PLENARY LECTURES

Innovation prospectives from nanotechnology materials

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Nanotechnology is an avenue which may pave the way for key enabling technologies. The nanotechnology term includes a broad range of application areas. Common for these is that there is a high degree of innovation. Research findings evolve to innovation potentials. The next challenge is on how to implement the nanotechnology materials into a sustainable business. The prospectives in that shift from research and innovation to business and market are multifold. Technology benefits themselves will not push the shift, and the technologies still have to fit in a value chain no matter what is the innovation character. One route to create impact and usefulness in a systematic way is to support innovation capacity. The meaning of this is to make usefulness in a systematic way and broader context so that a higher degree of innovations will make it to a market. Today, the regional and national strategies for economic growth are also important to consider in research and technology development. In this presentation we share experiences in the usefulness of sharing practices between researchers, learnings from national innovation programmes, as well as research and innovation for smart specialization for regional growth which are introduced by European Commission and may create synergies which align research and regional focus avenues to create better conditions for implementing nanotechnology innovations.

The role of electron microscopy in nanotechnology research

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Electron microscopy plays a very important role in nanotechnology research. Both Transmission and Scanning Electron Microscopes (TEM and SEM) are very sophisticated research tools that enable both qualitative and quantitative analysis of nanomaterials. Prior to the analysis of samples using these microscopes, the samples must go through various sample preparation techniques using specialized sample preparation equipment before they can be inserted into these microscopes. The SEM and TEM are coupled with various detectors, which allow for imaging, particle size distribution analysis and elemental composition analysis however, only TEM allows for the determination of crystallinity within samples and the imaging of crystal lattice fringes on

nanoparticles. These microscopes can be purchased as low or high voltage instruments. The lower voltage SEM's and TEM's are mainly used for biological applications, in which the natural state of the sample or material must be preserved while the higher voltage SEM's and TEM's are used for chemistry and physics applications. In this presentation, nanomaterial investigations using SEM and TEM would be discussed.

Research collaboration and funding: available options for Nigerian scientists

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Research is the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions. Research funding on the other hand is a term generally covering any funding for research activities irrespective of the field of study. There are four main types of funding and these include: scholarships and fellowships which are usually given to individuals; seed funding which is usually intended to get the researcher started on a project; project funding which is the main funding which the majority also referred to as research funding; and prizes and awards which usually entails giving plaques, certificates, and money. Local and international research fundings are available to Nigeria researchers, although, there are more international funding opportunities and very limited local funding opportunities. Due to Nigeria's lack of participation, some international funding bodies have started removing Nigeria's name from the list of eligible nations. One of the major ways a Nigerian scientist can successfully carry out good quality research despite the paucity of local funds is by having research collaborations, locally and internationally. Such collaborations will not only provide an opportunity for reduced financial burden but also enhance an improved research atmosphere through the sharing of ideas and resources to achieve a conclusion which is not only locally acceptable but of international dimension or application. The presentation will share information on some of the available funding for Nigerian researchers and discuss ways of establishing quality collaborations both locally and internationally.

Evaluation of dense metallic membrane by electroless route

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The dense metallic membranes are utilized in the petroleum industry in order to separate hydrogen (H_2) evolved from Steam Reforming Process (SRP). Hydrogen is considered as the future fuel and efforts are being made to explore both renewable and non-renewable ways to meet the needs of the hydrogen economy. Dense metallic membranes hydrogen transport that

separates hydrogen from carbon dioxide and other components of water-gas shift (WGS) mixtures derived from coal gasification and steam reforming process. The primary application considered is a hydrogen separation system for the production of hydrogen from synthesis gas produced from a coal-fired fundamental of dense composite inorganic membranes used for the transport of hydrogen. Another benefit of the hydrogen membranes is the ability to retain carbon dioxide (CO_2) at high pressure from the balance of the membrane feed. Here, we would like to present the evaluation of metallic membrane before SRP and after several hundreds of hours of service by using various characterization techniques such as FESEM/EDX/Mapping, FIB, XRD, AFM, and DSC/TGA to study the morphologies, structural characteristics of metallic membranes before and after the operation.

New frontier of fluorescently labeled nanomaterials in security and forensic: perspectives from fingerprinting to anti-counterfeiting

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Fluorescent nanomaterials (NMs) such as quantum dots (QDs) and rare earth upconversion fluorescent NMs (UCNMs) have emerged as new agents for developing latent fingerprints, due to their unique optical and chemical properties. They exhibit many advantages such as small size, high fluorescent intensity, good chemical and photo stability, facile surface modification, and low toxicity. These nanomaterials have a wide range of applications such as photovoltaic, bio-medical, anti-counterfeiting, solid state lighting, display technologies, etc. Their extremely important uses cover the development of security inks for anti-counterfeiting applications as well as fingerprinting in criminalities detections. Counterfeiting of valuable documents, currency and branded products is a challenging problem that has serious economic, security and health ramifications for governments, businesses and consumers all over the world. It is estimated that counterfeiting represents a multi-billion dollar underground economy with counterfeit products being produced on a large scale every year. Counterfeiting is an increasingly high-tech crime and calls for high-tech solutions to prevent and deter the acts of counterfeiting. At present, traditional developing methods such as powder dusting, cyanoacrylate fuming, chemical method, and small particle reagent method, have all been gradually compromised given their emerging drawbacks such as low contrast, sensitivity, and selectivity, as well as high toxicity.

Recently, much attention has been paid to the use of fluorescent nanomaterials including quantum dots (QDs) and rare earth upconversion fluorescent nanomaterials (UCNMs) due to their unique optical and chemical properties. I am charged to briefly outline and address the key challenges in this area, including the above mentioned concerns for anti-counterfeiting applications. I hope to also describe a unique combination of all possible kinds of security ink formulations based on lanthanide doped luminescent nanomaterials, quantum dots

(semiconductor and carbon based), metal organic frameworks as well as plasmonic nanomaterials for their possible use in anti-counterfeiting applications. This presentation also lay emphasis on latent fingerprint development based on QDs and UCNMs. Compared to latent fingerprint development by traditional methods, the new methods using fluorescent nanomaterials can achieve high contrast, sensitivity, and selectivity while showing reduced toxicity. My research contributions in the field of nano-enabled forensic will not be left out of discussion.

Changing the bogus narrative to simple green nanomaterials: a case of carbon nanodots

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Carbon dots (CDs) is one of the fascinating materials in nanotechnology. There are a lot of carbon based nanomaterials including carbon nanotubes (CNTs), fullerenes, graphene, and nanodiamonds which have been used in several applications but their usage is limited by some difficulties ranging from solubility, fluorescence abilities and so on. Carbon dots are carbon nanomaterials of <10 nm size discovered in 2004 as a by-product of purification of single-walled carbon nanotubes with high surface passivation for easy functionalization. They are lower size carbon materials with improved properties and defy the disadvantages inherent in other carbon nanomaterials. They are zero-dimensional with excellent novel and fluorescence characteristics. The precursors of carbon dots may include and not limited to carbohydrates, carbon nanotubes, carbon soot, graphite, citric acid, glycerol, L-ascorbic acid, glucose, citric acid-urea and thiourea. The focus on carbon nanodots or carbon dots or carbon quantum dots or graphene quantum dots is because all organic materials contain carbon, therefore the source material is readily available. However, it is more economical to obtain carbon dots from high carbon containing organic material. This work will bring to our doorsteps the newest technology of the century with the aim that researchers should verify this material and further unveil their applications for overall development.

Nanotechnology for sustainable water treatment

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Water is an essential resource needed on a daily basis for human consumption and usage. This resource is abundant on the Earth, covering over 70 per cent of its surface. Presently, the demand for clean and pure water already exceeds the supply. Due to this growing demand in supply of

quality water, the health, industrial and economic sectors have been grossly affected. According to United Nation Education Science and Cultural Organization (UNESCO) report that contains data on water consumption versus availability: it was predicted that two to seven billion people will be faced with water scarcity by the middle of this century. In addition, approximately 800 million people lack quality water and above two billion people lack essential facilities for water usage and production specifically in Africa and Asia continent respectively. United Nations (UN) has adopted an eight numbered declaration called Millennium Development Goals (MDG) which was expected to be achieved by 2015 to support some continents; the overall objective is centered on the needy countries by reducing to half the population of those that lack clean water and sanitation (MDG7). But inefficient development techniques have affected the water quality and its availability, which has compromised their capability to generate social and economic benefits. By 2050, it is projected that water demand globally will hike by approximately 60%, as a result of high demands. Industrial pollution is among the factors that cause destabilization to clean water, others are domestic and agriculture, and all these has contributed to reduction of economic productivity.

The limited quantity of available clean and pure water on earth necessitates the need to reuse and recycle water for the purpose of meeting up the demand for clean water with respect to human and industrial consumption. Pollution of water sources via industrial activities such as electroplating, smelting, pharmaceutical, tannery, textile, mining and others is considered as a global phenomenon threaten human survival and needs to be addressed using research and development. In view of the negative environmental impacts of exposure to industrial wastewater, there is a need to develop highly efficient and sustainable treatment techniques to remove hazardous constituent in the wastewater before discharge into the environment. The main challenge now is to develop nanoadsorbents that will simultaneously remove contaminants present in wastewater. Nanomaterials have been identified as a perfect adsorbent for this purpose. The conventional methods of water treatment which are physical, biological and chemicals, all have considerable limitations. Nanotechnology offers innovative aid to the attainment of UN-SDG on clean and portable water target. In this regards, activities of the Nanotechnology group of Federal University of Technology, Minna, includes development of nanoadsorbents, nanofilters for domestic, agriculture/aquaculture and industrial wastewater treatment and these would be shared with the participants.

Artificial intelligence in bioprocess development: applications and prospects

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Microorganisms have the capability to generate an array of biopharmaceuticals, biofuels and biochemicals with the potential to address key global challenges. However, the complex multivariate space of these systems challenges the development of viable bioprocesses.

Advances in Artificial Intelligence and Machine Learning provide opportunities for rapid development of economically viable bioproduction systems. This lecture articulates some strategies for harnessing the power of Artificial Intelligence to develop bioprocesses for biofuels such as biohydrogen, biomethane, bioethanol and others novel bioproducts. An overview of a deployed Machine Learning model for bioethanol production in the presence of various nanoparticle biocatalysts is presented. A comparison of machine learning capabilities with existing algorithms for effective bioprocess development is examined. Knowledge extraction from existing data using Machine Learning models for microbial processing is reported. The prospect of mitigating key global challenges through Artificial Intelligence in bioprocess technology is highlighted.

NanoMedicine and NanoToxicology: Two contradictory perspectives

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Nanomaterials are being used in a wide variety of biomedical applications. Responsible development includes understanding potential environmental, health, and safety (EHS) implications of nanomaterials as well as the ethical, legal, and societal implications (ELSI) of nanotechnology. There should be a unique balance between the applications and safety aspect of nanomaterials. Unique physio-chemical properties of nanoparticles make the investigation of their toxic consequences intricate and challenging. This makes it important to have an in-depth knowledge of different mechanisms involved in nanomaterials' action and toxicity. Nanotoxicity is majorly contributed to the small size and large surface area of nanomaterials, which allow easy dispersion and invasion of anatomical barriers in human body. Nano-toxicity has various effects on human health and diseases as they can easily enter into the humans *via* different routes, mainly respiratory, dermal, and gastrointestinal routes. This also limits the use of nanomaterials as therapeutic and diagnostic tools. This talk will be focussed on our commitment to the responsible development of nanotechnology as one of its four main goals and as an important part of its environmental, health, and safety (EHS) research strategy. This includes sound, scientific assessment of nanotechnology's benefits and risks, and an understanding of the potential EHS impacts of nanotechnology.