (WHO) Essential Drugs List (EDL) and common for children in liquid formulations is a widely used analgesic/antipyretic for all ages, especially in reducing post-vaccination fever in infants/toddlers. Its paediatric dose is sometimes calculated from the adult formula by health professionals based on its concentration in mg/kg of body weight. This is not always realistic for parents or care-givers to manage at home, especially among the unenlightened class. Children of very wide varying age bracket may receive the same dose for the fact that single paediatric dose of PCM in tablet form is not popular. This study evaluates a co-processed filler-binder-superdisintegarnt based on edible mushroom, *Lentinus tuber regium* incorporated to trigger rapid dispersion of a paediatric dispersible tablet (PDT) containing 125 mg of PCM prepared by solvent evaporation of alcoholic wet massed excipients. Granules were prepared and evaluated for its flowability and microbiological fitness and later compressed into tablets. Granules obtained were free from enteric or pathogenic organisms, flowable and its compression resulted to tablets with crushing strength, 30.60 ± 1.01 N; friability, 0.20 ± 0.01 % and crushing strength friability ratio (CSFR), 153.00. Uniform and complete dispersion of the PDT occurred in 28 s in 10 ml of water at 27 ± 2 °C. A spectrophotometric assay of the entire dispersion yielded 120.99±0.84 mg of PCM *in vitro*. It is hoped that this portable and easily dispersible single paediatric dose of PCM tablet will reduce the pains and sometimes, inaccuracies incurred in calculating paediatric doses of PCM from adult formula, especially among the unenlightened care-givers.

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Bio-flocculants from the extracts of ashed leaves of African almond tree and seed pods of bride of Barbados as harvesters of micro algae from fish pond waste water for biofuel production

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Keywords: bioflocculants, pride of Babadoos, African Almond, Pawpaw, Banana, palm frond, bioash

Harvesting of microalgae from ponds and other aquatic media have been the costliest aspect in the establishment of an algae economy. Attempts have been made by scientist world over at developing cheap, feasible and ecofriendly methods for solving this problem. This paper presents another attempt using waste and natural materials in harvesting algae cultures from waste aquatic media. Leaves of African almond tree and seed pods of bride of Barbados tree were collected and burnt in an open system. The ash generated were soaked in calculated amount of distilled water (pH 7.0), for 24Hrs. The filtrate obtained was used in the flocculation and sedimentation investigation at different concentrations and volumes. The results obtained showed that at the same volume of water (1Ltr), filtrate pH values were Pawpaw leaves (10.7), Banana leaves (10.8), Banana stem cutting (11) and Palm frond (10.9). The concentration of the extracts and volume used has a direct relationship with the precipitation rate and sediment height as measured with a meter rule. There was observed difference in product colour and density with the later expressing the nature of material flocculation rate in relation to flocculants concentration. The species present in the aquatic medium were identified using standard method of identification of micro-organism.

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Biomedical materials: applications in the human body implants

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Keywords: Biomaterials, biomedical devices, properties, applications, human body, natural function

Biomaterials are nonviable materials used in medical devices, intended to interact with biological systems. They are often used and/or adapted for medical applications, and thus comprise whole or part of a living structure, or biomedical device which performs, augments, or replaces a natural function. This paper discusses various classes of biomedical materials, their properties, applications and factors that affect their usage. Attempts were also made to enumerate problems that may be experienced by the use of biomaterials in the human body implants and emphasis made on the possible ways of solving them, implants.

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Characterization and use of low cost adsorbents for removal of a cationic dye and a metal ion.

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Keywords: Adsorption, Copper ions, Characterization, Methodology of Experimental Design, MB.

The objective of this study is to evaluate the ability of three potential adsorbents to remove copper ions and a cationic dye -Methylene Blue (MB). The low-cost adsorbents, used in this study, are Natural Phosphate (NP), Hydroxyapatite (HAP) and Calcined Snail Shell (CSS). Activated carbon (AC) was widely used because of its high adsorption abilities but it was restricted due to its high cost. In our study, AC was used as a reference. Analytical techniques have been employed to characterize the adsorbents. The Characterization of NP and HAP includes the elementary analysis and structural analysis (infrared spectroscopy, X-ray diffraction, scanning electron microscopy, TEM and BET).The characterization results showed the very high specific surface area of 230m²/g for HAP and 20m²/g for NP. The proximate physicochemical characterization of the CSS showed the $pH_{solution}$ to be 8.01, high fraction of the inorganic constituents (ash content = 93.76%), the presence of Ca^{2+} (99.74%) and the point zero charge (PZC) found at pH 7.9. The X-ray diffractometric analysis revealed the presence of aragonite. Several parameters such as adsorbent dose, contact time and adsorbate concentration have been optimized for the maximum removal of MB and copper ions. The Methodology of Experimental Design have been developed to determine optimal conditions. Experimental results show that NP, HAP and CSS can eliminate MB and copper ions .While, the adsorption of copper ions on CSS is very low. The data confirmed that the retention rate increase with adsorbent dose, contact time and decrease when initial concentration of MB increases. Overall, the findings of this study show that these materials can be exploited for MB and copper ions remediation and this is mainly due to its efficiency, low-cost and renewable source.

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Characterization of hydroxyapatite influence on tensile properties and biodegradation of polyethylene/starch blend for bone fixation

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Biodegradable materials have been used in several application including pins, screws and bone fixation plates, Thecurrent standards for biodegradable implants are poly (lactic acid) (PLA), poly (glycolic) acid (PGA) and their copolymers. PGA exhibits excellent bone-matching mechanical performance but exhibits loss of strength between 30 - 60 days. PLA on the other hand takes as long as 10 years for complete degradation, with a loss in strength after 180 days. Attempts to address these drawbacks have included blending the standards with macromolecules such as chitin, chitosan, fibrin, starch and so on. PLA/PGA implants can generate inflammatory responses due to the leaching of low molecular weight components and acidic products which constitutes a major challenge for these systems. Bio-based high molecular weight polymers (from linear low-density polyethylene (LLDPE)) and macromolecules (starch) have been proposed. The macromolecule is expected to degrade leaving pores in the polymer for hard tissue ingrowth. The problem with LLDPE/starch blend has been with the interfacial adhesion between polyethylene and starch. Because starch is hydrophilic and LLDPE hydrophobic, there is always immiscibility between the constituents. To overcome this drawback, glycerol has been used as plasticizer and this enhances processability and mechanical properties but results in delay of biodegradation. For proper control of biodegradation, hydroxyapatite (HA) has been proposed in this project. Hydroxyapatite contents were varied from 1.0% to 3.0% in intervals of 0.5% by parts and the blend phases were characterised. Biodegradation was studied by performing water absorption and enzymatic tests. Water uptake by the samples was carried out according to ASTM D570 and enzymatic tests were carried out on samples in phosphate buffered saline (PBS) solution containing α-amylase. Tensile properties of the samples before and after enzymatic degradation were determined in addition to surface changes. The results obtained show that the incorporation of HA content into LLDPE/starch blend returned a slight increase in strength at a p-value of 0.0008 but the rate at which the blend degraded depends on the amount of HA in it. As HA content increased, the moisture uptake of the blends increased and enzymatic degradation rate increased, giving rise to high percentage loss in tensile strength and modulus. Conversely there was a high gain in percentage elongation which is indication of ductility. This may help prevent catastrophic failure of the blends as a result of accidental overload or localized strain. The results have been explained as HA having affected the intermediate phase of the blends through hydrogen bonding by the hydroxyl group.

Chemical modification of celtis mildbraedii (Esa Fufuo), a tropical hardwood species to improve its durability

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Keywords: Durability, Chemical modification, Graveyard wood.

Celtis mildbraedii (Esa fufuo) is a high density hardwood species and is abundant in the forest of Ghana but has a low durability as one of its disadvantages. In this study, *Celtis mildbraedii* (Esa fufuo) has been chemically modified with Acetic Anhydride (AA) and Propionic Anhydride (PA) in dry pyridine to improve its durability against fungi and termites. De-ionized water (DW) was used in place of a modification agent as a control. Graveyard test was used to determine the effect of the modification in twelve weeks in-ground contact of the modified and the unmodified wood samples. Percentage weight loss, visual decay grades and termite destruction grades were used to analyze the durability of the modified samples. The modified samples were found to be more durable than the unmodified samples as shown by average decay resistance and the average termite destruction from week four to week twelve. (Weight loss AA = 0.2%a to 0.37%a: PA = 0.73%a to 1.52%a: DW 19.55%b to 59.10%c. The higher the weight lost the poorer the durability). (Decay Grade, AA = 10 to 9.87, PA = 10 to 9.87 DW = 6.67: Termite destruction Grade, AA = 9.60 to 9.93, PA = 10.0 to 9.93 DW = 4.73 to 0.27; all sample grades are from week 4 to 12.Grade 10 being the highest durability and 0 non durable).*Means with the same superscript are not significantly different at $P < 0.05$.

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Colorimetric and dynamic light scattering-based nanoparticles assays for tumour suppressor protein detection

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Keywords: (p53, transcription factor and DNA)

The guardian of genome: p53 is a tumor suppressor protein that plays a central role in cancer biology. It regulates the gene expression through binding with specific DNA response elements (RE), thereby enabling many important biological functions such as DNA repair and apoptosis. About 50% of human cancers can be associated with mutated p53 proteins that do not bind with the RE. Gold nanoparticles (AuNPs) are a useful sensing probes for biological analysis due to its interparticle-distance dependent color change property resulted from the collective excitation of surface electrons by light. In this study, we have developed a dual sensing platform based on this unique optical properties (i.e., colorimetric and light scattering) of AuNP to enable simple and fast label-free detection of p53 protein-DNA binding interactions. The p53 DNA-functionalized AuNPs undergo visible solution color change from red to blue in the presence of wildtype p53 protein (wtp53). The extent of color changes can be measured by the UV-visible absorption spectra. Typically, red-colored AuNPs exhibit a sharp surface plasmon resonance (SPR) peak at 520 nm wavelength while the SPR peak of blue-colored AuNPs is located at a longer wavelength. A highly linear concentration-dependent calibration curve based on the red-to-blue SPR peak ratio of DNA-AuNPs is established to quantify the amount of wtp53 in complex biological samples with a detection limit of 20 nM within 5 mins. TEM images show that the sequence-specific wtp53-DNA binding lead to the aggregation of DNA-AuNPs. Control experiments with the mutated p53 (mutp53) and human serum albumin (HSA) showed no distinct color change of the DNA-AuNPs (remain red and well dispersed) in the binding buffer. Dynamic light scattering (DLS) measurement is also conducted to profile the size changes of DNA-AuNPs in the presence of wtp53. It was found a more sensitive detection limit (pM) can be achieved via the nanoDLS assay as compared to the colorimetric assay with a lesser amount of DNA-AuNPs needed to differentiate binding interaction of RE with wtp53 versus mutp53 proteins. Hence, this DNA-AuNP probe can serve as a versatile biosensor for wtp53 detection without labels, enzymes, tedious protocol or sophisticated instrumentation, and it overcomes some of the major limitations of many conventional methods

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Comparative effect of alkalescent extracts of ashed pawpaw leaves, banana leaf and stem and palm frond, on the flocculation and sedimentation of micro algae from waste generated from freshwater fish pond.

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Keywords: Algae economy, Bio flocculants, Plant ash, Sedimentation,

Harvesting of microalgae from ponds and other aquatic media have been the costliest aspect in the establishment of an algae economy. Attempts have been made by scientist world over at developing cheap, feasible and ecofriendly methods for solving this problem. This paper presents another attempt using waste and natural materials in harvesting algae cultures from waste aquatic media. Dried leaves of Pawpaw, Banana, Palm frond and stem cutting from Banana, were collected and burnt in an open system. The ash generated were soaked in calculated amount of distilled water (pH 7.0), for 24Hrs. The filtrate obtained were used in the flocculation and sedimentation investigation at different concentrations and volumes. The results obtained showed that at the same volume of water (1Ltr), filtrate pH values were Pawpaw leaves (10.3), Banana leaves (10.4), Banana stem cutting (10.2) and Palm frond (10.7).. The concentration of the extracts and volume used has a direct relationship with the precipitation rate and sediment height as measured with a meter rule. There was an observed difference in product colour and density with the later expressing the nature of material flocculation rate in relation to flocculants' concentration. The species present in the aquatic medium were identified using standard method of identification of micro-organism are, *Chlorella vulgaris*, *Synechococcus sp*, *Scenedesmus obliquus*, *Tetraselmis suecica*, *Chaetoceros muelleri*, *Rhodomonas salina*, *Nannochloropsis oculata and Isochrysis sp.*

Conformational Changes of DNA on Graphene

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Keywords: Graphene, Label-free DNA bio-sensing, DNA Hybridisation, UV and Raman Spectroscopy

The majority of label-free DNA bio-sensing technologies are based on A=T and G≡C base pairing underscores. In these devices when a transducer converts the bio-recognition event into a readable signal, a change in DNA conformation is assumed, but the nature of the change is unidentified. Hence, this study, which evaluated DNA hybridisation on a graphene surface and in a sequence specific manner defined DNA conformational changes that occur. On the graphene surface, hybridisations of a self-immobilised single-stranded DNA probe with a complementary strand and triple-base mismatched strand were conducted. Structural transitions of DNA on the graphene surface were monitored using UV and Raman spectroscopy. To demonstrate transduction of the bio-recognition event, current-voltage measurements of graphene as the transducer were taken upon hybridisation. Upon hybridisation of the sensor, ssDNA/graphene/SiO_2/Si, with a complementary target DNA strand and triple-base mismatch strand, a decrease in the mean absorbance was observed. However, the absorbance of the probe-complementary duplex was found to be greater than that observed for the probe-triple-base mismatch duplex. A decrease in the intensity of the graphene 2D band upon self-immobilisation of single-stranded DNA on graphene, and a complete disappearance of the 2D band was observed for the probe-complementary duplex. Both before and after hybridisation, the sensor displayed a non-linear current-voltage responses. Inclusively, the intensity of the UV light absorbed by DNA upon hybridisation was proportional to the change in the electronic responses of graphene. Using these observations, a simpler, portable and novel sequence specific and selective DNA hybridisation-sensing device can be designed.

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Development of bicelles from natural sources for drug delivery

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Keywords: bicelles, chitin, chitosan, x-ray diffraction, FTIR spectrometry.

Bicelles are membrane mimetic models which have the potential to be used in various biomedical applications including drug delivery. Mostly, these systems are developed from synthetic sources. However, it is prudent to investigate the potential of natural sources as bicellar systems for these applications. In this work, chitosan nanoparticles were produced from local crab shells by chemical purification and investigated as bicellar systems for drug delivery. Chitosan has a great potential for biomedical and pharmaceutical applications due to its biodegradability, non-toxicity, good solubility, mucoadhesiveness and biocompatibility. Chitin and chitosan were produced and characterized by x-ray diffraction to determine the crystallinity and the crystallite size of the particles. FTIR analysis was done to investigate the functional groups present in chitin and chitosan. It was also used to investigate the transformation that occurred in the chemical structure of chitin to chitosan after deacetylation. Finally, the potential of chitosan as a bicellar system for drug delivery was analyzed based on the characterizations.

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Development of bioelectrical sensors for cancers, viral and microbial infections

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The burden of disease in Nigeria is very high, as in most of Africa. The cost of disease is escalated by delays in diagnosis as well as difficulties in monitoring treatment. In recent years, attention has turned to the development of diagnostics based on biosensors. Biosensors tend to be highly specific and accurate because they are based on reactions of particular analytes found associated with the condition of interest. It is hoped that we will develop an electro-conductive probe containing engineered immobilized cells in a matrix with an electrical sensor system. The active conducting materials in the proposed biosensor devices are conjugated polymers and the cells will be engineered and selected to specifically interact with a target analyte. Hence when the bio-sensing probe comes in contact with the analyte, a "signature" change in electrical potential would occur. The project is being put together as part of the focussed research areas in biomaterials at the Obafemi Awolowo University, Ile-Ife, Nigeria under the Pan-African Materials Institute (PAMI). The work is yet to take off. The team is highly optimistic of the potential impact this work could have in nanomedicine. The study shall be in phases with the first phase focused on the selection of target biomarkers and engineering of the cells to be immobilized with the appropriate electro-inserted antibodies. The next phase would be the development of the biosensing probe itself. The project should result in more sensitive and efficient diagnosis of cancers, viral and microbial diseases.

Development of diminazene aceturate–sodium oleate complex and preliminary evaluation for the treatment of trypanosomiasis in animal models

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Keywords: Diminazene aceturate-sodium oleate complex, properties, toxicity, effectiveness in trypanosomiasis

The study aimed to improve the efficacy of diminazene aceturate via complex formation with sodium oleate. The complex was formed by simply mixing aqueous solutions of the two ingredients and allowing the mixture to stand for 72 h. The resulting precipitate was harvested, and using standard protocols characterized and subjected to various *in vitro* and *in vivo* tests to assess its properties, toxicity and efficacy against *Trypanosoma brucei brucei* infections in comparison to pure drug. Results revealed that the complex was four times more lipophilic than the pure drug and yet its toxicity profile (LD_{50}) is > 5000 mg/kg. FTIR results showed that the functional groups in the pure drug were retained in the complex and that the complexation was via hydrogen bonding between the amino group of the pure drug and the oleic moiety of sodium oleate. There was no significant increase in the serum levels of hepatic enzymes or reduction in haematological indices upon administration of the complex or pure drug to mice as compared to their states before treatment. The complex was many times more active than the pure drug on *in vitro* cultures of *Trypanosoma brucei brucei and it was still active in vivo.* Complexation of the drug therefore could be a good way of improving its efficacy.

Development of Eggshell Powder for Possible Application in Direct Compression Technology

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Keywords: Eggshell, direct compression, powder and tablet properties.

This work is aimed at developing eggshell powder for use as a pharmaceutical excipient and to evaluate its use as a direct compressible excipient in tablets. Eggshells sourced locally were macerated in 1 % sodium hypochlorite solution for 12 hours and then washed thoroughly with distilled water, allowed to air-dry and pulverised. The powder was screened through a 0.18mm aperture sieve and then, sterilised by dry heat at 160 ^{o}C for 1 hour. Microbial counts were carried out to determine conformity with official standards. Heavy metal analysis was carried out using atomic absorption spectrophotometry. Compatibility studies of the eggshell powder mixed with ascorbic acid, avicel and stearic acid were carried out using a differential cannoning calorimetry and Fourier transform infra-red spectrophotometry (FTIR). Physical admixtures of the eggshell powder and avicel^{R} PH 101 in the ratios of 1:0, 0:1, 1:1, 1:2, 1:3, 2:1, 3:1, respectively were used in preparing ascorbic acid granules and tablets. A step-wise optimisation approach was employed. The egg-shell powder had better flow than avicel PH 101. The flow properties of granules and tablet properties were determined. The moisture content of the egg-shell powder was 0.68% and microbial analyses revealed compliance with official standards. Heavy metal analysis (confirmed with FTIR) showed that the following metals were present within tolerable limits: Lead (0.092%), Chromium (0.332%), Copper (0.111%), Iron (2.690%), Cadmium (0.390%), Nickel (1.313%), Arsenic (2.988%), Mercury (0.187%), Zinc (0.705%) and Manganese (0.424%). The granules had good flow properties and the best tablet batch contains 30% drug bulked with 1:1 eggshell/avicel pH 101 admixture having complied with recommended limits of hardness, friability, weight variation, drug content and uniformity of content. Thus, egg shell powder could serve as a direct compression agent for ascorbic acid tablets which may help to save cost of pharmaceutical production.

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Development of SAM-modified Multilayer SERS Substrates for Bioanalytical Environmental Applications

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Keywords: multilayer, SERS, substrates, self-assembled monolayers, Raman

Raman spectroscopy is among the new generation of analytical tools with a wide range of potential applications. It offers unique advantages including: provision of molecular information for direct analyte identification, lack of water interferences, little or no sample preparation, applicability in many environments, etc. Raman spectroscopy coupled to nanotechnology results in the enhancement of Raman intensity leading to enhancement factors (EF) of up to 10^{14} due to an effect called Surface-enhanced Raman scattering (SERS). SERS has been applied to food, pharmaceuticals, cultural artifacts, environmental monitoring and general analytical research. It is generally accepted that the success of SERS-based analyses depends largely on the quality of the SERS-substrates; nanoscale roughened metal platforms on which SERS measurements are performed. Therefore current research activities in this field focus largely on SERS-substrates development. This study discusses the improvement of SERS-based measurements using multilayer SERS-substrates (i.e., alternating layers of metal films and dielectric spacers on nanostructures). It was established that the multilayered surfaces increase the SERS EF as much as an order of magnitude relative to single layer SERS-substrate. To further understand the effect of dielectric spacers on the multilayer SERS enhancement, self-assembled monolayers (SAM) have been used as spacers in order to systematically control spacer uniformity, thickness, and dielectric constant. It was observed that the uniformity of the dielectric spacer significantly influenced the sensitivity of the resultant multilayered substrates. In order to assess the multilayer effect on the SERS signal reproducibility, SERS ratiometric measurements have been performed using SERS signals of the SAM dielectric spacer and that of the model analyte. By careful choice of optimal SAM, the conditions of SAM formation, and the amount of metal film deposited on SAM, it was demonstrated that SERS EFs can be further improved by *ca* 8-fold compared to previously optimized single layered SERS substrates.

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Effects of clay mixtures on mechanical properties of micro- and nano-porous alumino-silicate clay ceramics

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This paper presents the results of an experimental study of the effects of clay mixtures on the mechanical properties with controlled levels of plasticity, prior to the processing of porous ceramic water filters. Two clays with well characterized initial compositions (Iro and Ewuya clays) are mixed with varying proportions to control their plasticity. The mechanical properties of the mixed and fired clays are then elucidated using a combination of experiments. These include: the flexural strength, fracture toughness, Young's modulus, and thermal shock resistance of fired clay mixtures. The results show that clay mixtures with 45 vol.% - 60 vol.% of the Iro clay content and 40 vol.% - vol. 55% Ewuya clay content can be used to produce clay composite filters with robust mechanical properties. The thermal shock resistance of a mixed clay filter (containing 50% Iro clay and 50% Ewuya clay) is also explained using a combination of elastic and viscoelastic crack bridging models. The regimes for viscoelastic crack bridging are discussed by comparing the relaxation times to the shock durations. The potential importance of viscoelastic mixture are discussed via the residual strengths measurements. The implications of the results are then discussed for the mixing of locally available clays into robust micro- and nano-porous materials for applications in clay ceramic filters.

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Effects of surface engineering on biomedical devices for control drug delivery in cancer treatment

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The increasing rate of cancer patients worldwide, and especially Africa has led to numerous efforts to battle it. One approach to this has been localized drug delivery to reduce the quantity of drugs needed for therapeutic effect. Poly-di-methyl-siloxane (PDMS) is an elastomer with much focus on it as a microfluidic device. PDMS is one polymer of choice for localized drug delivery due to its biocompatibility, transparency, and ease of fabrication. However, its highly hydrophobic nature does not allow it to be used without modification. This work presents results of the effects of experimental and computational methods for PDMS surface modification on adhesion between cells and substrate. Also computational results of shear assay model for the effects on surface modification on cell adhesion is present. Modifying the surface of the PDMS was done by varying the mix ratio and curing temperatures during, and subsequently after fabrication. The results from the experiment shows that low base to curing agent ratio and increasing curing temperature gives a highly stiff PDMS. Also, the PDMS treatment via boiling water and Ultraviolet Ozone (UVO) methods makes it hydrophilic with the generation of hydroxyl (OH) group on the substrates. The results obtained experimentally was incorporated in a computational system. This was to model the effects of surface modification on cell detachment from substrates. These studies provided understanding of cell-surface interaction on a multi-scale. Morphological studies with Scanning Electron Microscope (SEM) revealed a layer and textured featured formed on UVO treated and PLGA coated PDMS. Shear assay model showed that cells on modified PDMS surface had low energy release rate on application of shear load. This signifies that cells adhered to the modified surfaces better, thus could not be easily detached.

Engaging *drama* in the discussion of material for life, health and the environment

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Keywords: Participation, The playwright, Drama, Environment, Material, Life, Health Communication.

This paper focuses on the effective role the *Playwright* and his craft (play production) can perform to complement the dissemination and communication on Material for Life, Health and the Environment. The paper deals with how a playwright, can use his creative work to facilitate the understanding of Material research findings as a whole, with more emphasis on environmental degradation. It also discusses the findings of a research conducted on women and the environment in contemporary Ghana. *The Woman and the Conservation of the Environment*: *The Case of Atwima Gyekye.* The findings on the research have been creatively woven into a Choreo-poem, entitled: *The Bird in a Changing World.* This poem demonstrates the lamentation of birds due to the destruction of the environment, especially, the forest and trees. In Ghana, and other African countries, all forms of negative tendencies causing health hazards, environmental problems, such as pollution, climate change, flooding, erosion and others emanate mostly from the people and their activities, hence, the same people should be engaged to solve the problem through drama participation. The Playwright's drama as an effective indigenous communication support has the power to teach and reveal the causes and effects of issues concerning Material for life, health and the environment. It can support the role of science in realizing the MRS which is considered as an important tool envisaged for achieving sustainable development, enhancing social inclusion, sustained economic growth, improving human welfare and above all eradication of poverty. As a demonstration, the researcher with other participants will perform the poem *The Bird in A Changing World* as part of the general body of the paper.

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Establishment of a planted filter for wastewater treatment of the Faculty of Science Ain Chock Casablanca.

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Keywords: Vertical flow filters, constructed wetland, filter material, gravel, pozzolan.

In the context of water stress, the Faculty of Science Ain Chock has taken the initiative to develop a system to purify its wastewater and to reuse it for the irrigation of green spaces and cleaning its premises. In order to bring out an optimized system under the local condition, different test has been made for various types of constructed wetlands (CWs). After identification and characterization of Faculty`s wastewater, we designed and implemented four constructed wetlands, using pozzolan as filter material in two constructed wetlands and gravel in the other two CWs. In the case of both types of CWs (pozzolan and gravel), one is vegetated with reeds and the second is unvegetated. All CWs are fed by the Faculty's toilet wastewater, after decantation. The results show that the reduction of organic pollution parameters is satisfactory mainly due to the combined action of macrophytes, bacteria and the physical barrier of the filter body. Indeed, we got to a settling of waste water 48 hours:

A good removal of suspended solids (67%) in the settling basin.

A good reduction of the three physico-chemical parameters selected at the exit of the two filters pozzolan:

84.88% of COD for the filter planted and 81.26% for the non-planted filter.

82.46% of BOD5 for the filter planted and 73.68% for the non-planted filter.

95.37% of the MES for the filter planted and 94.36% for the non-planted filter.

A good reduction of the three physico-chemical parameters selected in the output of both gravel filters: 81% of the COD to the planted filter and 74% for the non-planted filter.

75% of BOD5 for the filter planted and 70% for non planted filter.

95% of the MES for the planted filter and 94% for non planted filter.

In conclusion, using as pozzolan materials instead of gravel gave better results in terms of reduction of pollutants.

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Evaluation of Anti-inflammatory and Antimicrobial Activities of the Leaf Extracts of *Luffa cylindrica*

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Keywords: Luffa cylindrical; anti-inflammatory activity; antimicrobial activity.

This study was carried out to determine the phytochemical properties of L. cylindrica leaves, and to evaluate the anti-inflammatory and antimicrobial properties of leaf extracts of the plant. L. cylindrica leaves were extracted with ethanol and ethyl acetate. The phytochemical content of the plant was screened and then the anti-inflammatory and antimicrobial activities of the extracts were determined using standard methods. The ethyl acetate extract, which showed better activities was subjected HPLC analysis to determine the components. In the phytochemical analysis of the plant leaves, the abundance of alkaloids and flavonoids was revealed. Also, tannins, glycosides and starch were shown to be present in moderate amounts, while saponins were detected in lower quantities. All the extracts of L. cylindrica evaluated showed anti-inflammatory activity. But compared to the standard drug Diclofenac (50 mg/Kg), a good anti-inflammatory activity was recorded by the ethanol and ethyl acetate extracts at concentrations of 100 mg/Kg. In the antimicrobial evaluation, the crude ethanol and ethyl acetate leaf extracts of the plant leaves showed moderate antimicrobial activity against S. aureus, S. typhi and B. subtilis. The plant extracts showed no antimicrobial activity against E. coli, A. fumigatus and C. albicans. The ethyl acetate extract of L. cylindrica recorded better antimicrobial activity against the test isolates compared to the ethanol extract. The HPLC analysis revealed compounds with good anti-inflammatory and antimicrobial properties. The results of this study showed that the leaf extracts of L. cylindrica possess anti-inflammatory and antimicrobial properties. This confirms the folkloric use of the plant in the management of various diseases.

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Evaluation of the in-vivo anti plasmodial activity of the ethanol leaf extract of jatropha gossypifolla in mice infected with plasmodium berghei

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Keywords: Antimalarial, malaria, Plasmodium berghei, Jatropha gossypifolia

This research evaluated of the in-vivo anti plasmodial activity of ethanol leaf extract of *Jatropha gossypifolia* in the treatment of malaria in *Plasmodium berghei* infected mice. Leaves of *Jatropha gossypifolia* were collected and dried for two weeks after which the leaves were pulverized and macerated using ethanol. Phytochemical analysis [Trease and Evans, 1983] for alkaloids, tannin, terpenoids, saponin, phlobatannins, steroids, cardiac glycosides, flavonoids was carried out. Acute toxicity test was carried out using Lorke's method (1983) in order to determine the LD_{50}. The ethanol leaf extract of *Jatropha gossypifolia* (50-200mg/kg) was screened for prophylactic and curative activity against 50 (20-30g) *plasmodium berghei* infected mice using a method employed by Peters (1980). The schizonticidal effect during early and established infections was investigated. The acute toxicity result showed that the extract has high safety margin as its LD_{50} is 4472.14mg/kg. The preliminary phytochemical analysis done on *Jatropha gossypifolia* leaves showed that it contains different metabolites such as tannin, saponin, phlobatannins, flavonoids, terpenoids and cardiac glycosides. This correlates with an earlier study done by Murugalakshmi et al; 2014. *Jatropha gossypifolia* extract (50-200mg/kg) exhibited significant ($P<0.05$) prophylactic and curative activity in both day 4 and 7 with a considerable mean survival time comparable to that of the standard drug, quinine 100mg/kg. The leaf extract of *Jatropha gossypifolia* is said to have a high therapeutic index and is safe for use and posses significant antiplasmodial activity which confirms its use in folkloric medicine in the treatment of malaria.

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Evaporites as Antimicrobial Agents

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Keywords: evaporites, carnalite, natron, potash, trona

Evaporites include wide range of chemical precipitates formed on Earth surface from brines concentrated by solar evaporation in some basins. These salts are used in Nigeria and other African countries as food additives and as traditional medicines for gastrointestinal problems, haemorrhoids, menstrual pains, post-natal care and veterinary practices. Industrially the salts are used as composition of toothpaste, anti-acids, ceramic tiles etc. Four samples of evaporites (natron, potash, trona and carnalite) were evaluated for their elemental content using Atomic Absorption Spectrometry (AAS), safety profile (using OECD method) and antimicrobial properties using four clinical isolates (*Bacillus subtilis, Staphylococcus aureus, Escherichia coli and Salmonella typhi*).The major cations and anions detected from the salts include Na^+, Ca^{2+} Mg^{2+}, K^+, Cl^-, SO_4^{2-}, and CO_3^{2-} .The results also revealed that the minerals are relatively safe for consumption (oral LD_{50} > 5000 mg/kg in Wister rats). The minimum bactericidal concentration (MBC = 50 mg/ml) is generally twice the minimum inhibitory concentration (MIC = 25 mg /ml).These results could serve as rationale behind the traditional uses of evaporates as medicines.

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Functionalization of gold nanoparticles for cancer therapy and diagnosis

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Keywords: Gold nanoparticles, cancer, folate, prodigiosin, drug delivery

Cancer is a worldwide disease! Nanotechnology has provided many promising nanoplatforms for targeted drug delivery for cancer and some other diseases. Gold nanoparticles have some unique qualities that make them stand out among other metallic nanoparticles in terms of their application in medicine. These include being biocompatible, having high surface area-to-volume ratio and non-cytotoxicity. Gold nanoparticles were biosynthesized from plant materials of local origin in a record time of 30 seconds. These were then functionalized with some ligands and an anti-cancer drug, Prodigiosin. The conjugation was confirmed by using UV-Vis spectroscopy, Helium ion microscopy (HIM), Dynamic light scattering (DLS) and Fourier Transformed infrared (FTIR) spectroscopy. There was a consistent increase in the hydrodynamic diameter of the gold nanoparticles after conjugation. The result of the DLS showed a Z-average of 58.9±0.3nm for gold nanoparticles before conjugation, 62.7±0.6nm after conjugation with folate, and 70.5±0.2nm, after attaching the drug, prodigiosin. The PDI of the gold nanoparticles was close to 0.2 even after conjugation. The application of the functionalized gold nanoparticles in the context of cancer detection and treatment were then discussed.

Goat fat and shea butter-based lipospheres of ciprofloxacin hydrochloride

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Keywords: Ciprofloxacin hydrochloride, bioavailability, lipospheres, shea butter, goat fat, Span 80

The aim of this work was to improve the bioavailabilty of Ciprofloxacin hydrochloride by encapsulating with goat fat and shea butter. Lipospheres of ciprofloxacin hydrochloride were formulated using the thin film hydration technique. Twelve different combinations of shea butter, surfactant (Span 80) and goat fat were employed in the formulation of twelve different batches of ciprofloxacin hydrochloride lipospheres. The resultant lipospheres were evaluated with respect to their surface morphology, particle size distribution, encapsulation efficiency, loading capacity, *in vitro* antimicrobial efficacy and *in vivo* bioavailability. The average particle radius was 614.6 nm. The encapsulation efficiency was found to increase with an entrapment efficiency of 99.87 % The loading capacity decreased as the weight of the lipids increase. The test micro-organisms (*Salmonella typhi*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*) showed higher sensitivity to the formulation against the control especially *Staphylococcus aureus* where both the diluted and concentrated portions of the formulation was bactericidal while the concentrated and diluted portions of the unformulated drug (control) had inhibition zone diameter of 10 mm and 8 mm respectively. The serum concentrations of the drug at the different time intervals were far higher with the formulation than with the control. The release pattern of the formulation was biphasic with initial burst release within 30 minutes and another burst release at the 4th hour.

Green fuel and resources from spent spear grass and algae from spent fish pond water

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Keywords: spear grass, Nano cellulose acetate, gelled fuel, Algae, spent fish pond water

The green fuel and resources programme is one that has the components of sustainable bio resource utilization as veritable alternatives to diverse energy demands as well as intermediate and end products utility potential in the automotive and domestic sectors. Cellulosic biomass is commutatively converted to “green fuel” and its gelling component to obtain a highly viscous domestic heating fuel (gelled fuel). The innovative approach of using spent spear grass and other waste biomass in this process, makes it relatively cheaper, environmentally friendly and renewably sustainable for the low income populace. Weight per weight, this gelled fuel reduces fuel consumption by contemporary fossil kerosene by one third of the amount utilized for the same activity. The by-products are water (vapor) and a little amount of CO_2. The technology is of low-tech status, enabling the rural and urban woman to produce their own cheap and clean domestic heating fuel. Algae from spent fish pond water is harvested and oil extracted from it by simple mechanical and solvent method. The oil is converted to biodiesel and or automotive grease for various industrial and domestic applications. The use of the algae from fish pond, creates a sustainable reuse status for the waste stream from fish farming with consequent added financial gain to the local fish farmer who may wish to sell the waste stream to interested producers of either algae oil, biodiesel, automotive grease, pharmaceutical raw materials, food colourants and cellulosic biomass for bio butanol. This program gives value addition to sustainable fish farming at all levels of entry.

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Ibuprofen based solid lipid microparticle: *in vitro* and *in vivo* evaluation and characterization

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Keywords: Solid lipid microparticles, Ibuprofen, Anti-inflammation, Ulcerogenicity.

Contexts: Ibuprofen, a non-steroidal anti-inflammatory agent portrays its effects as analgesic (pain-killing) and antipyretic (fever-reducing) by inhibiting the activity of both cyclooxygenase-1 (COX-1) and cyclooxygenase-2 (COX-2), and thereby enhancing the synthesis of prostaglandins and thromboxane that lead to the anti-inflammatory property. However, it can cause gastric irritation.

Objective: To formulate, characterize and evaluate the *in vitro* and *in vivo* properties of ibuprofen formulated solid lipid microparticles for better activity and less gastric irritation.

Method: The SLMs were prepared by the hot homogenization technique using Ultra turrax (T25 Basic digital). Mixtures of *Irvingia wombolu* fat (IRW) and moringa oil (MO) and Phospholipon® 90G (PL90G) respectively (2:1 w/w) were prepared by fusion. Evaluation and Characterization based on the particle size and morphology, stability and encapsulation efficiency (EE%) were carried out on the SLMs. Also, *in vitro* release was carried out in phosphate buffer (pH 7.4). Anti-inflammatory and ulcerogenic properties were studied using rats

Results: The pH showed significant increase after two months of formulation with maximum of 6.4 and EE(%) obtained were 95.6, 89.4 and 61.6 of SLMs formulated with lipid matrix of Phospholipon® 90G 1% and 2% moringer oil 1% respectively. The *in vitro* release showed maximum release of 87.8 % and 98.97 % of the two different lipid based formulations while anti-inflammatory effect was up to 89.90% after 5 hours of inflammatory induction. The batches of SLM did not show any lesion which present good gastro-protective properties of the ibuprofen. ***Conclusion:*** The SLM exhibited good anti-inflammatory property of ibuprofen and increase its gastroprotection

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Improvement of Ibuprofen solubility using Self-emulsifying drug delivery system (SEDDS).

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Keywords: SEDDS, Aqueous solubility, Oil, Surfactant, Ibuprofen.

Self-emulsifying drug delivery system (SEDDS), which is an isotropic mixture of oil, surfactant with or without co-surfactant, can be used to improve the aqueous solubility of poorly soluble drugs such as Ibuprofen. Therefore, the aim of this study was to produce Ibuprofen SEDDS and evaluate its *in-vitro* and anti-inflammatory properties. Pseudo ternary phase diagram construction was carried out to identify stable formulations. Subsequently SEDDS were formulated using mixture of labrafac lipophile or its blend with peceol (oil), labrasol (surfactant) and lauroglycol 90 (co-surfactant). Evaluations carried out on the formulation include: visual isotropicity, emulsification time, drug content, in-vitro drug release, infinite aqueous dilution, post dilution drug precipitation, droplet size and *in-vivo* anti-inflammatory tests respectively. Obtained results showed that all the batches passed the visual isotropicity test, recorded emulsification time of less than a minute and promoted fast drug release. Infinite aqueous dilution showed no phase separation and *in-vivo* anti-inflammatory study demonstrated significantly higher anti-inflammatory activity ($p<0.05$) than ibuprofen powder. The droplet size, zeta potential and polydispersity index values ranged from 1070-6952 nm, -12 to 25 mV and 0.3 to 1.0 respectively. In conclusion, SEDDS improved the aqueous solubility of Ibuprofen and its anti-inflammatory activity.

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Investigating the adsorptive properties of synthesized and purified low silica Zeolites X from kaolin utilizing biophysical techniques

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This work is intended to produce well-defined pore sizes of zeolites from natural clay for biomedical application. The work hereby is reporting the successful synthesis of low silica zeolite X from natural kaolin utilizing modified hydrothermal reaction conditions. XRD was used to assign the major peaks of the synthesized zeolitic material, showing the crystallinity to be 98.33%. FTIR results confirmed the major vibration modes with bands located in the range from 650–745 cm^{-1} that were assigned to symmetric T–O–T vibrations of the zeolite framework, and a characteristic band at 970 cm^{-1} due to Si-O-Si and Si-O-Al asymmetric stretching vibrations. The average pore diameter of the zeolite was 4.6 nm based on Brunauer, Emmett & Teller (BET) techniques. The measurements also estimated the surface area of the zeolite to be 27.0546 ± 0.4541 m^2/g with an average pore volume of 0.016 cm^3/g. This is comparable to the measured single point adsorption total pore volume of pores (0.018 cm^3/g) and the Barrett, Joyner, Halenda (BJH) Adsorption cumulative volume of pores (0.24 cm^3/g), all obtained from the BET analysis. The absorptive properties of the zeolitic material were tested on three volatile organic compounds and the results indicated benzene was the best adsorbate followed by turpentine. The purified zeolite has the potential to be used for future investigation as drug carriers and delivery vehicles.

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Investigation on the potential of Minjingu phosphate rock for water defluoridation

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Keywords: Minjingu Phosphate Rock, Chemical activation, Water Defluoridation

In this study the potential of a phosphate rock mined from Minjingu area in Northern Tanzania, in removing fluoride ions from water is reported. The rock particles were chemically activated and then characterised by XRF, XRD and nitrogen physisorption. Results showed that the main component of chemically activated rock particles was calcium hydroxyapatite with Ca/P ratio of 1.55 whereas the main component of non-activated particles was calcium fluoroapatite (Ca/P ratio of 1.66). The results also indicated that activated rock material was mesoporous with a BET surface area of 57.4 m^2/ g. Results for water defluoridation showed that the material had a fluoride ion percentage removal of about 92.4% and 96.2% using batch and column methods, respectively, when the adsorbent dose was 8 g, contact time of 15 minutes, initial fluoride ion concentration 10 mg/L, pH values of 6.5 to 7 and batch volume of 50 mL. The results also showed that the material saturates after four and nine runs by using batch and column methods, respectively. The material could be regenerated using 1% NaOH and reused in the water defluoridation process. Langmuir, Freundlich and Temkin isotherms indicated that adsorption of fluoride ions on the material was favourable with fluoride adsorption maximum of 0.496 mg/g. The study therefore concludes that Minjingu phosphate rock material is a good water defluoridant.

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Loaded Prodigiosin Released from Degradable PLGA-Based composites: for Extended Localized Drug Release

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Keywords: Prodigiosin, PLGA-based millirods, biodegradable systems, extended localized drug released.

In this paper, biodegradation polymers were dissolved in dichloromethane (DCM), molded into cylindrical millirods with diameter of 5 mm, and 5 mm thick by solvent casting/molding. The rate of drug release and biodegradation of PLGA-based millirods of different polymer ratios were presented (immersed in PBS (pH 7.4) under mechanical agitation (60 revolutions per minute (rpm) and incubated at 37˚C). Paclitaxel (PT) and prodigiosin (PG) were the drugs candidates considered in this study. Polymer degradation rates and drug release profiles differed greatly though the same polymer matrix and drug loading (8% by weight) were considered. The rates of polymer degradation were significantly affected by the polymer ratio and molecular weight. Proscope HR 640 equipment and proscope image analyzer software were used to observe and monitor structural changes. Ultraviolet Visible spectrophotometer (UV-Vis) was used to determine the amount of drugs released at 535 nm for PLGA-PG samples and 210 nm for PLGA-PT samples. The percentage release of PG from PLGAs ratios; 50:50, 65:35, 75:25, 85:15 gave cumulative releases of 91, 96, 92 and 93.5 %, respectively. On the other hand, the percentage release of PLGAs 65:35, 75:25, 85:15 loaded with PT were 84, 98 and 94, respectively. There were no significant differences in the cumulative drug release in polymers loaded with PT or PG. Thermal analyses were carried out with differential scanning calorimetry (DSC) equipment. DSC monitors the heat effects associated with the phase transitions that takes place as a function of temperature. The implications of the results are then discussed for the design of biodegradable polymeric devices for extended localized cancer drug delivery.

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Magnetite nanoparticles for breast cancer detection

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Keywords: Magnetite Nanoparticles, Breast Cancer, Adhesion, Receptor-mediated Endocytosis

We present experimental and theoretical results obtained from a study of the adhesion and entry of magnetite nanoparticles (MNP) into MDA-MB-231 breast cancer cells. The adhesion between luteinizing hormone releasing hormone (LHRH) and breast cancer cells is measured using atomic force microscopy (AFM) technique. The results show that the adhesion force between LHRH coated AFM tips and MDA-MB-231 breast cancer cells is about twice as much as that between bare AFM tips and breast cancer cells; the adhesion force between LHRH-MNP coated AFM tips is also approximately twice as much as that between MNP coated AFM tips and breast cancer cells. The increased adhesion from LHRH coated tips suggests that LHRH can be used for the specific targeting of breast cancer cells. The receptor-mediated entry of ligand-conjugated magnetite nanoparticles into breast cancer cells is also investigated using thermodynamics and kinetics models. The predictions are shown to be in good agreement with both *in-vitro* and *in-vivo* experimental observations of nanoparticle entry into cells.

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Magnetite nanoparticles for specific targeting of breast cancer cells

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This paper presents the results of an experimental study of uniquely biosynthesized magnetite nanoparticles (BMNPs) using *Magnetospirillum magnetotacticum* bacteria. The BMNPs were functionalized by conjugation to luteinizing hormone releasing hormone (LHRH), a molecular recognition unit (MRU) with chemically synthesized nanoparticles (CMNPs) as control. The resulting nanoparticle structure, morphology and characteristics properties were examined using X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), Dynamic Light Scattering (DLS), Raman Spectroscopy, Fourier Transform Infrared (FTIR) Spectroscopy as well as quantitative image analysis. Insights on the adhesive forces of the functionalized magnetite nanoparticles needed to overcome the hydrodynamic and shear forces to target the breast cancer cells were explored. The adhesion forces between functionalized BMNPs and human breast cancer cells (MDA-MB-231 cell line) for improved selectivity and specificity were demonstrated using the Atomic Force Microscope (AFM). The BMNPs constituents had adhesion forces to breast cancer cells that were greater than those of CMNPs. The implications of the results are very useful for the development of nano-targets and magnetite nanoparticles for the specific targeting of breast cancer.

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Magnetic nanocomposite structures for elimination of residual breast cancer

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Keywords: magnetic nanocomposite, thermometry, heat transfer, modeling, breast cancer

The treatment for early-stage breast cancer typically involves mastectomy or lumpectomy followed by radiation therapy to remove any residual cancer cells. Although mastectomy leaves relatively less residual cells, it is an aggressive form of treatment for early-stage breast cancer. Therefore, treatment modalities that could enhance the use of lumpectomy are needed. In this work, the structural, magnetic and hyperthermic properties of magnetic nanoparticle (MNP)-filled PDMS nanocomposites are studied. These are studied as a function of MNP (maghemite) weight fraction. Then in an effort to investigate the in-vivo thermal doses, a 3D finite element method (FEM) model is used to simulate the heating of breast tissue under alternating magnetic field (AMF) parameters safe for human use. Results show that the properties of the nanocomposites are affected by the properties and weight fraction of MNPs. Furthermore, thermoseeds were shown to have the potential to achieve *in-vivo* hyperthermic or ablative temperature levels. The results show that, by controlling the amount of MNPs, this simple multifunctional nanocomposite system has the potential to achieve lesion sizes required to eliminate residual cells under AMF parameters that are safe for human use.

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Model of a suspension system for bicycle ambulances in rural communities

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Research has shown that large number of people in rural communities of Ghana die prematurely every year owing to the lack of access to well equipped health care services for immediate treatment of sudden fatal illnesses, accidents and complications in child birth. People have to travel long distances in order to access nearby health care facilities. Many efforts have been made to make patient transportation in most rural communities in Ghana and Africa as a whole faster and efficient. The most common and efficient effort is the bicycle ambulance. This has been beneficial design due to its ability to offer a locally appropriate and low cost solution to patient transportation in rural communities. It is readily accessible and also provides emergency treatment for patients during transportation. Despite the merits by the bicycle ambulance, the aspect of comfort, stability and speedy transportation of the patient and the trailer on which patient was put was not considered during the design of the existing bicycle ambulances in Ghana. In this work, Newton's second and third law was used to develop a model for a suspension system of bicycle ambulance in MATLAB Simulink. The spring system and the damper system were modeled separately. It was followed by the combination of the spring and the two systems together. The results obtained from the combination of the spring and the damper showed a decay curve that demonstrates the stability of the combined system on rough roads. This model considered a bump of 0.2m for the analysis. Further analysis could be done varying bump heights.

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Modeling of drug diffusion and inductive heating of implantable biomedical device for localized thermo-chemotherapy of tumor cells

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Keywords: Hyperthermia, Normal breast tissues and Tumor tissues, Biomedical device, Prodigiosin, P(NIPA)-based hydrogels, Localized drug release.

This paper presents the results of partly experimental and computational study of an implantable biomedical device for localized release of chemotherapy drug with a combined effect of hyperthermia and chemotherapy. Combination of magnetic induction, heat transfer and fickian diffusion concepts were used to model temperature changes and drug release from the biomedical device to a surrounding used to mimic a tumor tissue/normal breast tissues. The predictions of temperature distribution and prodigiosin release profiles for the biomedical device, agrees with the experimental results. The simulations revealed the tumor tissues have a higher concentration of diffused drug (prodigiosin) and temperature changes than the neighboring healthy tissues. The results show a synergistic effect of drug release and the effect of hyperthermia temperatures $(41 - 43\ ℃)$ to initiate apoptosis of tumor cells. Localized drug delivery in addition to localized hyperthermia stands the chances of improving cancer treatment modalities while sparing neighboring normal tissues/cells. The implications of the results are discussed for designing *in vivo* experiments to validate the device/tissue model for relevant preclinical cancer therapy.

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Molecular characterization of bacterioneuston found along the path of Osun river.

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Keywords: Bacterioneuston, Surface Microlayer, Osun River, Actinomy

Osun River like all water bodies consist of three layers; the surface microlayer, the underlying water and the bulk water. The River which runs southwards through the yorubaland in Southwestern Nigeria flows over 267km landspace, the River gained popularity due to curative believe of the Osun water. This study thus, in line with recent discovery of structurally novel aromatic polyketides from marine sponge-derived Streptomyces and Saccharopolyspora strains, suggesting that sponge-associated actinomycetes can serve as a new source of aromatic polyketide explore the surface microlayer of the Osun River for the culturable diversity of the actinomycetes associated. We assessed the physicochemical properties of the surface microlayer from three locations along the path of the Osun river. Activity within the neuston was assessed at both the community level, by measuring leucine bulk incorporation, and at the single-cell level, by using microautoradiography. Dissolved organic matter at the SML collected within the groove was compared to the other three locations along the path of the River. Bacterial abundance in the SML ranged from 6.2×10^5 cells mL^{-1} to 4.2×10^6 cells mL^{-1} The SML were dominated by Betaproteobacteria which contributed the most to total activity, followed by Actinobacteria. Molecular evaluation using 16s rRNA specific primers of the *Actinobacteria* shows 87% *Streptomonospora spp*

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Multiply-modified maize starches: production process optimization, physical and micromeritic evaluation for pharmaceutical application

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Keyword: Starch, modification, micromeritic properties, pharmaceutical applications

Starches are abundant in tropical regions and are of interest in many industries including the pharmaceutical industry. In their unmodified form, their applications in pharmacy are limited and they have been doubly modified to improve applications. In this research work, starch is further modified up to tertiary level using commonly available chemicals such as oxidizing agents e.g. hydrogen peroxide (H) and sodium hypochlorite (N), substituting agent e.g. citric acid (C) and cross-linking agent e.g. glutaraldehyde (G) in a primary modification level after establishing the best modifying conditions of temperature and time. Starches were further modified in a secondary modification process such that H treated starch is further treated with N or with C or with G. Finally those secondary modified starches without G were treated with G in a tertiary modification level. All the modifications were done using established methods. Hydration capacity and DSC analyses showed that the best treatment conditions were 70 ^{o}C for 30 minutes. Physical evaluations indicated that the modified starches showed no significant changes in true density which ranges from 5.0048±0.0650 g/ml for HN to 5.0126±0.4700 g/ml for G. However there were significant changes in their hydration capacities, swelling capacities, moisture uptake and micromeritic properties. The C-series swelled and broke into two distinct portions and may be considered as possible disintegrants. The N- series shrink below their consolidated volumes which may provide a new mechanism of disintegration. The HNG and HCG series showed graded swelling indicating potentials for application as binding agents in solid dosage design.

Nanomaterials Disposal and Climate Change

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Keywords: Climate change, Policy, Nanomaterials

Nanocomposites are hybrid materials with improved mechanical, thermal, electrical and chemical properties, produced by incorporating nanoparticles into conventional materials such as polymers and metals. As nanocomposites enter into widespread use, nanomaterials will end up in disposal waste streams that are ultimately discharged to the environment. Nanoparticles have been found to differ significantly in properties from their bulk counterparts. At every point of a material's life cycle, there are chains of events resulting in nanoreleases. What is actually released from a particular nanocomposite may change depending on the release scenario. To support innovative nanomaterial-based products with low life cycle risk profiles, greater information is needed on the potential hazards associated with specific exposure scenarios. In this article, emphasis was laid on the disposal stage of nanomaterial lifecycle considering materials recycling, incenaration and landfill. We reflected on the relevance of the nanomaterials disposal in addressing climate change, identification of impacts of climate change in the nanomaterials disposal and ensuing vulnerability, examination of the contribution of the nanomaterial waste sector to mitigation and sustainable development, the analyses of mitigation potential and technology options and we considered governance, institutions and stakeholders industry barriers to the fate and behaviour of nanosized pollutants.

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Nanotechnology applications, veritable tools to the mitigation of global climate change

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Keywords: Global Climate Change, Green House Gases, Green Nano Technology and Carbon Sequestration.

Under the sun, global climate change has posed a great danger to humanity in this present time. It is any identifiable change in the worldwide climate that has occurred over decades or even longer. Several researches have been and are currently being undertaken in global climate change and there is sufficient evidence to prove that climate change results from natural and anthropogenic sources. Also, researchers have identified Green Houses Gases as the cause of global climate change. Records show that since 1851, we have been in the warming trend; the average temperature has increased by $1^{o}C$. The eight hottest years of the century have occurred since 1979, data suggest a warming trend of 0.3-$0.6^{o}C$ over the last 100 years. The rate and duration of the warming in 20th century is larger than any other time in the last 1000 years. Reducing Green House Gas emission requires us to change the way we generate electricity, heat our homes and our means of transportation. These changes include generation of renewable energy sources, using less carbon intensive fuels/more energy efficiency, green nano technologies and carbon capture/ sequestration.

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Potentials of Fabricating Porous Ceramic bodies from Kaolinite Clay for Automobile Exhaust Purification.

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Key words: Kaolin, Porosity, Physical properties, Pore formers, Green bodies.

In this work, the suitability of using kaolin – styrofoam, sawdust, and high density polyethylene to produce porous ceramic bodies was experimentally investigated. Batch formulations of the samples were formed into green bodies and fired to 1150ºC. The porosities as well as the physical properties of sintered bodies were investigated. The samples gave the following limits of results: apparent porosity: 28.63% - 67.13%; water absorption: 17.07%-58.42%; bulk density: 0.79g/cm^3 – 2.75g/cm^3; apparent density: 1.49g/cm^3 – 2.34g/cm^3; and shrinkage:12.5% - 17.0%. Samples with high density polyethylene (HDPE) pore formers showed minor surface cracks after firing, but exhibited high porosity levels while samples with styrofoam and saw dust exhibited uniform surface characteristics with pores, high strength, thermal stability and no visible surface cracks. Apparent porosity as high as 67% has been calculated.

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Preparation and characterization of porous borosilicate scaffolds fabricated from polymethylmethacrylate beads

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Keywords: Bioactive glasses, crystallization, hydroxyapatite layer, porosity, scaffolds

Porous bioactive scaffolds have gained much interest in the field of tissue engineering due to their ability to act as substrates for cells and induct molecules, able to drive self-regeneration of tissues.Despite their bond forming abilities with soft and hard tissues, bioactive glasses have not received much attention in clinical use, as scaffolds, due to their poor mechanical properties and tendency to crystallize during sintering.Crystalline phases retards the formation of the hydroxyapatite layer, thus reducing the bioactivity of the glass and prevents the formation of porous amorphous glasses. Therefore, the objective of this study is to synthesize, test and characterize biocompatible borosilicate (bioactive glass) for use as a possible scaffold material in bone regeneration.To achieve the above mentioned objectives, the glass ingot was crushed, sieved, milled and dried. The obtained powder which had an average particle size of 20.539 µm was characterized using PSD, XRD and SEM/EDS. All powders were then sintered using a muffle furnace at a heating rate of 10°C/min to sintering temperatures from (520°C to 600°C). In order to achieve the required porosity for scaffold use, the powder was mixed further with different content of polymethymethacrylate (PMMA) bead (20, 40, 60, 65 and 70 vol. %) with size ranging between 250-300µm. The sintered materials were characterized by density, XRD and SEM/EDS. At higher temperature (580°C and 600°C) there was a decrease in densification rate of the material. In addition to that, at high bead contents (65 vol. % and 70 vol. %) large interconnected pores and porosity were achieved giving promising results towards the fabrication of amorphous bioactive scaffolds for tissue engineering.

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Preparation of erythromycin solid lipid microparticles from a natural polymer as a means of improving its oral bioavailability.

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Key words: Microparticles, beeswax, erythromycin ethyl succinate, parasitemia.

Solid lipid microparticles (SLM) have been explored for the delivery of poorly soluble drugs as well as for sustained drug delivery. In this work, SLMs made from a natural polymer (beeswax) were loaded with erythromycin ethyl succinate using the solvent emulsification-evaporation technique. The prepared SLMs were characterized for their entrapment efficiency, particle size, and particle size distribution. Antimicrobial evaluation was also done on the formulations. *In vivo* activity of the formulations were tested in mice by infecting five (5) groups of white albino mice (n=4) with standardized cultures of *E. coli.* The formulations were evaluated for their ability to reduce parasitaemia in the infected mice.

The encapsulation efficiency of the formulations was in the range of 77-95 %. The average particle size of the formulations were between 11 and 22 µm. The *In vivo* studies results showed much less parasitaemia and higher survival rate with the formulation than with the unformulated drug. This increase in activity of the formulation over the conventional drug could be indicative of an improvement in the oral bioavailability of the drug.

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Statistical Analysis of Recycled Polyethylene in Earth-Based Composite Building Materials

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Keywords: Polyethylene-reinforcements; flexural/compressive strengths, fracture toughness, Gaussian distribution, Weibull distribution,

This paper presents the results of combined experimental and theoretical studies of the statistical analysis of recycled polyethylene in earth-based composite building materials. The composites are produced with different volume percentages (0-30 vol. %) and particle sizes ($\sim 300 \pm 0.02\ \mu m$, $\sim 600 \pm 0.03\ \mu m$, $\sim 900 \pm 0.03\ \mu m$, $\sim 1200 \pm 0.02\ \mu m$, $\sim 1500 \pm 0.04\ \mu m$ and $1800 \pm 0.03\ \mu m$) of powdered PE in a laterite matrix. The composites with $\sim 900 \pm 0.03\ \mu m$ and 20 volume percentage of PE are shown to have the best combination of flexural/compressive strengths and fracture toughness. The statistical variations in the flexural/compressive strengths and fracture toughness are shown to be well characterized by the Weibull distributions. Probabilistic framework for the modelling of the reliability or failure probabilities associated with 20 vol. % of PE and particle size up to $\sim 900\ \mu m$.

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Surfactant-loaded Halloysite Clay Nanotube Dispersants for Crude Oil Spill Remediation

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Keywords: Halloysite Nanotubes, Oil Spill remediation, Oil-in-Water Emulsion.

Naturally occurring halloysite clay nanotubes (HNT) are effective in stabilizing oil-in-water emulsions and can serve as interfacially-active vehicles for delivering oil spill treating agents. HNTs adsorb at the oil−water interface and stabilize oil-in-water emulsions that are stable for months. Cryo-scanning electron microscopy (Cryo-SEM) imaging of the oil-in-water emulsions shows that these nanotubes assemble in a side-on orientation at the oil−water interface and form networks on the interface through end-to-end linkages. For application in the treatment of marine oil spills, halloysite nanotubes were successfully loaded with surfactants and utilized as an interfacially-active vehicle for the delivery of surfactant cargo. The adsorption of surfactant molecules at the interface serves to lower the interfacial tension while the adsorption of particles provides a steric barrier to drop coalescence. Pendant drop tensiometry was used to characterize the dynamic reduction in interfacial tension resulting from the release of surfactants from HNTs. At appropriate surfactant compositions and loadings in HNTs, the crude oil−saline water interfacial tension is effectively lowered to levels appropriate for the dispersion of oil. Ternary diagrams (Span 80-DOSS-Tween 80, Lecithin FPI-DOSS-Tween 80 and Lecithin FPI-Tween 80-Span 80) for the dispersion effectiveness of the surfactant-loaded HNT were then generated. A near complete dispersion effectiveness was attained by HNT loaded with ternary food grade surfactants; Span 80, Tween 80 and Lecithin FPI. The near complete dispersion effectiveness can be ascribed to the reduction in the electrostatic repulsion between the anionic head groups of the surfactant, and the formation of a steric barrier by the HNT. This work indicates a novel concept of integrating particle stabilization of emulsions together with the release of chemical surfactants from the particles for the development of an alternative, cheaper, and environmentally-benign technology for oil spill remediation.

Study of the physical and mechanical properties of coir fiber length and coconut shell powder reinforced low density polyethylene composites

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Keywords: polyethylene matrix, coconut shell, coir fiber, mechanical and physical Properties

Mechanical and physical properties of coconut shell powder reinforced recycled low density polyethylene composites were evaluated to assess the possibility of using it as a new material in engineering applications. Coconut shell filled composites were prepared from recycled low density polyethylene polymer matrix containing up to 15 % weight of coconut shell powder as fillers. The coir fiber was then added in various lengths which was also 15% by weight. The composite was produced using the hot press technique. The effects of coconut shell powder content and coir fiber on the mechanical and physical properties of the composites were investigated. It was shown that the value of tensile strength, flexural strength and hardness value increased up to 7.1MN/m^2,18.0GPa and 92.7 respectively, with increment in fiber length. Impact energy decreased with increase in fiber length (from 7.1J at 0 fiber length to 0.45J at 3mm fiber length). With the introduction of fiber length from zero to 10mm, a decrease in density and increase in water absorption was observed. These characteristics (density and water absorption) remained the same with increment in fiber length for a given composition of matrix/filler. This work has shown that coconut shell powder and coir fiber length can be used to improve properties of recycled low density polyethylene polymer composites.

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Study of the Physico-Technical Properties of a Multicomponent *Lentinus tuber regium* Based Co-processed Excipient (*Fizlent*)

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Keywords: Physico-technical, multicomponent, *Lentinus tuber regium,* coprocessed, excipient, *fizlent.*

Lentinus tuber regium (LTR), an edible mushroom grows naturally in Nigeria in early and late rainy seasons and could be cultured on a wide variety of agro-forestry products to produce feed, enzymes and medicinal products as: antitumour, antigenotoxic, bio-anti-mutagenic, anti-inflammatory, anti-lipidaemic, antihypertensive, anti-hyperglycaemic, antibacterial, antifungal and immune-modulatory effects. It contains protein and carbohydrate, especially oligosaccharides with high crude fibre which could aid bowel movement and reduce incidences of colon cancers in its users. Literature indicate that the fruit body is rich in iron and zinc, capable of producing sufficient iron to meet the recommended daily allowance (RDA) for minors if up to 200 g of LTR is consumed daily. In this work, the physico-technical properties of a novel co-processed multicomponent *Lentinus tuber regium* (LTR) based pharmaceutical excipient (*fizlent*) was studied. It was designed to improve the flowability and compressibility of LTR. A wet mass obtained by solvent evaporation of alcoholic dispersions of LTR, sodium bicarbonate, tartaric and citric acids in proportions of 80, 10, 6.5, 3.5 % w/w respectively was granulated, dried at 60º C and classified with 250µm sieve. Densities (bulk, tapped and particle), flow properties (flow rate, angle of repose, Carr's index, Hausner's ratio), swelling index, hydration capacity, differential scanning calorimetry (DSC), scanning electron microscopy (SEM) and pH were determined for the natural, processed LTR and *fizlent* to ascertain the improvement on the flowability and compressibility achieved in the co-processed excipient. *Fizlent* appeared as a compactable, tasteless, off-white powder without distinct odour. Its aqueous dispersion has pH of 6.92 ± 0.13. It possesses enhanced flow, compressibility and dilution potential of 70-80% (paracetamol) and ≤ 30% for metronidazole, ascorbic acid and ibuprofen. Thus, f*izlent* may be a useful filler-binder with potentials as directly compressible powder especially for most low dose drugs and may possibly serve as superdisintegrant agent.

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Structural characteristics and mechanical behaviour of polypropylene composites reinforced with *entada mannii* fibre

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Keywords: *Entada mannii* fibre, Composite, Polypropylene, Debonding.

The use of plant fibres as reinforcements of polymers has been a topical issue which has continued to attract interest among researchers. The structural characteristics and mechanical behaviour of polypropylene composites reinforced with NaOH treated and untreated Entada *mannii* fibre were investigated. The composites were fabricated by mixing *Entada mannii* fibre of 1, 3 and 5 wt %, and the polypropylene matrix with 5 wt % maleic anhydride polypropylene (MAPP) in a twin screw extruder followed by compression moulding. Tensile properties, impact strength and flexural properties of the composites were determined while the surface morphology of the composite fracture surface was examined using scanning electron microscopy (SEM) quipped with energy dispersive spectroscopy. The results show that NaOH treatment modified the surface characteristics and physical constituents of the fibres. Tensile strength and elastic modulus of the composites were improved with the treated and untreated fibre reinforced composites than unreinforced composites. Reduction in the % elongation was observed as the fibre loading increases for all the treated and untreated composites. A remarkable improvement in impact strength was observed for the alkaline treated composites compared with unreinforced composites. However, flexural strength and flexural modulus of the alkaline treated composites improved significantly while the fracture surface morphology of the untreated composites revealed fibre pullout, fibre debonding, and deposition of pores/holes which indicated a weak adhesion between the fibre and the matrix.

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Structural modification, thermal stability and adsorptive properties of cetyl trimemethylammonium cation intercalated kaolinitic clay

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In this study, organoclay materials were prepared by exchanging cetyl trimethylammonium cation (CTA^+) at levels corresponding to 25 and 50% of the cation exchange capacity of the kaolinitic clay. The unmodified and modified clay samples were characterised by infra-red (IR) spectroscopy, Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES), X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Thermogravimetric analysis (TGA). The observed increase in the basal spacing in the XRD diffraction patterns, the reduction in clay particle size and agglomeration as indicated from the SEM images together with the frequency shifts in IR absorption bands in the 1700 – 1600 cm^{-1} and 3700 – 3600 cm^{-1} in the modified clay samples provided direct evidence of intercalation of the cetyl trimethylammonium cation into the interlayer space of the kaolinitic clay. The thermal stability of the organoclay samples were found to be enhanced in comparison with the raw (unmodified) clay with temperature at which 5% degradation was attained varying from about 180°C to more than 400°C for the unmodified and organoclay samples respectively. The kinetics of degradation of the organoclay was modelled using two sensitive integral methods – Broido and Coats-Redfern equations and values of activation energy, 18.82, 22.58 and 27.68 $kJmol^{-1}$ were obtained for the raw and organoclay samples respectively. The improved interlayer microenvironment of the organoclay was exploited in the removal of water-soluble fraction (WSF) of crude oil (composed mainly of benzene, toluene, ethylbenzene and xylenes) from aqueous medium in batch kinetics and isotherm studies. The equilibrium data for the removal of BTEX from aqueous medium by the organoclay were well represented by the Langmuir isotherm model and gave values of maximum removal capacity, Q_{max}, of 396.42 $mg.g^{-1}$ ($R^2 = 1.00$) and binding constant; K_L, 1.54 $x10^{10}$ ($l.mg^{-1}$). The kinetics of adsorption on the modified clay followed the pseudo-second-order model and gave value of rate constant of adsorption, K, of 4.52 x 10^{-2} $g.mg^{-1}.min^{-1}$. These results indicate a potential for the application of surfactant modified kaolinitic clay in organic contaminant attenuation.

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Synthesis, characterization, *in vitro* bioactivity and wettability of sol-gel derived SiO2-CaO-P2O5 and SiO2-CaO-P2O5-Na2O bioglasses

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Keywords: Sol-gel; bioactive glasses; sodium oxide; in vitro bioactivity; contact angle.

During the last decades, considerable attention has been directed towards the use of bioactive materials, where bioactivity is defined as interfacial bonding of an implant, or a bioactive scaffold to tissue by means of formation of a biologically active hydroxyapatite (HA) layer on the bioactive material surface. Literature shows the importance of these materials because of their capacity to bond and integrate with bones in the living tissues. This bonding to living bone tissue occurs upon a sequence of reactions on the material surface followed by cellular reactions. The main applications of these bioactive glasses in the clinical field are mainly, if only to quote, the filling of bones (including teeth) cavities, the reconstruction of maxillofacial defects, and the production of dental devices. These Bioactive glasses are special systems which are generally composed of the oxides SiO_2, CaO and P_2O_5. They can be synthesized by traditional melt quenching or by the versatile sol-gel process. Commercially produced bioactive glasses have been made by conventional glass powder manufacturing methods, i.e. melting and quenching. Glasses in the ternary and quaternary system SiO_2-CaO-P_2O_5 ; SiO_2-CaO-P_2O_5-Na_2O were prepared by means of a sol-gel route starting from tetraethyl orthosilicate, calcium nitrate, TEP, and sodium nitrate. The obtained glasses were characterized by X-ray powder diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). These materials were subjected to immersion studies in simulated body fluid (SBF), and have been subjected to water contact angle measurements. A comparative study on Na_2O-containing (22Na) and Na_2O-free bioactive glass ceramics (44C) indicated that Na_2O could be an important constituent enabling achievement of an optimal combination of bioactivity and wettability.

Targeted immunoliposomal Nanodelivery of Chloroquine and Chloropheniramine Combination

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Keywords: antimalarial, chloroquine, artemisinin, resistance, immunoliposomes

Recent reports on the emergence and spread of resistance of *P. falciparum* to artemisinin based compounds are worrisome and there is deep concern that the parasite will soon develop complete resistance to such orthodox treatment. Poor treatment practices, substandard forms of the drug, inadequate patient adherence to prescribed antimalarial regimens remain the major cause of treatment failure and all these occur as a result of difficulty in implementation of ACT due to affordability and accessibility constraints. That is why the emergence and spread of parasites resistant to affordable antimalarial agents is a major factor that severely hinders the efforts to 'roll-back malaria' program. This has made it necessary to improve the efficacy of chloroquine, the cheapest and most available antimalarial drug. In a previous work, we enhanced the antimalarial efficacy of chloroquine in *P. berghei* infected mice. The current research focuses on: establishment of the best time interval to give the combination using *in silico* laboratory (bioinformatics) and wet laboratory methods (using *in vitro* cultures of *P. falciparum*). This will be followed by formulation of the combination in controlled release tablet form such that the drugs are released appropriately *in vitro* according to the pattern established in the previous sentence. After successful formulation, the combination will be delivered inside targeted immunoliposomal nanovectors to specifically target *Plasmodium* infected red blood cells. Through this approach, we would be able to overcome the drawbacks of chloroquine as well as improve the effectiveness of the drug by targeting the infection reservoirs. In this framework, nanotechnology appears as one of the most promising approaches to overcome the problem of chloroquine resistance.

The role of biology and materials science as a measure to prompt volume reduction of non-industrious waste to the environment

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Keywords: Waste, Environment, Processing, Management Facility and Materials

Waste simply means sludge and yet is something generated daily despite effort to prelude it and yet is disposed in the environment. Sludge can emanate from a waste treatment works, water supply treatment plant, or air pollution control facility; or garbage, rubbish, refuse, special waste or other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from domestic, industrial, commercial, mining, agricultural, or government operations. With the growing trend of biology that has to do with our present environment and material science that deals with various materials formed ,these two studies will serve immensely to curtail the matter dispense out from our homes, office as to non-industrious waste .If there exists good solid waste management facilities which do not dispose waste on-site, thus there will be of such avenues which include materials recovery facilities, transfer stations, and volume reduction facilities, that will channel this to of benefit to small scale industries. Industrial byproducts are segregated and managed as well as application for a materials recovery facility, will certainly aid industrialization which contributes positively to the economy. This sanitary nuisance will be view and remedies sought towards promoting positive and possible contribution to this economy.

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The use of a *Lentinus tuber regium* based co-processed excipient (*Fizlent*) as a novel directly-compressible filler-binder-superdisintegrant in ibuprofen tablet

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Keywords: Lentinus tuber regium, co-processed, fizlent, directly compressible, filler-binder-superdisintegrant, ibuprofen.

Ibuprofen, a poorly water soluble drug is not easily directly compressed into tablet due to poor flowability and compactibility. The suitability of a novel multicomponent *Lentinus tuber regium* based co-processed excipient (*fizlent)* as a directly compressible (DC) filler-binder and superdisintegrant in ibuprofen tablet was investigated. Ibuprofen (76.92% w/w) blended with *fizlent* (22.58 % w/w) and lubricated with 0.50 % w/w magnesium stearate was compressed at 8 tons in Erweka table top single punch tablet press fitted with 8.50 mm biconvex punch and die. Tablet weight, total drug content, crushing strength, friability and disintegration time were determined using the British Pharmacopoeia methods. The basket method in Erweka dissolution apparatus at 50 rpm was used for dissolution study in 900 ml phosphate buffer (pH 7.2) at 37 ± 1 ^{o}C for 60 min. The absorbance of samples withdrawn at 5 min intervals were spectrophotometrically determined at wavelength of 221nm. Glossy, intact, off-white, round and convex shaped tablets obtained disintegrated within 30.17 ± 1.94s. Other tablet properties complied within pharmacopoeia limit. The application of *fizlent* as filler-binder in DC of ibuprofen tablet solved problem of its poor compactability and flowability. The ability of the tablet to break down completely in 30.17 ± 1.94 s shows that *fizlent* has a superdisintegrant property. This aided the early release and dissolution of ibuprofen, hence its ability to achieve T_{50}, T_{80} in less than 5 min and T_{90} in 12.50 min. This enhances the onset of action and early attainment of peak plasma concentration of ibuprofen.

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Tripolyphosphate-functionalized waste Lyocell as adsorbent of heavy metals: Fabrication, characterization and adsorption studies

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Keywords: Heavy metal, Lyocell; sodium tripolyphosphate; characterization; binding mechanisms

Toxic heavy metal pollution from mining and/or manufacturing industries is one among several environmental problems affecting the world today. While some pollutants only cause minute impacts, heavy metals cause intense carcinogenic and other health effects when even little amounts are accumulated in the bodies of living species. For these, there have been increasing interests in finding effective remediation methods through which adsorption emerged. These days however, adsorption using low-cost, eco-friendly and biodegradable materials has become a top priority. In this research therefore, waste textile Lyocell was used as a cheap starting material to develop high-performance heavy metal adsorbent. Tripolyphosphate groups were chemically incorporated into the matrices of the waste Lyocell, owing to their strong chelation properties. Characterization and batch adsorption tests were conducted to understand the properties and metal binding mechanisms using Pb(II) as a model metal. The adsorbent worked effectively in wide range of metal concentrations and performed impressively even in acidic regions. The adsorption isotherm followed the Langmuir model and the kinetic was well described by the pseudo-first- and pseudo-second-order models. This study opens possibility to achieve the dual purpose of simultaneous waste fiber recycling and heavy metal treatment, and the resulting adsorbent is expected to show environmental benignity considering the less complexity of its preparation method and reagents used.

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Water KIS-A material miniaturization approach to water purification

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Keywords: UV-disinfection, Hybrid-filtration, energy-system, UV-reactor

The Millennium Development Goal (MDG) number seven targets to reduce half the proportion of people without access to safe drinking water by 2015. With very little time left, indicators reveal that the goal is far from met especially in certain parts of Africa. Part of the reason is the time and resources needed to implement large scale community water purification projects. As a viable option therefore, we propose the "Water KIS", KIS been an acronym for Keep It Small. Water KIS goes beyond the recent household level water treatment to include an overall individual level water treatment achievable through a unit integration of practical water purification methods. We thus present the techniques for miniaturizing materials used in the design of a hybrid filtration column comprising layers of sieve plastic filters, cloth filters, ceramic filters, activated charcoal and anthracite, gravel, dolomite and granite as well as zeolite while still maintaining their material properties. These techniques are further applied to achieve a miniaturized Ultraviolet disinfection reactor capable of maintaining a self sustaining energy system. We thus show by computer based simulations that these two miniaturized systems can be coupled by appropriate hydraulic considerations to achieve a 1.5 liter compact, light weight, movable water purifier capable of purifying water from any source which can be deployed on an individual level.

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A comparative study for the simultaneous removal of Cobalt (II) and Nickel (II) ions from aqueous solution using natural iron oxide, synthetic goethite and goethite nanopowder

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Keywords: Natural iron oxide, goethite, goethite nanopowder, simultaneous removal, heterogeneity

The adsorption efficiency of a natural iron oxide was studied in comparison with goethite and goethite nanopowder for the simultaneous removal of cobalt and nickel ions. The adsorbents were prepared/synthesized and characterized using SEM, FTIR-ATR and XRPD techniques. Influence of parameters such as contact time, dose of adsorbent and pH were studied at room temperature. Maximum absorption for Co(II) and Ni(II) ions, for all three adsorbents occurred at an equilibrium contact time of 80 mins, dose rate of 0.1 g/L, and pH 7. Co(II) ions showed greater affinity to all three adsorbents. Goethite nanopowder was found to be the most efficient adsorbent with maximal adsorbed quantities of 148.5 mg/g of Co(II) and 110.6 mg/g of Ni(II) ions. This was followed by synthetic goethite at 117.8 mg/g of Co(II) and 100.6 mg/g of Ni(II), lastly by natural iron oxide at 103.9 mg/g of Co(II) and 85.2 mg/g of Ni(II) ions. Analysis of the pH dependent isotherm data presented the Freundlich isotherm model as the best fit model for all three adsorbents and metal ions, indicating heterogeneity of the surface binding sites during adsorption. Analysis of the time dependent kinetic data presented the pseudo-second order kinetic model as the best-fit model, indicating chemical adsorption between the adsorbent surface and metal ions, hence a good correlation between equilibrium and kinetics. The findings indicate that the three adsorbents are effective materials and may be used for the simultaneous removal of cobalt and nickel ions from aqueous solution.

A comparative study of tensile behaviour of cocoa-pod husk particles – filled polyester and epoxy composites.

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Keywords: Cocoa pod, Mechanical properties, Polyester, Epoxy, composites.

A study of the comparative tensile response of polyester and epoxy resins filled with raw untreated cocoa pod husk particles has been carried out. Particle filler concentrations, which varied between 0 and 15 w/w %, were used in the preparation of the required test specimens. Tensile test was carried out and the effect of filler concentration on the polyester and epoxy matrices was correlated and analysed. It was observed that within the filler concentration range investigated and the limit of the experimental error, the tensile properties (strength and modulus) were found not to be significantly affected by increasing filler concentration for the two matrices. This work has significant implications for the utilization of this important post agricultural harvest waste material, which pollute the environment in the cocoa-producing regions of the world especially in the West African subregion, in its use as filler in the fabrication of polymer-based articles for non-load bearing applications. The study found that apart from the common use of cocoa pod in the soap making industry, it would have immediate impact as a possible filler material of choice in floor and roof tiling, partitioning and other architectural and aesthetic applications in the building and construction industry.

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A comparative study of the tensile and flexural properties of sisal, banana and bamboo hybrid fibres epoxy composites.

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Keywords: Hybrid composites, Natural fibres, Thermosetting polymer, Mechanical Behaviour

Opportunity abound for more innovative development work involving naturally-occurring fibrous materials with good and strength properties for use as reinforcement in polymeric composites fabrication. Hybrids have also been shown to perform better than single fibre reinforcement in polymeric matrices. Utilisation of these waste materials in new composite materials fabrication is important in engineering economics especially for resource savings and ecological considerations. It is in realization of this that tensile and flexural behaviour of chemically retted sisal (*Agave sisalana*), bamboo (*Bambusa vulgaris*) and banana (*Musa sapientum*) hybrid fibre reinforced epoxy composites are investigated. Banana-sisal, banana-bamboo and bamboo-sisal hybrids were carefully incorporated into epoxy matrix in the fabrication of the composites. The carefully characterised fibres were cut to short lengths and ASTM sample pieces were fabricated in an appropriate mould. The analysis of the data obtained on the fabricated specimens were found to show promises in various non-load-bearing engineering application especially in the power sector (wind-power blades), building (panels, flooring etc.) transportation (automobile, railways, aircraft, ship etc) interiors. More extensive and intensive investigation covering various areas are needed before prototypes can be fabricated after appropriate optimisation.

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A novel synthesis of quasicrystal Al (1xxx)/carbonised coconut shell nanoparticles via ball milling

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Keywords: Synthesis; ball milling; Al (1xxx); maximum absorbance; quasicrystal; nanoparticles

A novel synthesis of Al (1xxx)/carbonised coconut shell (CCS) nanoparticles using a ball milling technique was investigated. Initial Al/0.1%CCS powders of an average size of 51.06µm was milled for a period of 70 h. The milled particles at 16, 46 and 70 h were characterised using X-ray diffractomer (XRD), scanning electron microscope (SEM), transmission electron microscope and UV-Vis spectrophotometer. Result revealed that the calculated particle crystallite size from XRD aided with Scherrer's equation is consistent with particle image sizes obtained from SEM aided with software. TEM image depicted variation in orientation and appearance of the Al 1xxx/CCS nanoparticles at different milling time. The wide variation in the particle size is attributable to different ball impacts on the individual powders during the ball milling process. Increased maximum absorbance observed with the milled particles when compared with the initial powders is an indication of quantum/nanosizing effect due to ball milling. The synthesized Al (1xxx)/CCS nanoparticles could be used as filler for enhancing the mechanical properties of a polymer based composite.

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Activated carbon as a surrogate for carbonaceous matter in gold ores: degradation via enzyme treatment

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Keywords: Carbonaceous gold ores, carbonaceous matter, Phanerochaete chrysosporium, enzyme treatment.

Pre-treatment of the carbonaceous matter in refractory gold ores is necessary in order to decrease the undesirable uptake (preg-robbing) of dissolved aurocyanide complexes (e.g., [Au (CN)2]-). The carbon content of this type of gold ore can be as high as 5-7% [1, 2]. Preg-robbing of aurocyanide complexes by carbonaceous matter is affected by surface modification, which has prompted the use of various pre-treatment methods [1, 2]. Previous work [3] demonstrated the effectiveness of the white rot fungus, *Phanerochaete chrysosporium*, in reducing preg-robbing and it was proposed that the microorganism achieved this, partly, through oxidation by secreted enzymes. This research was conducted to further evaluate the role of these enzymes in modifying carbonaceous matter. Carbonaceous matter and activated carbon share similar surface properties; as such, powdered activated carbon (PAC, 97% passing 53 μm) was used as a surrogate material. *P. chrysosporium* was cultured under the stationary condition in a litre of 1% glucose medium [4] for 7 days, after which the cell-free extracts (CFE) were harvested and used to treat PAC for 14 days. The enzymes of lignin and manganese peroxidase were present in CFE with activities of approximately 1.8 and 2 mU/mL, respectively (an activity unit (U) is defined as the amount of enzyme to react with 1 μmol of substrate per 1 minute). The mechanism of degradation appears to be oxidation and cleavage of the characteristic poly-aromatic C=C bonding in activated carbon to produce mixed aromatic and aliphatic functional groups (13C-NMR) and also decrease the BET surface area from 1430 to 697 m2/g in 14 days. SEM images indicate that the degradation of activated carbon was more effective and uniform when 5 mg PAC in 10 ml CFE was used, while degradation was localized when a larger mass of activated carbon was used. Further work is ongoing to determine the effect of enzyme treatment on aurocyanide adsorption and it is expected to decrease, based on the above-mentioned results.

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Advanced composite technology in reusable and expendable launch vehicles

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The need for ever-increased performance of space equipment has driven the space industries into developing extremely high-performance composites that are pushing their operating envelope in terms of strength-toweight ratios, durability, and several other key aspects towards outstanding improvements. This paper describes the research development in composite for future reusable launch vehicle (RLV) and expendable launch vehicle primary structures, which is seen in the experimental vehicle's study under the European Space Agency Future Launcher Preparatory Program (FLPP) and NASA future Space Exploration systems. Specific aspects related to the level of advanced composite technology performance in RLV and ELV application are described. A series of trade studies are also undertaken to identify materials capability of meeting the requirements for a high propellant mass fraction, high thrust to weight ratio propulsion and extended reusability. The overall economic impacts of composites in spacecraft architecture for future space exploration systems.

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Africa's Mineral Resources and their Impact on Her Development in the New Millennium

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The continent of Africa is endowed with vast mineral resources including precious, ferrous and non-ferrous, rare earth, strategic and critical and fossil fuel minerals and materials. The US Geological Survey indicates that 30% of the global mineral resources are hosted within geological basins in the African continent. These minerals and materials form the foundation for a technological world in manufacturing, medicine, space, information technology, smart living and the comfort of humanity and provide a backbone to global economies and security. Developed and strongly emerging economies have been successful in deriving value addition from these minerals and materials for economic prosperity. For example in 2011, the upstream value of US minerals was estimated by the US National Mining Society to be equivalent to $74 billion. These raw minerals were transferred into $633 billion value-added minerals, and major sectors, such as manufacturing and construction, using these value-added mineral products, added $2 trillion (a value multiplier of 27) to the US GDP of $16 trillion. However, the continent of Africa continues to derive the value of her vast mineral production from only the upstream source, without benefiting from the downstream value addition. For stronger growth and development, Africa must lay a foundation with vision and strategies to capture a significant component of her mineral wealth. This presentation will focus on the vast mineral resource endowment in Africa, her strategic position within the global minerals production and the economic, defense and technological uses of these minerals. The presentation will also focus on the challenges Africa faces in transferring the primary minerals into value-added products for increasing the value of her mineral resources for economic development. These challenges include lack of energy, infrastructure, access to capital markets by local investors and sustainable development. They also include trade, cultural, language and ethic barriers that impede the exploration, development, extraction and usage of these minerals. Finally, the presentation will lay out a vision with strategies for Africa to capture a significant component of her mineral wealth through value addition.

Beyond the Earthingware Grating Bowls

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The earthenware grating bowl, the Apotoyuwa, as known in Ghanaian local parlance, has been and continue to be a familiar feature in most domestic kitchens in West Africa especially Ghana. It also adds to the tableware crockery for local restaurants in some Ghanaian communities. Production sources can be found around clay deposits in Ghana's countryside where traditional and contemporary pottery is practiced. This historical product has provided employment and generated income along its value chain. The paper studied one of such historic traditional pottery centers at Kwahu South District in the Eastern Region of Ghana. Oframase, Amanfrom and Jejeti are the Grating Bowl production centers which have a combination of 2,123,084 tons of clay. All these clays are being used for Grating Bowls only. The paper looked at the potentials of these clay deposits as a source of raw materials for economic value products. Physical and chemical studies were conducted for the clay deposits in the three towns. The deposits have high potentials for refractory products, paint, bricks, tiles, pottery and colouring oxides which can add to the development of these communities.

Keywords: grating bowl, tableware, traditional, pottery, deposits

Building capacity thorough foundry technology in a metal industry

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Key Words: Building, Capacity, Foundry, Technology and Metal Industry

Casting processes compresises of moulding materials and their requirements; Patterns: Types and various pattern materials. Various casting methods, viz., sand casting investment casting, pressure die casting, centrifugal casting, continuous casting, thin roll casting; Mould design; Casting defects and their remedies. Casting is one of the oldest manufacturing processes. Metal castings form integral components of devices that perform useful functions for human beings, an idea schematically .The cast component has a shape, size, chemical composition and metallurgical microstructure which is determined by engineering decisions arrived at by ;Design Engineers (Mechanical Engineers),Pattern Makers ((Skilled Craftsman, CAD),Casting Engineers (Metallurgical Engineers) ,Manufacturing Engineers (Mechanical, Metallurgical Engineers) . It is the first step in making most of the products. Steps: - Making mould cavity - Material is first liquefied by properly heating it in a suitable furnace. - Liquid is poured into a prepared mould cavity - allowed to solidify - product is taken out of the mould cavity, trimmed and made to shape. The concentration is following the successful casting operation: Preparation of moulds of patterns Melting and pouring of the liquefied metal .Solidification and further cooling to room temperature Defects and inspection.

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Characterization of the texture evolution in AISI 430 and AISI 433 ferritic stainless steels during simulated hot rolling

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Keywords: hot rolling, recrystallization, EBSD, texture

Multi-pass compression tests were carried out on the Gleeble-1500D® and Gleeble-3800TM® thermo-mechanical simulators to investigate the effect of temperature, strain rate and inter-pass time on the development of the texture in ferritic stainless steels (FSS) AISI 430 and 433, the latter an Al-containing variant. Orientation Distribution Functions (ODFs) through the electron backscattered diffraction (EBSD) technique was employed to characterise and study the texture present in the steels after hot working. The mean flow stress analysis showed that, the dynamic recrystallisation to dynamic recovery transition temperature decreases with an increase in strain rate in both grades of stainless steels possibly allowing texture optimisation at lower hot rolling temperatures. Higher finishing rolling temperatures, lower strain rates and longer inter-pass times led to improvement in the formation of the desired γ-fibre texture which contributes to ductility or drawability in these steels. Dynamic recrystallization which promotes the formation of the desired γ-fibre texture was found to occur in both AISI 430 and 433 at temperatures above 1000 ^{o}C and strain rates less than 5 s^{-1}. Generally AISI 433 develops a stronger gamma texture than the AISI 430 when hot rolled under similar conditions.

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Comparative studies of the viscoelastic properties of polyethylene, polyisoprene and polyvinyl chloride subjected to constant loads at different constant temperatures

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Keywords: viscoelasticity, strain rate, cross links, heat distortion temperature

Viscoelastic properties of selected polymers subjected to constant loads at different temperatures have been studied. The prepared samples were mounted in a furnace and subjected to a tension under constant loads at a specific temperature. Initial strain rates were determined. The change in elongation of the polymeric materials were measured and recorded. The loads were then increased for the same temperature and also at different temperatures. Graphs of strain against time were then plotted and the equations for the curves obtained were differentiated and the times substituted into the equations to obtain the strain rates. Generally, the initial strain rates were relatively higher due to chain uncoiling in the polymeric materials. Under a load of 0.5 kg, at temperatures of 50^{o}C, 100^{o}C and 150^{o}C, polyethylene recorded minimum strain rates of 0.00346 min^{-1}, 0.01128 min^{-1}, 0.00346 min^{-1} respectively with corresponding times of 28.06 mins, 18.16 mins and 6.52 mins. Polyisoprene, on the other hand, recorded comparatively low values of minimum strain rates as follows: under a load of 0.5 kg, at temperatures of 50^{o}C, 100^{o}C and 150^{o}C respectively, the minimum strain rates were 0.0032989 min^{-1}, 0.003478 min^{-1}, 0.015146 min^{-1} with corresponding times of 39.4 mins, 29.51 mins and 9.52 mins. PVC recorded the highest values of minimum strain rates under the same conditions with values 0.0131794 min^{-1}, 0.024498 min^{-1} and 0.0301 min^{-1} with corresponding time values of 24.21 mins, 14.24 mins, 12.26 mins. This can be attributed to PVC having the lowest heat distortion temperature compared to polyisoprene and polyethylene. Polyisoprene recorded the least strain rates under similar conditions of load or temperature due to the presence of crosslinks and double bonds in its molecular structure. Polyisoprene exhibited the highest stiffness and consequently the highest resistance to heat flow. The viscoelastic properties of the polymers used were characterized by temperature, loading, minimum strain rates and the time for the occurrence of minimum strain rates. The minimum strain rates moved to shorter times as temperature increased. At low temperatures, the deformation of the polymer was slow. However, at high temperatures, the deformation was fast.

Comparative study of the effects of heat treatment on corrosion behavior of selected steels in 3.5M sodium chloride

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The corrosion behaviour of selected steels of low carbon, medium carbon and high carbon steels in 3.5 molar sodium chloride (NaCl) solution were studied. The samples were heat treated and immersed in 3.5 molar NaCl solution for corrosion test investigation. The immersion test was setup for 60 days for the comparative study of the behaviour of the selected steels in the corrosive media. Metallography examination of the steel samples revealed the presence of ferrite and pearlite in all the as-received, normalized and furnace-cooled steel samples. Comparative studies of the selected steels indicated that the highest corrosion resistance was exhibited by the high carbon steel at various heat treatments which could be as a result of higher chromium and molybdenum than the medium carbon steel and low carbon steel in the 3.5M NaCl solution. The medium carbon steel exhibited the lowest corrosion resistance which was due to the presence of porosity within its microstructure, although its chromium content is higher than that of the low carbon steel.

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Comparison of corrosion behavior of welded zone and parent metal of low carbon steel pipe (X65) in acidic and alkaline environments

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Key words: X65 Steel, Welded zone area, Parent metal, Corrosion behavior

The corrosion behavior of welded zone area and parent metal are being investigated and compared in environments pH values (4, 7 and 10). Immersion tests were carried out on the samples at room temperature. Weight measurements and Scanning Electron Microscopy is used to study the effects of pH on the corrosion behavior of the low carbon steel samples (X65). At periodic intervals, the weight loss of the uncoated X65 samples in the pH 4 medium was more than the pH 7 and 10. This is mostly due to attack of chloride ions on the surface of the X65 steel. It is expected that the welded zone area will exhibit more corrosion behavior in the different corrosive media than the parent metal.

Contamination of food by iron from grinding mill

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Keywords: Iron overload, iron contamination, corrosion, grinding discs, maize, cassava.

There is a possibility of metal contamination and dietary overload associated with the grinding mechanism which results in surface interaction between the milled food stuffs and the metal grinding discs. This research was carried out on maize and cassava samples due to the high intake of dishes such as banku, akple, eba, kenkey, etc. by almost 90% of Ghanaians on daily basis. The research was aimed at ascertaining metal contamination and deducing the extent of contamination. Iron levels in dry maize, wet maize, dry cassava and wet cassava processed by the grinding disc in the Tarkwa Municipality were 12.04 mg/kg, 14.86 mg/kg, 14.98 mg/kg and 17.15 mg/kg respectively, and the corresponding levels in a wooden mortar and pestle were 5.11 mg/kg, 7.11 mg/kg, 7.11 mg/kg and 9.11 mg/kg. This corresponds to 135,109,110 and 88 percentage rise in the mortar and pestle values respectively. Comparing the iron levels in samples processed by the grinding disc and those processed at the lab, there was an increase in iron content resulting from the contribution of iron from the grinding disc to the food samples. There is a higher risk of metal overload in males aged 19 years to 50 years than their female counterparts given the average daily required intake of 8 mg/kg in males and 18 mg/kg in females. Health issues associated with iron overload such as hemochromatosis, cirrhosis, heart failure, bronze pigmentation of the skin and excessive fatigue necessitates immediate action to remediate the problem.

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Corrosion and hydrogen storage characteristics of V-rich Ti-V-Cr hydrogen storage alloy

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Keywords: Corrosion rate, hardness, hydrogen storage properties, BCC and Laves structure

The microstructure, hardness, corrosion behaviour and hydrogen storage properties of a Ti-V-Cr at.% alloy were investigated. The V-rich alloy was produce by arc melting under argon in an open hearth crucible furnace. The microstructure was examined by scanning electron microscopy (SEM) with energy dispersive x-ray spectroscopy (EDX), and the phases were identified by X-ray diffraction (XRD). The Vickers hardness of the alloy was measured using a 2 kg load, and the corrosion behavior in 6M KOH was determined using potentiodynamic testing. The hydrogen absorption/desorption characteristics were examined by performing pressure-composition-temperature (PCT) measurement at temperatures of 30, 60 and 90°C. XRD analysis showed that the as-cast alloy contained a primary (V) body centered cubic (BCC) phase and secondary, intergranular Laves phases. The average Vickers hardness was found to be 415 HV_2. The E_{corr}, I_{corr} and corrosion rate of the alloy were -767 mV, 1 $\mu A/cm^2$ and 0.011 mm/y respectively. The maximum absorption capacity of ~2 wt% H was measured at 303 K. The H capacity remaining in the metal after desorption process was 0.33 wt% while the useful/reversible/desorption capacity was 1.56 wt%. The ternary alloy investigated in this work is a potential candidate for use as hydrogen tank in fuel cell technology because it has relatively high useful capacity.

Corrosion and wear behavior of spark plasma sintered Ti_6Al_4V/Al_2O_3 cermet

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Keywords: Ti6Al4V; SPS; Corrosion; Wear

Titanium and its alloys exhibit significantly low hardness and poor wear behavior which limit their usage in areas where the synergy of wear and corrosion is active such as in biomedical applications. Whereas several studies have focused on the surface modification of these alloys to improve wear resistance; mostly by coating, very few research is conducted on the modification of the bulk microstructure of these alloys. The objective of this study is to improve on the wear and corrosion resistance properties of Ti6Al4V alloy by incorporating Al_2O_3 into the matrix. γ-Al_2O_3 was mixed with Ti6Al4V powder at varying volume percentages and sintered using the Spark Plasma Sintering (SPS) technique. The sintered compacts were characterized based on their densities, microstructure, phase compositions and micro hardness values. Wear and corrosion studies were conducted on sintered samples using tribometer and potentiodynamic polarization techniques, respectively. The results show that increasing γ-Al_2O_3 content decreased the relative densities whilst increasing the micro hardness of sintered compacts. Porosity of the cermet is seen to increase with increasing alumina content and a decrease in corrosion rate is observed as alumina content increased, while the coefficient of friction under wear increased with increasing Al_2O_3 concentration.

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Corrosion investigation of African walnut shell (*Tetracarpidium conophorum*) as coating material in oil and gas Industry

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Keywords: African walnut shell, gravimetric, potentiostatic polarization, and dipping

This study was conducted to assess the possibility of using African walnut shell as coating material on mild steel in the oil and gas industry with a view to assess its binding strength and corrosion behaviour. The walnut shell acts as extender pigment ranging between 0 -100% at intervals of 20% in the paints formulation and dipping technique was employed to coat the mild steel. The initial and final weights of the samples before and after immersion in 3.5% NaCl were recorded at an interval of 2 days for a total of 16 days and the corrosion rates were determined. While, the potentiostatic polarization experiment was carried out using a potentiostat with three electrode cell; the coated sample as the working electrode immersed in 3.5% of NaCl. The adhesion of the coat was evaluated using pencil hardness test according to ASTM D3363. The result displayed by weight loss method, polarization techniques and pencil hardness test revealed that optimal corrosion resistance rate and adhesion was obtained for sample painted with 60% walnut shell. The positive results obtained were supported by the presence of some oxides in the walnut shell, such as P_2O_5, SiO_2 among others, which acts as binder and reinforcement in the paint formulation.

Corrugated laterite Based Ceramic Roof Tiles Stabilized with Cement

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Keywords: Cement, ceramic, corrugated, laterite, roof tile

The use of laterite based materials as ceramic roof tile contributes to the innovation and application of local materials within our immediate environment. In this study the aim is to design and produce corrugated laterite based roof tile and investigate it water absorption and penetration. Paste of laterite-cement mix was formed with water to cement ratio of 3:1. The percentage composition of the cement used was 15% and 20%. The paste was poured into a wooden frame (dimension of 200mm x 300mm x 200mm) with an underlying corrugated metal sheet, while another corrugated metal sheet was placed on the paste to ensure formation of the corrugated shape on both sides. Water analysis carried out on the cast samples showed that the sample with 20% cement composition had a better resistance to water absorption and penetration. The result of this study indicates that the formation of corrugated roofing tile using laterites is feasible and it is possible to have good water resistanct property if fully optimized.

Cyclic stress relaxation (CSR) of filled rubber and rubber components

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Keywords: Cyclic, Stress, Relaxation, Rubber, Elastomer

Under repeated stressing it is well known that rubber materials exhibit cyclic stress relaxation (CSR). Previous work has shown that the amount of relaxation observed from cycle to cycle is significantly greater than that expected from static relaxation measurements. The reduction in the stress attained on the second and successive loading cycles as compared to the stress attained on the first cycle in a stress strain cyclic test of fixed amplitude has been measured for elastomer test pieces and engineering components. It is seen that the peak force, under cyclic testing to a specific maximum displacement, plotted against the number of cycles on logarithmic scales produces a straight line graph, whose slope correlates to the rate of cyclic stress relaxation per decade. The rate of cyclic stress relaxation was found to increase with displacement amplitude in all modes of deformation. Plotting the rate of stress relaxation per decade against the maximum average strain energy attained in the cycle reduces the data measured in different deformation modes for both simple test pieces and components to a single curve. This approach allows the cyclic stress relaxation in a real component to be predicted from simple laboratory tests.

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Development of a regenerative silicon carbide (SiC) diesel particulate filter (DPF) coated with electroless deposited catalytic metals

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Diesel Particulate DPFs (DPFs) are becoming a more effective solution to meet the stricter regulations being placed on diesel vehicles from the Environmental Protection Agency (EPA). However, DPFs are costly and a method of catalyzing the regeneration of these DPFs using metals is the focus of much research. We developed a method of Electroless deposition metals (Ni, Fe, Co, and Cu) onto the surface of Silicon Carbide (SiC) Ceramic Foam DPFs to harness the potential catalyzing characteristics of these metals in the exhaust of diesel engines to develop a continuously regenerating DPF. The characterization of elements on the SiC DPFs surface was confirmed using Scanning Electron Microscopy and Energy dispersive X-rays (SEM/EDX). These DPFs were then tested in the exhaust of a single-cylinder diesel engine using pure diesel fuel while chemical and differential pressure data was collected. In turn, we can confirm that SiC Ceramic Foam DPFs are sufficient in reducing particulate matter in diesel exhaust. Preliminary results shows that only NO_2 of the two products of catalytic regeneration (NO_2 and CO_2) increased for the Ni-plated SiC DPFs. The feasibility of electroless deposition coating (EDC) for the plating of (Ni, Fe, Co and Cu metal catalyst on SiC ceramic foam diesel particulate filters to enhance oxidizing and regeneration of the DFS has been demonstrated. These desirable metals elements on the SiC DFS ceramic foam appear to be responsible for their improved oxidation of soot particulates in the combustion exhaust emission of the diesel engine.

Development of Natural Fiber Reinforced Plastic Composite

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Natural fibers such as bamboo fibers is compared with glass fiber in various aspects and has shown significant advantages over glass fiber in some areas. They are low-cost fibers, readily available with high mechanical properties and low density. Environmental problems associated with plastic waste disposal has been addressed by recycling of plastic waste into other products such as natural fiber reinforced plastic composites. This study presents the development of composites for use in wind turbine blade design using natural fiber reinforced low density polyethylene. Natural fibers were extracted from bamboo stem, plantain stalk, and coconut husk by mechanical and chemical methods into composite design. Chemical modifications were employed to improve the interfacial matrix-fiber bonding resulting in the enhancement of properties of the composites. Mechanical properties of the natural fiber reinforced composites were determined and the experimental results showed that the bamboo fibers had sufficient strength, which is comparable to that of conventional glass fibers. Composites developed from the various fibers exhibited great mechanical properties.

Early and late strength characterization of Portland cement containing calcined low-grade kaolin clay

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Keywords: Low-grade kaolin clay, pozzolanic materials, strength, Aluminium environment, Silicon environment

Heat treated low-grade kaolin clays are now considered as a suitable pozzolanic material to metakaolins. However their suitability as a good pozzolanic material depends on the geochemistry and structure of the clay usually influenced by the geographical environment. This study investigated a low-grade kaolin clay from Nyamebekyere in the Ashanti region of Ghana. The influence of the calcined material on the early and late strength development of Portland cement were analyzed. The early 3 and 7 days strength as well as the late 28 days strength of Portland cement replaced with 20% by weight of the calcined material yielded the optimum strength values. Further analysis using solid state Magic Angle Spinning Nuclear Magnetic Resonance (Ss MAS NMR) probed into the Aluminium (Al) and silicon (Si) environment to detect the presence of Al and Si hydrates using the optimum mixture proportion. The Ss MAS NMR results showed that the strength enhancement of the optimum mixture was due to the growth of stable monosulphate compounds and formation of more secondary calcium and aluminium silicate hydrates. For higher reliability in concrete integrity, the study recommends the use of 20% calcined clay from Nyamebekyere as Portland cement replacement.

Earth as a potential building materials for affordable housing in Africa

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Keywords: Earth, Building Materials, Clay, Housing, Stabilization.

The increasing demand for affordable housing, particularly in developing African countries the need for low cost building materials (BMs). Traditionally used BMs can provide potential solutions. In this paper, possible earth based building materials and construction techniques to meet this demand are reviewed. To start, the historical perspective on earth construction is presented and their durability assessed. The different classes of soil, referred to as earth in building construction, are presented. The different ways to classify soils include geological origin, mineral content, particle size or consistency. The main traditional techniques globally used for building with earth are rammed earth, daub, adobe and cob. Rammed earth techniques, adobe, and compressed earth blocks (CEBs) materials are the most widespread used in construction today. The property of soil can be enhanced by addition of one or more stabilizers; red sandy loams with 10 to 20% clay and 60 to 70% sand content being the ideal soil for stabilized soil block (SEB). Stabilizers such as cement, lime, and straw and the stabilisation mechanism are highlighted. As a rough guide, sandy soils need 5 to 10% cement for stabilization, silty soils 10 to 12.5% and clayey soils 12.5 to 15%. Compaction when ramming or pressing blocks greatly influence the result. Properties of stabilized and/or compressed earth blocks are compared with those of conventional cement blocks.

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Effects of coconut shell and coconut fibre on the mechanical properties of polyester composite

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In recent times, particulate filled polymer composites are becoming more attractive because of their low cost, light weight and wide range of applications. Fibre materials such as carbon fibre and Glass fibre are the conventionally used reinforcement materials in polymer composites. However, natural filler (Agro-based) materials are emerging as suitable alternatives to Fibre materials for reinforcing polymers such as polyester due to their high abundance, renewability and cost effectiveness. Unsaturated Polyester resin was reinforced with 100um particle size of coconut shell and coconut fibre using variable particle loadings of 5, 10, 15, 20 and 25 weight percent. Samples of the prepared composite materials were subjected to various mechanical tests and microstructural analysis. The results showed that the coconut shell reinforced particles exhibited higher hardness values than coconut fibre reinforced particles; and will be more suitable for applications requiring high hardness. Other results showed that the flexural strength was greatly enhanced at 25 and 15 percent filler loading for coconut fibre and coconut shell respectively. The performances of the two composites tested were poor when subjected to tensile loading. It can be seen that tensile strength of the pure polyester reduced when it was reinforced. This means that these composites should not be considered in applications that would subject them to tensile loading. From the results, coconut fiber reinforced unsaturated polyester composite has a better mechanical properties than coconut shell reinforced polyester composite.

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Effect of minor elements on the crack initiation and S-N performance of a cast Al-Si-Cu-Ni-Fe piston alloy

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Keywords: Al-Si, piston alloy, Fatigue, Crack initiation, Casting defects

The effect of minor elements on the fatigue performance and crack initiation behaviour of a cast Al-Si piston alloy is presented. The chemical composition (in wt.%) of the base alloy (P) investigated include: 10.6Si, 1.36Cu, 1.08Ni,1.06Fe, 0.78Mg, plus Mn, Cr, Ti and Zn in trace amounts . Three other alloy variants of the base alloy with different minor elements were then prepared and investigated: a.) P + 0.2Cr + 0.3Mn (PMC), b.) P + 0.02Sr + 0.28Al5TiB (PSG) and c.) P + 1.06Cr (PC). Fatigue tests were carried out using T6 heat treated bend bar specimens at room temperature on a 50 kN Instron 8502 using a 4-point bend loading geometry and a load ratio of 0.1 at 15 Hz. The maximum surface stress on the specimens was predicted using finite element analysis. The origin of fatal fatigue cracks was investigated by analyzing the fracture surfaces of failed specimens using a scanning electron microscope (SEM) fitted with an energy dispersive X-ray (EDX) unit for phase identification. Furthermore, the origins of secondary cracks on the surface of selected S-N specimens were also analyzed by SEM. The results show that the alloys containing Cr (PC) or a combined addition of Cr and Mn (PMC) exhibit high fatigue life compared to the base alloy (P) and that containing both Sr and TiB grain refiner (PSG). This behaviour is attributed to low porosity levels in the PC and PMC alloys. It is also observed that porosity was the dominant crack initiation site for all alloys investigated except for the PMC alloy in which cracks emanated from intermetallic particles (particularly the Al_9FeNi phase). The observed scatter in fatigue life is discussed in terms of the observed fatigue crack initiation sites

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Effect of physical properties of aggregates on workability, segregation and compressive strength of light, non-reinforced concrete.

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Keywords: Concrete, aggregate, segregation, workability, strength.

Strength of concrete is one of the most important properties of concrete that is measured through compressive strength test, to determine the capacity of the load that a concrete can carry which is applied directly and the crushing load per unit surface area of the applied load to the concrete. In this research work the following shapes of aggregate were used: Angular, Elongated, Smooth rounded, Flaky aggregate, & Control aggregate to cast 60 cubes of concrete. The trial mix ratio used was 1:3:6 with a water/cement ratio of 0.5 and the physical characteristic of the aggregate was determined and compared with the standard. The cast cubes were cured for 7, 14, 21, & 28 days and their average compressive strength and average density were calculated, the compressive strength for angular were 9.48N/mm2, 11.36N/mm2, 14.50N/mm2, and 18.28N/mm2 respectively; elongated: 9.08N/mm2, 10.00N/mm2, 13.01N/mm2, and 16.36N/mm2 respectively; smooth rounded: 9.01N/mm2, 10.61N/mm2, 13.21N/mm2, and 16.98N/mm2 respectively; flaky: 10.01N/mm2, 12.00N/mm2, 15.11N/mm2, and 18.16N/mm2 respectively and control aggregate (17.56N/mm2, 21.30N/mm2, 23.82N/mm2, and 26.01N/mm2. The average density for angular were 2202.47kg/m^3, 2141.23kg/m^3, 2307.16kg/m^3, and 2322.96kg/m^3; elongated: 2099.75kg/m^3, 2105.68kg/m^3, 2334.81kg/m^3, and 2431.60kg/m^3; smooth rounded: 2206.42kg/m^3, 2202.47kg/m^3, 2269.63kg/m^3, and 2382.22kg/m^3respectively; flaky: 2350.62kg/m^3, 2303.21kg/m^3, 2346.67kg/m^3, and 2392.10kg/m^3respectively and control aggregate: 2396.05kg/m^3, 2347.65kg/m^3, 2431.60kg/m^3, and 2422.72kg/m^3 respectively. The angular aggregate has the highest strength value and showing a good resistance to segregation when compared with the others except the control which has the highest strength.

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Effects of soil properties and geogrid placement on CBR enhancement of gravel soil for road pavement layers

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Keywords: CBR, Geogrid reinforcement, Gravel soil, Road pavement, Ghana

This study explores the interaction between the plasticity index and gradation properties of a gravel soil within a soil-geogrid reinforced composite structure for a pavement. The mechanism for strength development when unbound soils are reinforced with geogrid is not well understood. Even for design purposes, performance tests are usually required due to the wide range of products and specifications. Three samples of soil with different plasticity index (PI) values and gradation were constituted by blending a natural gravel soil with clay powder; the resulting soils were tested with and without reinforcement. Then by placing one and two layers of geogrid at certain depth within sample height, the effects of reinforcement, PI and grading on CBR values are investigated in soaked conditions. The results shows that as the PI increase the CBR value decreases. Reinforcing natural gravel soil with geogrid will increase the CBR value. The results also indicate that as the proportion of coarse aggregate particles in the soil increases, the CBR of a reinforced soil also increases for all locations of the reinforcement.

Effects of Stress on the Pitting Behavior of Pipeline Steels

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Keywords: corrosion pits, fracture mechanics, finite element analysis, stress concentration.

Corrosion pits pose a serious threat on engineering structures when subjected to external applied stresses. Applied stress can cause the pits found on the surface of the steel to transition into cracks. In this work, the stress concentration due to corrosion pits was modeled using a combination of fracture mechanics and finite element approach. The stress distribution around the pit was determined using finite element models. The finite element analyses for different pit configurations were carried out and their aspect ratio were also taken into consideration. The loading conditions inputted during the analyses are similar to those exposed to the structures during service. The implications of the results are used for the design and lifetime prediction of engineering structures such as pipelines, pressure vessels, storage tanks e.t.c.

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Electrochemical assessment of ammonium benzoate as corrosion inhibitor of mild steel in 0.5M HCl solution: grey relational model approach

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Keywords: Corrosion, Ammonium benzoate, Hydrochloric Acid, Mild Steel, GRA.

Surface deterioration by corrosion is one of the complications associated with ageing facilities and components especially under some service environments. Studies involving performance of corrosion inhibitors had been identified as one of the critical research needs for improving the durability of mild steel used in various industrial applications. This paper investigates the inhibiting effect of Ammonium benzoate against thecorrosion ofmild steel in 0.5M HCl solution. The steel samples were cut to corrosion coupons, and immersed into 0.5M HClmedium at 30^0C using gravimetric and electrochemical techniques. The microstructures of the developed thin films and uncoated samples were characterized by optical (OM) and scanning electron microscope (SEM/EDS). Moreover, X-ray diffractometer (XRD) was used to identify the phases present. Results obtained reveal that the compound (Ammonium benzoate) performed effectively giving a maximum inhibition efficiency of 79% of 2% v/v concentration from weight loss analysis and 80.9% at 2%v/v concentration from polarization test.Moreover, the results obtained from potentiodynamics polarization had good correlation with those of the gravimetric method. The adsorption of the inhibitor on the mild steel surface from the acid was found to obey Temkin's adsorption isotherm. Scanning electron microscopy (SEM/EDX) observation confirmed the existence of an absorbed protective film on the metal surface.In addendum, Grey Relational Model [GRA] was used for the optimization of the experimental parameters since processing parameters played an important role in the quality of protective film produced. The optimal values obtained by the model were validated by confirmation of experiments.

Evaluation of palm oil and palm kernel oil as collector reagents in froth flotation of Ninji graphite.

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Keywords: Froth flotation, Ningi graphite, collector reagent, palm kernel oil, palm oil.

In froth flotation, the recovery and purity of the final product depends on various parameters that include the type and the amount of reagent, nature and particle size of solid, and adsorption of reagent on solid particles. Within this context, reagent type and intended usage are important factors that are mostly considered in froth flotation. In this work, the froth flotation performances of Ningi graphite are investigated using the conventional collector reagent (oleic acid) and two local collector reagents (palm kernel oil and palm oil). The froth flotation performance with the Denver flotation cell is also investigated before conducting chemical analysis tests. The results from our study showed that palm kernel oil is a better collector reagent compared to the palm oil, and confirmed that the local reagents can be used in the froth flotation of Ningi Graphite.

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Flow softening characteristics of extruded Ti-6Al-4V alloy

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Keywords: compression test, constitutive modelling, dynamic recrystallisation

The flow softening behaviour of extruded Ti-6Al-4V in its as-received condition was investigated via isothermal hot compression testing. The initial microstructure showed elongated α-Ti surrounded by a network of intergranular β-Ti. Prior to the test, cylindrical samples were machined to Ø8 x 12 mm to maintain an aspect ratio of ≤ 1.5. Uniaxial compression tests were done on a Gleeble 3500 at deformation temperatures of 850, 900, 950 or 1000 °C and strain rates of 0.01, 1 or 10 s^{-1}. Constitutive equations were developed to describe the kinetics of the deformation process. Thereafter, optical micrographs were taken to establish the deformation mechanism. The results show that flow stress increased with decreasing deformation temperatures and with increasing strain rates. At a strain rate of 0.01 s^{-1} and temperatures of 950 and 1000 °C, the flow stress increased to a peak value with increasing strain, followed first by rapid flow softening and then a steady state stress region. However, at temperatures below 950 °C, flow softening balanced the rate of work hardening, leading directly to steady-state flow stresses. An oscillating flow stress curve was observed at all deformation temperatures for samples tested at a strain rate of 1s^{-1}. At the highest strain rate of 10s^{-1}, the flow curve showed a broad peak followed by continuous flow softening. Kinetic analysis provided an average stress exponent n of 3.3818 and an activation energy Q of 620.98 kJ.mol^{-1}, which are in good agreement with reported values. Error analysis and the correlation coefficient R^2 of the measured and predicted stresses showed reliability of the constitutive equations. Microstructural analysis confirmed dynamic recrystallisation of the β-Ti at deformation temperatures below 950°C at 0.01 and 1s^{-1} strain rates.

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Geochemical and mineralogical properties of selected medicinal/cosmetic clays used by women in South Africa

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Keywords: Clay, smectite, illite, cosmetic, Healing

The therapeutic use of clay had been dated since prehistoric time. Due to the wide spread of infectious diseases and increasing antibiotic resistant bacteria, there had been reports of excessive use and abuse of antibiotics in a quest to combat these pathogens. Clay had been a useful natural product due to its antibacterial properties. The absorptive properties of clay minerals support their applications in the treatment of both gastrointestinal and skin ailments. Clays for many years have been used for cosmetic purposes, and are major components in traditional beauty regimens. Many spas apply clay due to its soothing effect for several therapeutic treatment. Based on indigenous knowledge that had constantly been transferred from generation immemorial till recent times, women within the different provinces of South Africa apply clays topically for the purpose of exfoliating, cleaning and invigorating the skin to its natural radiance. Due to the complexity in the absorption and diffusion of chemicals from the clay to the human body through the skin, study into their particle size will be carried out. According to EC Regulation 1223/2009 the presence of As, Be, Cd, Cr, Hg, Ni, P, Pb, Sb, Se, Te, Tl, Zr and their compounds is prohibited in cosmetics. This study aims at investigating the level of concentration of these trace elements in the clay materials. Using instrumental analyses such as XRF, XRD and ICP, 10 cosmetic clay samples obtained from herbalist shops in different markets were characterised for their mineral and chemical composition along with suitable control samples (non-cosmetic clays).

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Geopolymer Binder: A Potential Replacement for Ordinary Portland cement

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Keywords: Geopolymer binder, Ordinary Portland Cement, Alumino-silicate, alkali silicate, mortar.

Ordinary Portland Cement (OPC) is a very important material in the construction industry. The production of OPC is energy intensive and produces an equal amount of CO_2 per ton of cement. There is need for low cost and environmental friendly binder that can replace OPC. Geopolymer binder is a potential alternative to OPC. Geopolymers are alkali-activated alumino-silicate polymers. They have a three dimensional structure similar to that of zeolites but unlike zeolites are amorphous. They are produced by mixing alkali silicate solution with an alumino silicate source material like metakaolin, fly ash or rice husk ash. They show unique mechanical, thermal and chemical properties and have a wide range of applications in several industries. This paper presents mechanical properties of geopolymer binder mortars and its applications in the construction industry. Insights from this work will be used to develop guidelines for the design of binders that are affordable and eco-friendly in our society

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INFLUENCE OF GALVANIC INTERACTION ON THE LEACHING BEHAVIOUR OF GALENA SPHALERITE ORES IN ACIDIFIED HYDROGEN PEROXIDE

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Keywords: Leaching, Galvanic Interaction, Dissolution and Passivation

The influence of galvanic interaction on the leaching behaviour of galena-sphalerite ore has been investigated using electrochemical techniques. Electrochemical measurements considered included open circuit potential (OCP), potentiodynamic polarisation and chronoamperometry. The as-received ores were pulverized and screened to particle sizes 150µm, 106µm, 75µm, and 53µm. Chemical compositions of the ore was determined using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), X-ray fluorescence and X-ray Diffractometer. Some of the identified metals were lead, zinc, copper and iron. Thereafter, electrochemical studies were conducted in 1 M H_2SO_4 with varying concentration of H_2O_2 as oxidant. The results show that the grains of the ore appeared inter-grown together with variation in chemical and mineralogical compositions within the particle sizes. The results from the electrochemical studies revealed that addition of H_2O_2 to H_2SO_4 enhanced the dissolution rate of the sulphide ores with dissolution rate increasing with increasing H_2O_2 concentration. The evolution of the open circuit potential in the investigated samples increased with increase in oxidant concentration suggesting that H_2O_2 oxidant had a strong influence on the surface reactivity of the sulphide ore. The dissolution potential also shifted to more positive values with increase in H_2O_2 concentration. Current density fluctuations were observed during chronoamperometry measurements which can be attributed to simultaneous dissolution and passivation of concentrates at the electrolyte-particle interface.

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Human Martian/Lunar Exploration Habitat, Space Architecture and Launch Vehicle Design

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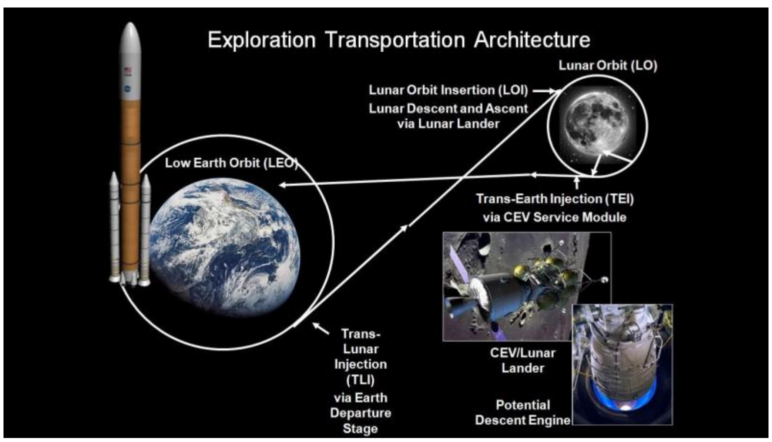
With a renewed resolve to explore and better understand the heavens, mankind looks to take the next gigantic leap—toward the red planet. If we choose to go to Mars or moon, however, we will require a transportation system of magnitude and complexity far greater than any previously designed. To be worthy of the voyage, such a system must not only provide accurate navigation of interplanetary space, but also ensure safety of a crew and facilitate opportunities for research and development. Space industries are being challenged to design a spacecraft system that optimally meets the above requirements, and propose concept space architecture, the necessary propulsion, space habitat, and life support capability for human habitation.



Exploration Transportation Architecture (Courtesy Of NASA)

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Hybrid sprak plasma sintering of WC-based hardmetals

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The utilization of spark plasma sintering (SPS), also known as field assisted sintering (FAST) and pulsed electric current sintering (PECS) has been observed as effective technique for rapid consolidation of fully dense materials. Nevertheless, the effectiveness of this technique for sintering some classes of materials, especially non-conductive materials and larger samples with controlled and homogenized stoichiometry, microstructure and phases can sometimes be compromised. Technological efforts have therefore been focused on varying means for improving the effectiveness of SPS consolidation methods. In this study, the effectiveness of the sintering techniques of hybrid SPS and Hot Press sintering technique for the consolidation of tungsten carbide containing varying amounts of cobalt contents and chromium is investigated and compared with conventional SPS techniques. Conventional WC-Co and WC-Co-Cr powders were sintered using conventional SPS machine and in both SPS and hybrid heating modes in a hybrid SPS-hot press machine. The effectiveness of the sintering techniques are assessed with respect to microstructural and phase interactions studied using SEM and XRD techniques as well as their mechanical properties.

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Indigenous fungi species from crude oil and petroleum contaminated soil for metal recovery

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Keywords: fungi, metal recovery, cobalt, copper, nickel, sulphide bearing minerals

Microorganisms (bacteria and fungi) are commonly found in any living or previously living matters. Fungi were seldom used for the recovery of metals either from their mineral bearing ores or from their aqueous solutions. Crude oil and oil contaminated soils were collected from the inland rig in Angola and Johannesburg, (South Africa) respectively. Strains isolation, growth, culture and characterisation were conducted. Four fungi species were observed namely. *Trichoderma longibrachiatum, aspergillus niger, aspergillus terreus, penicillium cecidicola, meyerozyma guilliermondii and candida auris*. While *Aspergillus niger,* has been found efficient for the dissolution of oxidised low –grade ores, this paper will discuss the effectiveness of petroleum indigenous *trichoderma longibrachiatum, aspergillus niger, aspergillus terreus, penicillium cecidicola, meyerozyma guilliermondii and candida auris* for the recovery of Co, Cu and Ni from their South African platinum group sulphide bearing minerals.

Influence of Ru additions on the hardness and densification of WC-VC-Co alloys

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The aim of this work is to establish the effect of Ru additions on the hardness and densification properties of WC-VC-Co alloys. Alloys of 80WC-10VC-(10-*x*)Co-*x*Ru (wt%) were prepared by mixing constituent powders and Hot Isostatic Pressing (HIPing) at 1430°C. Mixing was done by ball milling 100g of powders in a 1kg capacity mill at a ball-to-powder ratio of 30:1 for 8h. The ball mill products were further mixed using a tubular mixer at a ball-to-powder ratio of 3:1 at 94rpm. Prior to HIPing, the powders were compacted using uniaxial pressure at 100 kN load. The Vickers' hardness of samples was measured under a 30kg load in accordance to ISO 3878, and the densities of samples were measured according to ISO 3369. The densification was determined by dividing the measured density by the theoretical density according to the rule of mixtures. Addition of Ru improved the hardness of WC-VC-Co alloys by ~8% (Fig. 1a), but decreased densification by ~0.6% (Fig. 1b) for up to 3wt% addition of Ru. The improvement of hardness by Ru was attributed to its known effect as a WC grain growth inhibitor and solution hardening of the binder phase. It is, therefore, anticipated that the abrasion resistance of WC-VC-Co alloys is also enhanced by the addition of Ru. Densification values above 98.5% were obtained for all alloys, although there was a decrease of densification with Ru additions. The effect of Ru on toughness, as well as wear and corrosion properties will be established in ongoing work.

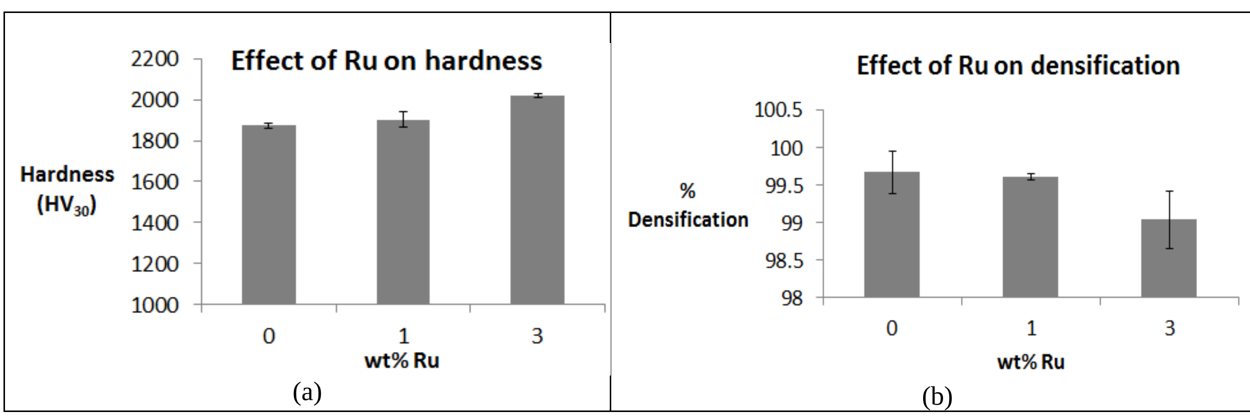

Figure 1. Effect of Ru on (a) hardness and (b) densification of WC-VC-Co alloys.

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Investigation of structural and radiological shielding properties of pozzolana-portland cement

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Keywords: Pozzolana, Compressive Strength, flexural Strength, Ordinary Portland, Cement

The physical properties of the ordinary Portland cement (OPC) are enhanced when the matrix of the OPC is partially replaced by admixtures such as Pozzolana. This research investigated the radiological properties side by side with the usual structural strength of Pozzolana-Portland Concrete (PPC) at different ratios of 0% (S_0), 10% (S_1), 20% (S_2), 30% (S_3), 40% (S_4), 50% (S_5), 60% (S_6), 70% (S_7) and 80% (S_8). Radiological property of a material is its ability to shield or absorb radioactive particles/rays from being released into the environment when housed in containment. Compression test was performed using CONTROL electronic type compression testing machine. Test samples were made of concrete (mixture of Portland and Pozzolana cement) cubes and cylinders. The experiments were conducted at a temperature of 27 ± 2^oC at the following days of aging; 7, 14 and 28. Neutron activation analysis (NAA) was carried out to determine the elemental compositions of Pozzolana and ordinary Portland cement. The compression test results showed that S_2 has more compressive strength than that of the ordinary Portland cement at 28 days of curing. Flexural and ultrasonic tests were conducted to confirm the results. The neutron activation analysis results showed that Europium, Hafnium, Copper, Calcium, Iron, Cobalt and Aluminum, all of which have significant macroscopic cross sections (shielding properties) dominate more in Pozzolana cement than in the ordinary Portland cement. X-ray shielding analysis was also performed to ascertain the NAA results. Linear attenuation coefficient (μ_l) of each sample at photon energy of 0.1Mev was determined with S_5 showing highest value. X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM) analyses were further carried out to identify the phases contributing to the highest strength in S_2 and highest shielding (μ_l) in S_5. The results in all showed that Pozzolana positively affects structural and radiological properties of the ordinary Portland cement (OPC).

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Mechanical Properties of Recycled Polyethylene-Reinforced Laterite Bricks for Building Materials

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Keywords: Particle−reinforcement; Mechanical Properties; Fracture Toughness; Crack Bridging

Polyethylene waste is a nuisance to the environment. It takes up to thirty to fifty years, without complete degradation. This paper describes the use of waste Polyethylene as reinforcement in laterite bricks for sustainable building materials. The bricks are produced with different volume percentages (0-30% v/v) of PE. The flexural-compressive strengths and fracture toughness values of the composite blocks were compared with those of mortar (produced from river sand and cement). The composite containing 20 vol. % of PE had the best combination of flexural/compressive strength and fracture toughness ($\sim 6.6 \pm 0.02\ MPa$, $4.1 \pm 0.03\ MPa$ and $0.76 \pm 0.04\ MPa\sqrt{m}$, respectively). The flexural-compressive strengths as well as the fracture toughness values then decreased, respectively, to minimum values of $\sim 4.4 \pm 0.04\ MPa$, $1.9 \pm 0.03\ MPa$ and $0.54 \pm 0.03\ MPa\sqrt{m}$ for 30 vol. % of PE. The trends in the measured strengths and fracture toughness values are explained using rule−of−mixtures and crack tip shielding models.

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Microstructural and microhardness evolution during high pressure torsion of cast Al-7Si-4Cu-3Ni alloys

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Keywords: Aluminium, Al-Si, Severe Plastic Deformation, Microhardness, High Pressure Torsion,

Samples of a Sr-modified and unmodified cast aluminium alloy containing 7%Si, 3.89%Cu, 0.62%Mg, 0.22%Fe and other minor elements were processed using high-pressure torsion (HPT). This was carried out at room temperature and a constant pressure of 3.0 GPa to 0.25, 0.5, 1 and 10 HPT turns (T). Microstructural examination carried out via light optical and scanning electron microscopy revealed that most of the intermetallic phases had broken down and redistributed within the matrix after 10 T. However, there were still unbroken Si-rich phases after 10 T. The 3-parameter Weibull function was shown to provide the best fit for the particle size distribution. After 10 T, the particle distribution was observed to be skewed towards smaller sizes indicating continuous microstructural refinement during HPT. The circularity of the particles also increased with the number of HPT turns. Microhardness and scatter bars along the specimen diameters increased with increase in strain (i.e, from the specimen centre to the edge). However, microhardness homogeneity along the diameter was not achieved even after 10 turns. The results show that unlike pure aluminium and other wrought alloys, heavily alloyed multicomponent Al-Si alloys such as this one require more than 10 T to achieve sufficient refinement.

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Microstructural and mechanical properties of $Al_{0.7}CoCrFeNi$ high entropy alloy (HEA)

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Keywords: High Entropy Alloys, Uniaxial Compression, Nanopillars, $Al_{0.7}CoCrFeNi$

High Entropy alloys (HEAs) are solid solution alloys containing five or more principal elements in equal or near equal atomic percent (at %). In this study, the $Al_{0.7}CoCrFeNi$ HEA was synthesized by vacuum arc melting and homogenized at 1250 ^{0}C for 50 hours. The microstructure shows the presence of 2 phases. The BCC (A2+B2) and the FCC phase. Nano-pillars were fabricated from the single crystal $Al_{0.7}CoCrFeNi$ HEA in the [001] of the BCC (A2+B2) phase and [324] of the FCC phase having diameters ranging from 400 nm to 2 μm using the focused ion beam and compressed using the Hysitron Nanoindenter. High yield strengths of about 2.2 GPa was observed in the BCC (A2+B2) phase and about 1.2 GPa for the FCC phase. Size effect occurs in both phases, the smaller pillars having the highest strength values. Comparing the BCC phase of the HEA with pure BCC metals shows a reduced size dependence with increased yield strength but the FCC phase in comparism with pure FCC metals shows similar size dependence with increased yield strength. This is attributed to the difference in lattice resistance of the two phases.

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Mineralogical characterization of geophagic clays and possible implications on gut microflora

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Keywords: Clay, microflora, metal resistance, clay microchemistry, minerals

Geophagia, supposedly linked with traditional African communities is fast becoming a global phenomenon and common practice mostly amongst women irrespective of their age, race and location. The urge and deliberate consumption of geophagic clays is largely believed to be due to some therapeutic effects on the geophagic individual. Some deleterious effects had be traced to the consumption of clay materials. A majority of the clays are consumed without being processed leaving the consumer at risks of certain health complications. The human stomach has some probiotic bacteria that support the immune system. They are useful in the treatment of several gastrointestinal ills, prevention and treatment of obesity, support the absorption of nutrient, useful in the treatment of bacteria vaginosis and diarrhea. With the alarming rate at which individuals are consuming clays, it is critical to investigate the impact of this practice on probiotics. In this study, the effect of some of the minerals associated with geophagic clays on isolated microflora such as *Lactobacillus, Saccharomyces boulardi, Bifidobacteria and Enterococcus faecium* for tolerance level. Using specific minerals in their salt forms at different concentration and pH, the tolerance level of isolated microflora will be ascertain.

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Mineralogical profile of geophagic clayey soils sold in selected South African informal markets

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Keywords: Geophagy Clayey soils Quartz Mineralogy Kaolinite.

Geophagia, the intentional ingestion of soil has both useful and negative wellbeing effects due to the biomass, physicochemical, mineralogical and geochemical composition of the gritty material. In a few circumstances, clayey soil is viewed as a supplement to healthful deficiencies resulting from a less than stellar eating routine. Geophagy, has been of interest to researchers and analysts due to continued habitual practice by diverse communities globally in spite of reports contraindicating its purported health benefits. The gritty materials remain a territory of enthusiasm considering the nature in which they are obtained, transported and storage. Geophagic clayey soil from chosen casual markets in South Africa were investigated and characterised utilizing XRF, XRD, FTIR, PH, and electrical conductivity to survey the nutritious qualities that support the continued utilization by mostly females and pregnant ladies in Soweto, Limpopo, Midrand and Johannesburg central business district. XRD results of the analysis carried out on the six representative samples obtained from several informal markets reveal that the clay material is mainly composed of kaolinite with minor palygorskite, illite, Amesite, Gupeite, Hematite and Magnetite. Quartz was the major non-clay constituent identified. The results from the XRF analysis on the samples portray average values of major elements such as SiO_2 (54.02%), Al_2O_3 (35.45%), Fe_2O_3 (6.73%), K_2O (2.76%), MgO (1.16%) with MnO, Na_2O and P_2O_5 falling below 0.5%. Titanium was a major heavy metal identified from the samples which may result in heavy metal toxicity. The potential medicinal application of these clayey soils is supported by the kaolinite contents, in contrast the trace elements are pointers of probable adverse effects on humans.

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Nano-Mechanical studies and deformation of layered structures (Tortoise shell)

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Keywords: Tortoise shell, nano-indentation, hardness, elastic moduli, deformation

The nano-mechanical properties on tortoise shell will be elucidated in this paper. These materials experiences, and has been designed to endure, very different loading conditions in their environment and during their function. This work will explore the deformation and failure mechanisms of tortoise shell with interfaces between relatively "hard" and "soft" layers. Nano-indentation experiments will be used to study the hardness and deformation of the different layers. The work will also develop mechanics-based models for the design of robust materials. Insights from this work will be explored for the design of energy-absorbing materials such as helmets for motorcyclists and polo players which protect them from injury due to falls or hammer impact.

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Noise at a South African underground manganese mine: status-quo and resulting hearing programme

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Keywords: Noise induced hearing loss (NIHL); Hearing conservation program (HCP); noise levels; decibel (dBA); occupational noise; audiometric testing.

Occupational noise is deemed to have disastrous consequences on the health of individuals including noise induced hearing loss (NIHL). NIHL is an actual pandemic that affect most of all industries worldwide. In the South African mining industry, noise induced hearing loss among between the top five occupational illnesses and continues to cost millions of rand in compensations and claims. NIHL is known to have disastrous consequences on people even though it cannot lead directly to death. The prevalence of this pandemic has pushed government into actions notably in establishing new regulations to stop its recurrence. Mines nowadays are required by law to implement a noise management plan including a hearing conservation program (HCP) to prevent any case of NIHL from happening. This paper covers the status-quo of the noise exposure level and prevalence of noise induced hearing loss (NIHL) at a typical underground manganese mine in the Northern Cape (South Africa) over the past 5 years in order to assess the effectiveness of the hearing conservation program (HCP) implemented at the mine. A review of audiometric testing results of the employees at Wessels Mine was performed. The data were accessed from the database of the mine’s clinic and analysed. A walk through survey was conducted to observe the work practices and employees’ behaviour as related to noise in their working sections. Note that noise levels measurements were taken around the mine both in surface and underground beforehand.The results obtained showed that the number of people diagnosed with NIHL from the year 2012 to 2015 was three peoples for both Mamatwane and Wessels Mine. Wessels Mine experienced one major case of NIHL in the financial year 2013-2014. It was also noticed that high noise levels at the mine was generated by mechanized equipment. The principal sources of noise were mostly from production areas underground and processing plant on surface. Since the audiometric data collected from the clinic showed little incidences of noise induced hearing loss, it is clear that NIHL is not a prevalent issue at Wessels Mine actually. This tells us that the hearing conservation program employed at Wessels mine is yielding good results and is therefore effective in preventing NIHL. However, there is still room for improvement. The mine needs to develop new strategies to further control noise both in underground and surface working areas. Some working sections still exceed the tolerable noise exposure level of 85 dBA.

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Non-Facies based wavelet denoising for rock typing

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Keywords: Discreet Wavelet Transform (DWT), Flow zone indicator (FZI), Hydraulic flow units (HFU), Mallet's fast algorithm, Rock typing.

Wavelet theory provides a new way to reduce noise in a signal or set of data. This work demonstrates how the discreet wavelet transform can be used as a denoising tool to denoise porosity – permeability transforms for rock typing. The target is to create a smoother yet representative data pattern out of a comparatively noisy set of data. Three hydraulic flow units were clearly identified for rock typing from a highly noisy set of data. Further scrutiny of the plot by the discreet wavelet transform showed that five hydraulic flow units were evident from the same set of data. The change was attributed to the fact that the rock typing technique adopted was performed without considering facies based conventional techniques. The wavelet technique has been proved useful in the petroleum industry and further work is needed to further scrutinize and recoup the unrelenting abilities of the theory predominantly for denoising purposes.

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On microstructure evolution of fine grained under multiaxial cyclic loading

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Keywords: Multiaxial, effective strain amplitude, proportional loading, nonproportional loading, dislocations

In this work the evolution of substructure and surface features was correlated with the loading path. In addition, the effects of strain amplitude on the microstructure and surface features were studied. The slip patterns observed on the surfaces were correlated to the nature of the loading path. The average grain size of the CG nickel was on the order of and 50 µm. Multiaxial tests were accomplished at effective plastic strain amplitudes of 1.0x10-4 and 1.0x10-3 under both proportional and nonproportional loading. Transmission electron microscopy (TEM) analysis was performed to relate the substructure evolution to multiaxial cyclic loading conditions. The nickel was characterized in terms cyclic stress-strain response, cyclic hardening, and deformation dislocation structures in accordance with the loading conditions. Results show that saturation stress increases with increase in cumulative plastic strain amplitude. Optical micrographs of the surface features obtained from the CG specimens cycled show different slip patterns owing to the different loading paths and effective plastic strain amplitudes. TEM images reveal that different loading conditions as well as the strain amplitudes result in different dislocations structures.

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Organometallic complexes in the petrochemical industry

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Organometallic complexes have been synthesized, characterized, and used in a variety of ways for several decades. Over the past fifteen years, or more, we have studied a series of organometallic complexes. These include complexes containing the transition metals nickel, palladium, platinum, and iron as the central atoms. These complexes have had ligands containing such elements as nitrogen, oxygen, sulfur, and selenium. The complexes were characterized by elemental analyses, NMR spectroscopy, mass spectrometry, infrared spectroscopy, and x-ray crystallography (in a few cases). The stabilities of many of these compounds were studied; mainly by mass spectrometry. Recently two such systems, the (phenoxyimidazolyl-salicyaldimine) iron and the bis-(3,5-dimethylpyrazol-1-ylmethyl)benzene nickel (II) complexes, were used in catalysis of tandem ethylene oligomerization and Friedel-Craft alkylation of toluene.

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Oxidation of TBC coated Nickel based superalloy and gamma titanium aluminides for land based engines

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Our ability to power modern airplanes and land based engines depends largely on the thrust generated most importantly by aero engines. Over the past 30 years material cost has become an important factor, especially in commercial aero engines where light weight and high temperature materials are needed for improved efficiency and specific thrust. The required combinations of high temperature properties has led to the applications of nickel-based superalloys and most recently gamma based titanium aluminides in gas sections of aeroengine. This paper examines the high temperature oxidation behavior of nickel based alloys and gamma titanium aluminides with thermal barrier coatings. The kinetics of oxidation of the coated structures has been studied at various temperatures (800, 900, 1000^0C) that are relevant to gas turbine engines. In this study, the effects of oxidation on the stress intensity factor (mode I and mode II cracks) and the energy release rate are computationally simulated using the ABAQUS^{TM} software. Results are discussed in relation to the principal strain in the top coat/TGO interface. The implications of the results are discussed for the design of improved land-based engines and aero-engines.

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Performance Evaluation of Refractories in Copper Converters

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Keywords: performance, chrome-magnesite bricks, Pierce-Smith converters

Refractory consumption in kg/ ton of copper produced is one of the most important tools used to evaluate converter refractory performance. The objective of this study was to evaluate the performance of two types of refractory bricks used in the Pierce-Smith converters. The refractory consumption in all the converter campaigns studied was quite high (above 10 kg/ton), compared to an average of 1.93 kg/ton reported for other smelters. Refractories are subjected to high temperatures, compressive stresses, and chemical attach by the slag. Erosion by dust evolved and turbulent melt baths have been reported. Thermal shocks cause spalling. The focus was on refractories that have been used in previous converter campaigns and the operating conditions obtaining in the converters. Different parts of a converter are lined with different classes of bricks. Chemical compositions, types of bonding, unit prices and brick wear rates were evaluated. Factors affecting the converter operations were also considered. Chemical analyses showed both brick types are chrome-magnesite consisting of semi-rebonded fused grains. Type 1 bricks had higher ratios (0.43 for tuyere bricks and 0.48 for interior lining bricks) of chrome/magnesia (Cr_2O_3/MgO) than Type 2 bricks (0.32 for tuyere bricks and 0.24 for interior lining bricks). An increase in this ratio increases the refractory resistance to slag dissolution. This supports the observation that Type 1 bricks exhibited lower wear rates than Type 2 bricks.

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Performance Evaluation of Rheological Properties of Clay from the Western Region of Ghana

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Keywords: Bentonite, Drilling fluid, Gel strength, Plastic Viscosity, Rheological

The rheological properties of drilling fluid are an important component for successful drilling program. The ability of water based drilling fluid to suspend drilling cuttings depends largely on the gelling property of the clay. Bentonite which is a colloidal clay exhibits best this ability thus it’s widely use in the petroleum industry. Ghana imports bentonite for its drilling operations, however there are clay deposits in all ten Regions of Ghana. This work focuses on the evaluation of the rheological properties of local clay samples obtained from Wasa Akropong, Shama and Inchaban in the Western Region of Ghana, to ascertain their suitability as substitute for bentonite. Clay samples obtained from Wasa Akropong, Shama and Inchanban in the Western Region of Ghana were milled using jaw crusher and ball mill. The powdery form of these clay samples was obtained using 75 micrometer sieve. Both aged and unaged samples of the clays were prepared and subjected to gel strength, plastic viscosity, yield point and thermal stability tests. Imported untreated bentonite clay was also prepared for both aged and unaged to be used as a benchmark in this research work. The rheological performance of the local clays showed that they can only be used in the petroleum industry if they are beneficiated and further test performed on them as these clays met some but not all of the API requirements. Clay from Ghana has been used mainly in the ceramic, brick and tile industry but not the petroleum industry. This work provides knowledge on the possibility of using these clays from Ghana in the petroleum industry.

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Phase proportions, carbon equivalent, mechanical properties and their effects on the cost of railway axle steels

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Keywords: Railway axle, Mechanical properties, Carbon and alloyed steels, Thermo-Calc simulations, Pearlite volume fraction, Economics, Alloying elements.

Railway axles are safety-critical component of trains and are designed for service lives of up to 30 years. Carbon and alloyed steels with good mechanical properties are highly recommended, and must meet accepted standards and guidelines. This paper assesses the relationship between carbon equivalent, phase proportions, and mechanical properties, as well as how these parameters affect the costs of producing railway axle steels. Phase proportions (simulated using Thermo-Calc), carbon equivalence, mechanical properties (UTS and yield stress) and unit costs per ton of axle steels such as AS1440/4340, LZ50/35CrMo, MS3/MS6, EA1N/EA4T/34CrNiMo6/30NiCrMoV12, AISI 10038, Cr-Nb-V, Cr-V and Cr-Mo grades were calculated. Most axle steels had the characteristic ferrite-pearlite microstructure with carbides and inclusions. Carbon content is the main factor that affects the yield and UTS. As the carbon equivalent increased, the yield strength, ultimate tensile strength and pearlite weight fraction increased with decreased percentage elongation. The increased volume fraction of pearlite had a direct effect on UTS, as expected, and an indirect effect on yield strength since the ferrite grain growth is hindered, reducing ferrite grain sizes (following the Hall-Petch relationship). Decreased ferrite grain size is the one of the main factors that improves yield strength and toughness simultaneously. Alloy steels with UTS and yield strength above 750MPa and 370Mpa had costs above $3300 per ton. For high proportions of pearlite (0.6 to 0.9 weight fraction), the cost was between $3200 and $3500 per ton. Expensive and high amounts of V, Nb, Cr, Mo and Ni increased the cost, but only contributed small direct effects on stress through solid solution and precipitation hardening.

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Preliminary study of spark plasma sintered VC-Ni alloys

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Keywords: Vanadium Carbide, Nickel binder, Sintered density, Hardness

Vanadium carbide has outstanding tribological behaviour, superior to other similar carbides in Groups IVB and VB, except TiC. Most research on vanadium carbide uses it as an additive to enhance wear performance, inhibit grain growth and decrease density, and it has also been used as a partial replacement for WC in WC-Co. This work is on alloys of VC-Ni to provide potential lighter and more corrosion-resistant materials. Three alloys of compositions VC-4Ni, VC-10Ni and VC-22.1Ni (at.%) were produced by spark plasma sintering (SPS). The mixed powders were sintered at 1150oC and 50MPa, holding for 5 minutes. The as-sintered alloy densities were calculated using Archimedes' principle, using the ASTM B962-15 standard. The porosities of the alloys were calculated using the sintered density parameters. The alloys were prepared metallographically and examined by scanning electron microscopy (SEM) to determine the homogeneity of the phase distribution and identify the phases, and by X-ray diffraction (XRD) to confirm the phases. Vickers microhardness was measured using a load of 5kg for 15s.

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Production of iron nuggets from the Akpafu-Todzi iron ore using waste plastics and waste biomass as reductants

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Keywords: Reduction; Akpafu-Todzi iron ore; Waste plastics; Waste pure water sachets; Waste biomass

Disposal of waste plastics is currently a huge global problem, especially in the least developed countries where proven avenues for recycling such wastes are non-existent or not well documented. In this work we investigate the potential for producing high grade iron nuggets from the Akpafu-Todzi iron ore in the Volta Region of Ghana, using waste plastics and waste biomass as reductants. Carbonaceous materials were generated from waste pure water sachets (PWS) by pulverising an embrittled mass obtained through a melting-quenching sequence. Reduction studies were conducted on composite pellets of the ore containing the PWS and PNS and various blends of PWS-PNS. The extent of reduction after 40 min was determined for the individual polymers and the blends as reductants. It was observed that iron nuggets can be produced from the Akpafu-Todzi iron using waste plastics and its blends with waste polymers. The measured extent of reduction ranged from about 75.5% to about 99.95%, with the highest attained for the blend of PWS and PNS prepared in the ratio 30 % to 70 %.

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Recycled Thermoplastic Composites for Load Bearing Applications

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Keywords: Reinforced Thermoplastic Composite Lumber, Recycled Plastics, Structural, Infrastructure, Bridge

Long-term performance and extended service life are issues of vital importance to civilian and military infrastructure. Traditional materials, such as wood and steel suffer from expensive corrosion and bio-degradation problems, to address these concerns an alternative is required. Several bridge installations composed entirely of a reinforced thermoplastic composite lumber (RTCL) material have been developed that are capable of supporting the load of an M1 Abrams tank at approximately 64,410 kg (71 tons). The RTCL material selected for these applications is polypropylene (PP) coated fiberglass blended with high-density polyethylene (HDPE). Advantages of using RTCL include, corrosion, insect, and rot resistance; no toxic chemical treatments required to increase service life; environmentally friendly; diversion of waste plastics from landfills; reduction of deforestation, green house gases, and global warming. RTCL has many advantages but does behave differently than traditional materials and certain properties must be addressed during the design stage. Two bridges built in 2009 are continually monitored, have performed well in operation, and are more cost-effective than any other construction material. Details of the material, design considerations, and construction are reviewed.

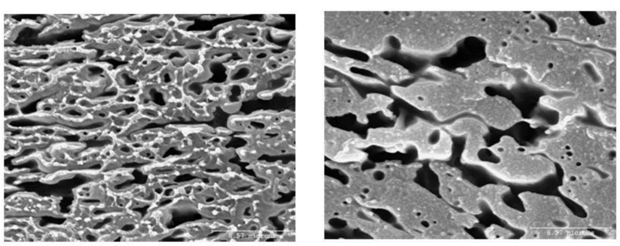

Figure 1. SEM micrographs at 8.57 µm scale of a co-continuous IMPB composed of high-density polyethylene (HDPE) and polystyrene (PS) processed using (a) standard processing methods and (b) high compounding specialized processing methods.

Figure 2. M-1 Abrams tank (71 tons) crossing the RTCL bridge T85-18 at Fort Bragg on September 18, 2009.

Table 1. Material mechanical property requirements

Ultimate tensile stress	3000 psi	20.68 MPa
Tensile modulus of elasticity at 1 % strain (loaded at 50 %/min)	350,000 psi	2.41 GPa
Ultimate compressive stress	3500 psi	24.13 MPa
Flexural stress at 3% outer fiber strain	2500 psi	17.24 MPa
Allowable flexural stress	600 psi	4.14 MPa
Allowable shear stress	350 psi	2.41 MPa

* Standard test methods: Tensile (ASTM D638), Compressive (ASTM D695), and flexural (ASTM D6109)

*All mechanical properties listed are recorded at room temperature (23 °C or 73 °F) and are the property minimum required

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Reducing mine effluent conductivity using laterite as an adsorbent and barium hydroxide as a precipitant

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Keywords: Dissolved Components, Conductivity, Effluent, Laterite, Adsorption,

As chemical components dissolve in water, one parameter that changes significantly is the conductivity and thus, it is used as an indicator of wastewater quality. This paper presents the study to reduce the effluent conductivity using laterite as an adsorbent and barium hydroxide as a precipitant. The main constituents of the effluent are sodium, potassium, calcium, iron, magnesium, nitrate, sulphate and chloride. Three types of laterite samples, Kottravechy (KV), Ridge Kottravechy (RK) and Ridge Cut-Back (RCB) were used for the adsorption studies. The concentration of magnesium and calcium ions increased with increasing effluent volume treated while sulphates, nitrates, chlorides, sodium and potassium decreased when treated with laterites. Sulphate sorption was higher in RK (99.65%) and RCB (99.65%) followed by KV (63.45%). Nitrate removal was highest in RK (59.97%) followed by RCB (41.70%) and KV (37.25%). Also, chloride sorption was highest in RK (45.93%) followed by RCB (19.16%) and KV (18.21%) after passing 110 litres of the effluent. All the three types of laterites tested can be used to treat mine effluent. However, RK treated large volumes (about 100 litres) of the effluent with the highest adsorption characteristics. The average sorption capacity range of RK was found to be between 0.18 mg/g and 0.46 mg/g. The adsorption isotherm for sodium, nitrate and chloride adsorption using RK laterite fits well with Langmuir adsorption isotherm while that for potassium followed Freundlich adsorption isotherm. Chemical precipitation of sulphate ions reduced sulphate ions content from 290 ppm to 29 ppm (90% reduction) but increased conductivity and pH due to the introduction of more hydroxide ions into the effluent.

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Repassivation behaviour of the passive film formed on lean duplex stainless steel (UNS S32101) and austenitic stainless steel (UNS S30403) in a CO_2-saturated oilfield slurry

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Keywords: UNS S32101, UNS S30403, repassivation, passive film, erosion, erosion-corrosion

Comparison has been made between the repassivation behaviour of the passive film on lean duplex stainless steel UNS S32101 and austenitic stainless steel UNS S30403 in a CO_2-saturated oilfield erosion-corrosion environment containing sand. Multiple sand impacts on the stainless steels were achieved in a recirculating jet impingement rig which was coupled with a potentiostat for electrochemical measurements. A velocity of 24 m/s and sand loading of 500 mg/L are employed for the impingement. Potentiostatic measurements were made on samples subjected to liquid-solid impingement to study the kinetics of film reformation on the alloys. Results show that the passive film repassivates faster at the lower temperature of 20^{o}C compared to 50^{o}C with the lean duplex stainless steel (UNS S32101) displaying superior repassivation kinetics at both temperatures. The implications for erosion-corrosion resistance of passive materials are discussed.

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Safety in Small-Scale Underground Mining in Ghana

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Keywords: small-scale mining, safety, human health, mercury amalgamation, underground

Small-scale mining of precious minerals has contributed immensely to the socio-economic growth of Ghana. The sector provides employment for thousands of people, mostly indigenes of the communities in which they operate, and thereby stemming rural-urban migration. The small-scale mining sector in Ghana also provides raw materials for locally based mineral industries and contributes to foreign exchange earnings. The mining is done in various methods; the “Anomabo” method, the Chisel and Hammer method, Underground “Ghetto” method and the Dig and Wash method. The legalization of small-scale mining by the Small-Scale Gold Mining Law, PNDC Law 218 of 1989 was to revive the small-scale mining sector, facilitate supervision and minimize associated environmental hazards. Although, there is a noticeable improvement in the efficiency of operations, the sector continues to pose serious dangers to human health and the environment. Ground failures resulting from weak unsupported or poorly supported stopes have led to loss of human lives and various degrees of injury in recent times. Dust and fumes from chiseling, drilling and blasting of ore pose major health threats due to poorly ventilated stopes. Moreover, mercury amalgamation technique which is heavily relied on for ore extraction poses a serious health threat, and is deleterious to a wide range of ecological entities. This study identified the safety issues in small-scale underground mines in Ghana. Field visits were made to three different small-scale underground mines around Tarkwa in the Western Region of Ghana to assess the safety conditions of the mines and mine-workers. A visit was also made to the office of the Minerals Commission, a regulatory body, to interact with personnel on the need for health and safety training for the mine operators to curtail the recurring catastrophes associated with the operations.

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Rheology of modified water based Isinya and Amboseli Clays: Effect of sodium carbonate and sodium carboxymethylcellulose.

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Keywords: Bentonite, Rheology, Carboxymethylcellulose, Viscosity, Sodium carbonate

Two Kenyan state owned entities are investing heavily in geothermal power exploration in Rift valley, to find enough steam for developing geothermal plants with capacities of up to 10,000 MW. This will require more than 1,000 wells to be drilled using Bentonite as a drilling mud. The aim of this study is to evaluate the suitability of six different samples from two different geographical regions (Isinya and Amboseli) in Kenya, for possible use in well drilling in their raw and modified forms. Particle – particle interactions in the clay suspensions was considered in the study of the rheological properties. The samples were modified with Na_2CO_3 (reduce the amount of calcium) and CMC (reduce the amount of water lost to the formations) in various concentrations. It was observed that flow properties (apparent and plastic viscosity, shear stress and yield point) changed depending on the clay source, additive chemical composition and concentration.

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Separation of nonmetallic inclusions from solar grade silicon (SoG-Si) via the application of high frequency electromagnetic

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Keywords: Electromagnetic separation, nonmetallic inclusions, silicon, fluid acceleration.

Several nonmetallic inclusions have been characterized in multicrystalline solar grade silicon (SoG-Si) ingots. SiC and Si_3N_4 are the two main kinds of nonmetallic inclusions encountered in solar silicon. Due to high purity requirements these nonmetallic inclusions need to be separated. During the directional solidification process of multicrystalline silicon, these nonmetallic inclusions are pushed to the top of the solidified silicon ingot. As a result the top part of the silicon ingot representing 10 – 20 % is cut off as scrap before sawing to silicon wafers. Attempts such as gravity sedimentation and filtration have been proposed for recycling top-cut SoG-Si scraps. This paper discusses application of high frequency electromagnetic field to the removal of nonmetallic inclusions from silicon. The application of high frequency EM field induces strong fluid flow and also local fluid acceleration that combine with electromagnetic body force to separate particles from silicon. The effects of separation parameters such as current, frequency and time are also discussed.

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Short Fatigue Crack Growth Behaviour of a Cast Al-Si-Cu-Ni piston alloy

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Keywords: Al-Si, piston alloy, Fatigue, Crack initiation, Casting defects

The short fatigue crack growth behaviour of a cast Al-Si piston alloy is presented. The chemical composition (in wt.%) of the base alloy (P) investigated include: 10.6 Si, 1.36 Cu, 1.08 Ni,1.06 Fe, 0.78 Mg, plus Mn, Cr, Ti and Zn in trace amounts . Three other alloy variants of the base alloy with different minor elements were then prepared and investigated: a.) P + 0.2 Cr + 0.3 Mn (PMC), b.) P + 0.02 Sr + 0.28 Al5TiB (PSG) and c.) P + 1.06 Cr (PC). Fatigue tests were carried out using T6 heat treated bend bar specimens at room temperature on a 50 kN Instron 8502 using a 4-point bend loading geometry and a load ratio of 0.1 at 15 Hz. The maximum surface stress on the specimens was predicted using finite element analysis. The top specimen surface was polished to 0.05 µm finish to allow free initiation from microstructure features and provide accurate monitoring of crack initiation and interaction with microstructure at periodic intervals using acetate replicas. The acetate replicas were analysed using optical microscopy and ImageJ. The crack-microstructure interaction was investigated using scanning electron microscopy (SEM) on specimens for which the test was stopped just before failure. Intermetallics and porosity are observed to significantly influence the short fatigue crack growth rate of the alloys investigated. It is also observed that short cracks retard and/or arrest when they encounter hard particles (i.e., Si or intertmetallics). It is observed that fatigue cracks initiated mainly from pores and Al_9FeNi particles and then propagate through the α-Al matrix. Crack deflection is observed when it interacts with intermetallics and eutectic regions.

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Simonkolleite-graphene foam composites and their superior electrochemical performance

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Keywords: simonkolleite sheets, graphene foam, composites, supercapacitor

In the developing field of energy storage technology, the design and fabrication of efficient energy storage devices with high energy and power densities are of growing concern today. Numerous scientists have engaged in active research to develop robust and reliable energy storage systems which will match the increasing demand for energy in a variety of applications from energy storage systems in portable hand-held devices to back-up systems in hybrid electric motor vehicles. Supercapacitors (SCs) with high power densities and long cycle life as compared to much common hybrid batteries in use today are promising candidates for such applications. However, they are also characterized with low energy densities in comparison to batteries which create a drawback for their wide applications. Simonkolleite-graphene foam (SimonK/GF) composite has been synthesized by a facile solvothermal and environmentally friendly technique with excellent electrochemical properties. The obtained product was initially analyzed by scanning electron microscopy (SEM), Brunauer–Emmett–Teller (BET), X-ray diffraction (XRD), Fourier Transform Infrared Resonance (FTIR) Spectroscopy and Cyclic Voltammetry (CV) techniques. The microscopy results reveal hexagonal sheets interlaced with each other and adjacent graphene sheets. The existence of graphene foam in the simonK/GF composite is further confirmed from the structural and the optical characteristics obtained from XRD and FTIR respectively. The BET results obtained indicate an improvement in the surface area due to the addition of graphene foam to a value of 39.58 m^2 g^{-1}. The N_2 adsorption/desorption also shows the presence of active mesopores required for charge transport. As a promising electrode material for supercapacitors, the composite shows a high specific capacitance value of 1094 F/g at 1 A/g with a coulombic efficiency of 100% after 1000 cycles. These results show a potential for adoption of this composite in energy storage applications.

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Socioeconomic and environmental assessments of illegal small-scale mining in Ghana

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Keywords: (small-scale mining, *galamsey*, livelihood, dredging, water quality)

Small-scale gold mining continues to make significant socioeconomic impact on many individuals and communities, and it is seen as an alternative and sustainable livelihood for poverty alleviation in rural communities in Ghana. Small-scale gold mining has been carried out for over hundreds of years in Ghana. It is currently and widely operated in the country by both licensed operators and illegal miners popularly known as *galamsey* operators. *Galamsey* activities have been on the rise in recent times, given the rising numbers of illegal Chinese miners and the relatively inexpensive Chinese-made less sophisticated mining equipment. The activities have involved rampant excavation for gold in farmlands, protected forest zones, large-scale mining concessions among others, and the dredging of streams and rivers, of which the Bonsa River, located in the Western Region of Ghana is no exception. The *galamsey* activities in the Bonsa River and the impact on the community were studied. The activities include dredging the river bed and excavating the river banks for gold. The study assessed the economic and environmental impacts of the *galamsey* activities, through the administration of questionnaire, interviews, mapping of degraded lands and water quality analysis. The results showed that over 10 km² of vegetation cover along the river bank was depleted, with excavated materials often dumped in the river course. Water quality analysis indicated that turbidity, total dissolved solids (TDS) and colour exceeded the threshold limits established by the Environmental Protection Agency of Ghana and the World Health Organization. The cost of treating water from the Bonsa River by the Ghana Water Company was also found to have increased by over 90%. However, the results of the questionnaire analysis suggested a tremendous improvement in the economic status of the people of Bonsa. An urgent policy decision was recommended to address the *galamsey* menace in the country.

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Characterization of the susceptibility of Nb-containing ferritic stainless steel during gas tungsten arc welding using the Houldcroft technique

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Keywords: Houldcroft; solidification cracking; ferritic stainless steel; Gas Tungsten Arc Welding

Niobium (Nb) is known to cause solidification cracking of stainless steels during welding. The solidification cracking susceptibility of type AISI 436 ferritic stainless steel (containing 0.6 wt% Nb) was studied using the self-restrained Houldcroft method. Gas Tungsten Arc Welding (GTAW) with different traveling speeds was used. Increasing the welding traveling speed resulted in an increasing crack length. SEM fractographic studies of the Nb-stabilized ferritic stainless steel crack showed the hot crack was usually transgranular. SEM-EDX analysis revealed the elements Al, Nb, N, Si, O, and C as contributing to the solidification cracking. The lower the welding speed, the finer the dendrites. Optical micrograph revealed columnar grains meeting at the centerline where the crack occurred. There was epitaxial grain growth from the HAZ into the weld metal. In conclusion, it is seen that the Nb-stabilized ferritic stainless steels cracked at all the welding speeds. It is recommended to weld Nb-stabilized ferritic stainless steel with care since the steel is susceptible to solidification cracking.

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Study of as-cast Nb-Ru samples

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Keywords: Phase equilibria, Niobium alloys, Scanning electron microscopy and X-ray diffraction

The Nb-Ru system is of interest because the NbRu phase has potential for phase high temperature shape memory alloys. Previous workers have identified the phase transformation variously as involving twinning, of cubic-to-tetragonal and tetragonal–to-orthorhombic (or monoclinic) transformations. Since the shape memory effect is associated with an equilibrium phase transition, it should be achievable, regardless of the fabrication method. As well as the terminal (Nb) and (Ru) solid solutions, two intermetallic phases have been identified: NbRu and $NbRu_3$, but the boundaries between the different phases are still not fully established. This investigation looked at six as-cast alloys of different compositions across the Nb-Ru system, which were made from 99.95 % purity Nb and Ru. The samples were made by arc-melting under an argon atmosphere, using titanium as an oxygen-getter. These samples were sectioned and prepared metallographically for optical microscopy, SEM and XRD analyses. The phases found were (Nb), (Ru), NbRu and $NbRu_3$, as expected. Although the samples were mainly homogeneous, there was porosity in the (Ru) phase between the $NbRu_3$ dendrites in the $Nb_{28.5}$:$Ru_{71.5}$ at.% sample. The $Nb_{14.2}$:$Ru_{85.8}$ at.% sample was single-phase (Ru).

Surface hardening of AISI 8620 steel with cassava (Manihot spp.) waste

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Keywords: cassava leaves, bio-processed waste, value addition, microstructure, case hardness

This paper presents the results of an experimental study of the effects of biocyaniding with dried cassava leaves obtained from Manihot spp. with $BaCO_3$ energizer. These are processed and used for the surface hardening of AISI 8620 steel. The case microstructures associated with carbo-nitriding are elucidated along with the effects of bio-cyaniding on the microstructure, microhardness and wear properties of the carbo-nitrided surfaces. The bio-processed waste (B-PW) was diffused (by heat treatment) into the surfaces of AISI 8620 steel using four different powder sizes (212, 300, 600 and 850 µm) and four different temperatures (750, 800, 850 and 900^{o}C). The resulting microstructures and micro-hardness profiles were then characterized along with the pin-on-disk wear behavior of the "case microstructures" that were formed. Superficial hardness and wear resistance were observed to increase with increasing particle size of B-PW and increasing pack cyaniding temperature (PCT). Finally, the wear mechanisms were also investigated by using scanning electron observations of the worn surfaces of the disks. The implications of the results are discussed for value addition to cassava waste.

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Sustainability management of the global production of platinum group metals (PGM) with regard to hydrogen economy

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Keywords: Hydrogen Economy, Sustainability Management, PGM, PGM mining

The hydrogen economy could be fast attained if only needing to rely on the broad available hydrogen feedstock which does comprise hydrocarbons or fossil-fuel reserves, nuclear fission products, natural gases and carbon-free renewable resources such as water. The hydrogen economy has however rated its objective very high in terms of its ecology leg among the three components defining sustainability. Technologically, hydrogen-economy idealists are striving to find out viable materials to sensibly cut the cost affordability to the PGM fuel cell technology and turn it to an unquenchable profitable creative technology in which the hydrogen economy will also meet social and environmental needs. In the current stage of building the hydrogen economy, the following three key major factors are to be addressed, the sustainability of the global PGM mining industry, the efficiency of production of hydrogen from renewable resources, the cost cutting of the production of platinum catalysts membranes. With regard to the long term supply and sustainability, concerns such as the mining cycle of PGM or the oxymoronic sustainable mining of the global PGM reserves have been debated. The mining cycle; which is the modern mining industry, processes from exploration and deposits discovery to evaluation through development to operation and ending with rehabilitation. Mining cycle is this recurrently evolving cycle of the deposits discovered and developed against the known resource prospected remaining which is a key issue surrounding resource availability and/or depletion; up to now, PGM mining is seen as key starter with regards to the global hydrogen economy.

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Sustainable production of quality bronze alloy bearings in under-resourced small scale casting facilities

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Keywords: Composition, microstructure quality, hardness, wear.

Bronze sleeve bearings are important friction materials used in a variety of applications. Leaded tin bronze is one such grade of bronze bearings commonly used. Small foundries in Zambia produce bronze billets by gravity sand casting without much composition or process control. The mostly solid billets are then machined into final products. The aim of this work was to investigate conditions under which such under-resourced foundries can produce near net quality bearings. In addition ways of attaining affordable improvements in process quality control and product properties such as microstructure, hardness and wear were examined. Visits were made to three major foundries in Zambia during course of research (2013 to 2015) from where samples were collected. Two permanent moulds were designed and used to cast test bearing materials. A simulation software was used to test feeding conditions in one mould. Near net sleeve bearings requiring only minimal machining can be produced in a small foundry. Special attention must be paid to metal feeding, cooling conditions and the resulting microstructure.

Synergistic Toughening of Natural Fiber-reinforced Earth-based Composites

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Keywords: Toughening; Pullout, Debonding, Crack bridging, Resistance-Curve

This study presents a combine experimental and analytical investigation of the toughening behavior in natural fiber-reinforced earth-based composites. A specially designed single fiber pullout apparatus was used to provide a quantitative determination of interfacial properties that are relevant to toughening brittle materials through fiber reinforcement. The parameters investigated included a specially designed high strength earth-based matrix comprising of 60% laterite, 20% clay and 20% cement. The toughening behavior of whisker-reinforced earth-based matrix is analyzed in terms of a whisker bridging zone immediately behind the crack tip and interface strength. This approach is consistent with microscopy observations which reveal that intact bridging whiskers exist behind the crack tip as a result of debonding of the whisker-matrix interface. Debonding with constant frictional stress was obtained and this formed the basis for the analytical model considered and the underlying crack-microstructure interactions associated with Resistance-curve behavior was studied using in situ/ex situ optical microscopy to account for the bridging contribution to fracture toughness. The effect of multiple toughening mechanisms (debonding and crack bridging) was elucidated and the implications of the results are considered for potential applications in the design of robust earth-based building materials for sustainable eco-friendly homes.

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Synthesis and characterization of magnetite (Fe_3O_4)/natural rubber (NR) nanocomposite for electromagnetic interference (EMI) shielding applications

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Key words: Magnetite, Natural rubber, Nanocomposites, co—precipitation, EMI shielding

Magnetic nanoparticles possess wide range of application in various areas, such as electromagnetic shielding, magnetic filters, information storage and biomedicines. Herein, we synthesized nano-sized magnetite (Fe_3O_4) particles using a modified co-precipitation method. The synthesized magnetite nanoparticles was used to synthesize natural rubber (NR)/Fe_3O_4 nanocomposites by solution process. The nanoparticles and composite morphology, structural and magnetic properties were investigated using Transmission Electron Microscopy (TEM) Scanning Electron Microscopy(SEM) and X-Ray Diffraction (XRD) techniques. The size of Fe_3O_4 synthesized was observed to be in the range of 10 – 20 nm as revealed in TEM images. XRD pattern of synthesized powder corresponded to that of pure Fe_3O_4 and was highly crystalline in nature. This was supported by higher resolution TEM images and their corresponding selected area electron diffraction (SAED) patterns. The natural rubber (NR)/Fe_3O_4 nanocomposites was observed to exhibit high saturation magnetization. Furthermore, the thermal properties and electromagnetic shielding efficiency were investigated. The interaction between Fe_3O_4 and the NR matrix was elucidated using both spectroscopic and microscopic techniques. The thermal stability and EMI shielding effectiveness (SE) properties were good. The results from this study suggest that NR/Fe_3O_4 nanocomposites may be a promising material for EMI shielding applications and antistatic discharge matrix for miniature devices' encapsulation.

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Synthesis and Microstructural characterization of kaolin reinforced polymer composites

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Kaolin reinforced polyethylene composites have been found to posses mechanical properties that makes them suitable for a wide range of applications such as floor and roofing tiles, pavement bricks, and recreational benches among others. It was therefore imperative that a study on the microstructure was conducted to know how it affects the performance of the composite. Polyethylene-Kaolin composites were prepared by the Melt Compounding Method into eight batch formulations, varying both the polyethylene and the kaolin content. Sachet water rubbers were used as the polyethylene part, mixing its melt with kibi kaolin to form the composite. Tests such as optical microscopy, Scanning Electron Microscopy and X-ray Diffractometry were used to analyse various composite samples to assess their microstructure. After the optical microscopy the Polyethylene-Kaolin composite with 120:80 content revealed enough of the kaolin mixing with the polyethylene matrix and therefore forming a gelatinous phase that explains its superior mechanical properties. The Scanning Electron Microscopy revealed pores consistently in almost all of the composites which may arise because of the forming process. The SEM micrographs of the composites with higher kaolin content revealed agglomerates of kaolin in the microstructure which may be due to the inadequate mixing of the kaolin with the polyethylene matrix. The X-ray Diffractometry also revealed intercalation of the kaolin samples with polyethylene matrix due to the shift in the peaks of the kaolin phase from the pure kaolin XRD peaks. The XRD also revealed that the microstructure of both the polyethylene and kaolin are preserved even after the composite formation. The results are discussed to influence the synthesis of polymer composites and it implications of their microstructures

The effect of acidic environment on the corrosion behavior of 316 austenitic stainless steel

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Austenitic steels are non-magnetic, face centred cubic (fcc) structure with at least 16 wt% chromium, 6wt% nickel, and are commonly used in incessant and irregular high temperature services. They found application in the harsh environments of the chemical, oil production and power generation industries, and in utility goods such as furniture, automotive trims and cutlery, as well as food processing equipment and medical equipment where aesthetic appearance and corrosion resistance are important. Type 316 contains up to 3 wt% Mo, has an improved general and pitting corrosion resistance, and is widely used in marine applications and coastal environments and is often called marine grade stainless steel. The 316 stainless steel were studied to determine the effect of increased concentration of acidic solution on the corrosion behaviour. The microstructures were studied using optical microscope and scanning electron microscope, while the phase was determined by XRD. The corrosion behaviour of the 316 stainless steel was studied by immersion and potentiodynamic methods using weight loss and Autolab potentiostat equipped with NOVA software respectively. It was concluded that increasing concentration causes increase in the corrosion rate and current density of the sample.

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The effect of heat treatment on the mechanical properties of Al-6082 alloy

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Keywords: Solution Heat Treatment, Quenching, Ageing, Hardness, Tensile Strength

Aluminium alloys have been increasingly used for especially aerospace and automotive transport, because of the excellent strength-to-weight ratio and good corrosion resistance [1]. Aluminium-6082 is one of the noblest Al alloys consisting of Mg, Mn and Si. Al-6082 is formable, weldable and machinable; in addition to high ample strength [2]. However, improving tribo-corrosive properties of these alloys is necessary. Grain refinement has been identified as one of the means by which the mechanical properties of Al alloys are further enhanced [2]. Microstructural orientation, which affects the mechanical behaviour, is highly influenced by heat treatment. Therefore, in this study, the effect of heat treatment conditions on hardness and tensile strength of Al-6082 was investigated to establish a baseline upon which further possible material improvement can be examined. 20 samples of Al-6082 alloy, for hardness tests and tensile tests, were solution heat-treated in a furnace at 520°C [3] for two hours, then withdrawn and quenched in room temperature water within 30 seconds. Afterwards, the samples were artificially aged in an oven held at a temperature of 175°C. Four samples were withdrawn in logarithm successions to generate the power curves typical of artificial aging of aluminium. The first set was withdrawn after 2 hours, with successive withdrawal periods doubling the previous at 4, 8, 16 and 32 hours. Tensile test results reveal that the average values of yield strength and ultimate tensile strength agree with literature for specific tempers from O through T5, T6 and T7. However, Vickers Hardness values, subject to 3 kg load, did not yield the expected profiles. To establish a reliable base line, a new experiment was done. This time, solution heat treatment duration was increased to 6 hours before quenching while artificial aging time intervals start from 2.5 hours; next to 5, then 10, 20 and 40 hours. Some significant difference in hardness result, compared to the previous, was then found; these corresponding to expected results and yielding the reliable base line being sought for future experiments.

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The role of size effects on the bulk, surface and transport properties of Copper-Tin liquid alloys

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Keywords: Bulk properties; Transport properties; Cu-Sn; liquid alloy; size difference; surface properties

A statistical mechanics model based on Complex formation and a Flory's approximate model have been used to theoretically investigate the effects of size difference on the bulk and transport properties of Copper-Tin liquid alloys by computing free energy of mixing, concentration fluctuations in the long wavelength limit, Warren-Cowley short range order parameter and the ratio of diffusion coefficients of the alloys at 1200K.The surface properties were studied using two different statistical mechanical approaches which are both based on the concept of a layered structure near interface. The results of the bulk and transport properties studies indicate that size difference increase the degree of the chemical association between the Cu atoms and the Sn atoms within a significant range of Cu composition in the Cu-Sn alloys while the results of surface properties study suggest that size difference increase the degree of segregation of Sn at the surface of the liquid alloys within a significant range of Sn composition. The studies of bulk and transport properties of Cu-Sn liquid alloys also reveal that Flory's approximate model has noticeable limitation.

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The role of vacancies in carbide formation in bulk platinum and on carbon solubility inplatinum nanoparticles

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Keywords: Vacancies; Platinum carbides, Precipitation, Nanoparticles, Carbon Solubility

Under well-controlled conditions, quenching experiments can yield information on vacancy clustering, vacancy/impurity interactions, and impurity solubilities. Additionally, subsequent heat treatments can yield not only the above, but also the course of precipitation reactions, transition mechanism details and phase stability ranges. In-situ high voltage electron microscope (HVEM) irradiation at different energies and temperatures can provide not only radiation-induced microstructural changes and phase transition details, but also vacancy/interstitial atom binding energy information. In fcc platinum, based on simple a hard-sphere model, carbon atoms are 37% oversized to fit into 0, 0, 1/2, type octahedral interstitial sites. Vacancies are thus a prerequisite to accommodate carbon atoms into the platinum lattice. TEM results from quench and quench-aging procedures on bulk platinum will be described concerning the co-precipitation of closely bound carbon/atom vacancy pairs to form a single layer carbon thick, GP zone type precipitate and then the subsequent role of vacancies in its transition to the tetragonal Pt_2C structure. In addition, from TEM and HVEM studies, details of the structure and temperature range of other vacancy formation assisted metastable phases such as Pt_3C_{1-x} and Pt_7C will be reported. As particle size decreases, the ratio of surface to volume atoms increases and this is particularly dramatic in the nanoparticle size range. This change can greatly alter the diffusion dynamics of the platinum atoms and the number of vacancies generated. Calculations will be presented to show the greatly enhanced carbon solubility possible in platinum nanoparticles, and ways to achieve this solubility in isolated nanoparticles will be discussed.

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Thermodynamic properties of Zn-Cd liquid alloys at 800K and 900K

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Keywords: Zinc-Cadmium Alloy, Thermodynamic properties, Self association model, Segregation.

This work presents a study of the thermodynamic properties of Zinc-Cadmium (Zn-Cd) liquid alloy at 800K and 900K using a simple thermodynamic model, the Self-Associate model. This model is based on the formation of self-associates. Our results show good agreement between the experimental data and the calculated data at the two temperatures which is evidence that the Self-Associate Model is appropriate for Zn-Cd alloys. The results obtained from the computed concentration-concentration fluctuations in the long wavelength limit, the ratio of the mutual and self-coefficients, $\frac{D_M}{D_S}$ and Warren-Cowley short range order parameter indicate that Zn-Cd liquid alloy is a segregating alloy and that the degree of segregation in Zn-Cd liquid alloys increases with temperature.

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Thermophysical property characterization of yttria stabilized zirconia (YSZ) thermal barrier coating structure

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Keywords: Thermal Barrier Coatings, Yttria, Zirconia, Corrosion, Thermal conductivity

To achieve higher thermal efficiency, the objective of gas turbine development is to produce engines that can withstand increased gas turbine inlet temperatures, beyond 1600 ^{o}C which will result in gas turbine metal surface temperature of 1200 ^{o}C. Thermal barrier coatings (TBCs) can reduce the effective temperature, to which these engine components (the substrates) are exposed, by several hundred degrees Celsius. Yttria-partially stabilized zirconia (YSZ) is the current state-of-the-art TBC material that is applied to gas turbine blades and vanes to provide thermal protection and corrosion resistance at high temperatures. A typical thermal barrier coating consists of two layers over the substrate: a ceramic top coat is used to provide thermal protection; and a metal alloy bond coat to provide a thermal expansion gradation layer between the ceramic and metal alloy substrate, improve adhesion of the top coat, and protect the substrate from oxidation. This paper focuses on the thermophysical property characterization of these thin ceramic films within a temperature range of 500 ^{o}C and 1100 ^{o}C. These properties dictate the thermal protection capacities of the TBCs. A high fidelity density measuring equipment was used to accurately measure the density of the samples. The measured density values were then supplied as inputs to Laser Flashline equipment so the thermal diffusivity and specific heat capacity of the samples could be measured. Using a molybdenum reference, the thermal conductivity of the sample were also measured. All samples tested were discs in shape measuring 12.7mm in diameter and about 0.25mm (250µm) in thickness.

Total productive maintenance in metal industry

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Key words: Total, Productive, Maintenance, Metal and Industry

Total Productive Maintenance (TPM) is a concept that is responsible for establishing a corporate culture that will maximize production system effectiveness, organize a “Genba-Genbutsu” system to prevent losses and achieve optimal results such as“reduction –to- Zero” targets as “Zero – defects” and “Zero breakdowns” in the entire production system life cycle. Total Productive Maintenance process involves improving skill of workers, increase reliability, idle time reduction, high asset productivity, material loss reduction and accidents reduction. Total productive maintenance involves every member of staff of Engineering Works, top management, middle management and the front- line operators. The main focus of the paper is to present the best maintenance option for sustaining the Engineering works of the Ajaokuta Steel Company Limited with a view of adopting the best global practice to achieving the eight pillars of Total Productive Maintenance (TPM). The principles that hinged on changing maintenance practice were discussed, thereby bringing out some maintenance operations to bear. Suggestions and recommendations were given so as to propel Engineering Works to improve on the maintenance techniques and sustain the concept of Total Productive Maintenance.

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