NANO2019/P001
Industrial application of nanotechnology in corrosion protection of steel structures in corrosive coastal environments

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The industrial application of nanotechnology in corrosion protection of steel structures in corrosive coastal environments has been reviewed. Annual rate of oil spills due to corrosive pipelines continue to increase in the Niger Delta due to inadequate protection of oil pipelines. From 1997 to 1999, there were 815 oil spills, out of which 170 (20.85 %) were caused by corrosive pipelines costing the companies ₦ 4,228.4 Billion (repair cost, ₦ 115.6 Million; clean-up cost, ₦ 2,269.8 Million; and community compensation, ₦ 1,843.0 Million). Nanocomposite additives for anti-corrosion coatings are used (such as gloss: NANO10029; satin: NANO10033; stainless steel: NANO20001 per gallon) and the surfaces of steel structures designed for very oxidizing and corrosive coastal environments are greatly enhanced. The electrolytic method of cathodic protection is used in making the buried pipeline to be protected at the cathode (negative terminal), thus protecting it from the corrosive coastal environments by immunity using direct impressed current from photovoltaic modules. The adequacy of protection is tested using the $Cu/CuSO_4$ reference electrode and a digital multimeter to record pipe-soil potential along the pipeline.
Keywords: Anti-corrosion coating, corrosion protection, nanotechnology, steel structures

NANO2019/B002
The effects of production variables on physicochemical properties and *in-vitro* cytotoxic activities of 5-Fluorouracil nanoparticles against Squamous cell carcinoma (SCC)

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A 2^3 factorial experimental design was used to study the effects of polymer type (A), the nature of the organic phase (B) and the homogenization speed (C) on the particle sizes (S), the amount of drug entrapped (E) and the *in-vitro* release properties of the formulations (R). 5-Fluorouracil nanoparticles were prepared using emulsion evaporation technique. The particle sizes were estimated using a dynamic light scattering technique, and the drug release profiles were done using the BP dissolution apparatus. The amount of drug entrapped was spectrophotometrically determined. The effects of A, B, C, AC, BC, and ABC on S, E and R were expressed as coefficients of the polynomial equations generated. The effects of A, B and C on E were positively correlated, but that of A and B on R and S were inversely proportional. The ranking for combined effects on the R was, AC ≤ BC≤ ABC, while that of E and S were, BC≤ ABC ≤AC

and ABC≤ BC ≤AC respectively. TD3, 6, 7 and 8 had smaller particle sizes, increase cumulative drug released and significantly improved cytotoxic activities when compared to TD1, 2, 4 and 5 formulations. The two natural biodegradable polymers (Neem and Acacia) investigated were successfully used to synthesize 5 FU polymeric nanoparticles. The production variables had significant effects on the physicochemical properties of the nanoparticles and the cytotoxic actives of the nanoparticles.

Keywords: 5-Fluorouracil, factorial design, emulsion solvent, evaporation technique, biodegradable polymers

NANO2019/P003
Preparation of two-dimensional semiconductor nanomaterial molybdenum disulfide (MoS_2) for next generation electronics

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This work is based on the preparation of extraordinary, ultrathin two-dimensional (2D) molybdenum disulfide (MoS_2). Molybdenum disulfide is one of the most typical 2D transition metal Dichalogenides (TMDs) like graphene. Two-dimensional materials have attracted tremendous attention from researchers from different fields of condensed matter physics, material sciences and nanotechnology for the past decade after the exfoliation of graphene from graphite in 2004. In this work, the exfoliation and dispersion of bulk MoS_2 into thin layer MoS_2 in water, Isopropanol and DMF, via liquid phase exfoliation is reported. The optimal synthetic conditions for formation of monolayer and few layers are considered, including, sonication time, solvent type and solution concentration. Morphological and crystallinity of monolayer and few layers MoS_2 nano-sheets were characterized by SEM, AFM, X-ray diffraction spectroscopy and Raman spectroscopy. The lateral size of the exfoliated MoS_2 nano-sheets is in the 1-7 μm range and the thickness is approximately 0.8-5 nm. This method is simple and scalable, and the fabricate MoS_2 can find applications in the development of next generation electronics.

Keywords: Molybdenum disulfide, transition-metal dichalcogenides, graphene, liquid phase exfoliation

NANO2019/B004
Neem root mediated-biosynthesis of silver nanoparticles: antimicrobial activities and application as detergent additive

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This study reports the biosynthesis of silver nanoparticles (AgNPs) using the aqueous extract of neem root. The synthesis was carried out under ambient conditions by reacting 1 mM silver nitrate with the aqueous extract of neem root (10:1). Characterization was done by UV-vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). The antibacterial and algicidal activities of the biosynthesized AgNPs were investigated against some clinical bacterial isolates and a bloom-forming cyanobacterial strain, respectively. Their potential application as an antimicrobial detergent additive was also evaluated. The biosynthesized AgNPs displayed maximum absorbance at wavelength of 425 nm. The particles were predominantly spherical in shape with size ranging from 10 to 40 nm. Data obtained from FTIR indicated that protein molecules in the extract played very active role in the reduction of silver ions to form AgNPs. The particles demonstrated considerable antibacterial activities against clinical isolates of *E. coli*, *Streptococcus* sp, and *K. pneumoniae* as they induced inhibition zone of 12-23 mm. The algicidal activity displayed by the particles against the bloom-forming cyanobacterial strain was appreciable. Similarly, the incorporation of AgNPs as additive in the locally made detergent led to total inhibition of growth of *E. coli*, *K. pneumoniae*, *Candida* sp, and *A. flavus*. Results obtained in this study therefore suggest the promising applications of the particles as an antimicrobial agent in water treatment and drug development. The particles also exhibited potential application as an antimicrobial additive in detergent production.
Keywords: silver nanoparticles, biosynthesis, antimicrobial activities, algicidal activities, detergent additive

NANO2019/B005
Application of nanotechnology in plant nutrients fortification for crop improvement

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Nanotechnology can be a feasible solution to food nutrient deficiencies which are of major challenges to human health, particularly the rural poor. Food nutrients are fortified using many approaches including industrial fortification, broadening dietary and drugs usage. These methods

are very expensive and unsustainable to accomplish. Plants adsorb and absorb nutrients from organic and inorganic fertilizers with low nutrients absorption capability. Nanofertilizers however, enhance nutrients availability to the target regions, reduce loss and pollution free. This report focused on the interaction of nanoparticulates and micronutrients applied to the soil, environmental impact, nutrients uptake and use capacity and food nutrient contents. Several current studies revealed that plants absorbed nano-nutrients easily and increased plants productivity. Meanwhile, many toxicity challenges arose on nanoparticles application in crops. Plant nutrients biofortification, therefore, could be a panacea to crop yield improvements as they evaded toxicity and prevent environmental pollution. This review provides insight into plant nano-nutrients biofortification and the imminent promises of this technology which include cost-effectiveness, resource use efficiency, improved human health, and farmers' income.
Keywords: Nanofertilizers, biofortification, nutrients absorption, plants' productivity, human health

NANO2019/P006
An insight into frustrated magnetism: a case of geometrical frustration in three-site triangular system

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A system is said to be frustrated if neighbouring spin cannot have orientations in a particular direction that will minimize the energy of the system. For the frustrated triangular system study in this paper, it is observed that if two of the neighbouring spins minimize their energy by aligning in opposite direction, the third spin becomes frustrated because it cannot simultaneously anti-align with its neighbouring spins. A further study of the ground state energy of this system gives a six-fold degenerate ground state energy of –J/4 and four-fold degenerate ground state energy of -3J/4 for the Ising and Heisenberg model respectively. These observed multiple degeneracies in the ground state are attributed to the geometrical frustration inherent in the system. It surprising that the quantum spin fluctuation in the Heisenberg model could not completely remove these multiple degeneracies. The results obtained from this investigation can be applied to magnetic nanoparticles, which are a class of nanoparticles that can be manipulated using magnetic fields. Magnetic nanoparticles can be directed with a magnetic field, which allows, for example, delivery of drugs to a tumour. Activities of magnetic nanoparticles can also be improved for sensitivity of medical imaging techniques that use magnetic signals.
Keywords: Ising model, Heisenberg model, quantum spin, geometrical frustration, ground state energy, magnetic nanoparticles

NANO2019/B007

Antimicrobial activities of silver nanoparticles biosynthesized from the leaf extract of *Calopogonium mucunoides* on selected oral bacterial pathogens

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In the pursuit of innovative solutions to the escalating threat of antimicrobial resistance, nanomaterials with antibacterial potentials are currently being researched. This study reports the antimicrobial activities of biosynthesized silver nanoparticles (AgNPs) against *Streptococcus pneumoniae* ATCC 33400, *Streptococcus pyogenes* JCM 5674 and *Klebsiella pneumoniae* BYK-9. The AgNPs were produced from the aqueous leaf extract of *C. mucunoides* and characterized by UV–visible spectrophotometry, X-ray diffraction (XRD), and transmission electron microscopy (TEM). The antibacterial study was carried with varying concentrations of the nanoparticles using agar-well diffusion technique. The ruby-red coloured AgNPs were found to be crystalline, 7.5 nm in size and spherical in shape with surface plasmon resonance occurring at wavelength of 435 nm. The nanoparticles inhibited *K. pneumoniae* BYK-9, *S. pneumoniae* ATCC 33400 and *S. pyogenes* JCM 5674 at 50-150 µg/ml. The highest zones of inhibition of 21.00 ± 1.41, 20.50 ± 0.71 and 22.00 ± 1.41 mm were obtained at 150 µg/ml against *S. pneumoniae* ATCC 33400, *S. pyogenes* JCM 5674 and *K. pneumoniae* BYK-9 respectively. The results obtained suggest that the biosynthesized *C. mucunoides* leaf extract-AgNPs have great potentials in the treatment of infections caused by *S. pneumoniae*, *S.pyogenes* and *K. pneumoniae*.

Keywords: Nanomaterials, nanosilver, biosynthesis, *C. mucunoides*, crystalline, oral pathogen

NANO2019/B008

Activation of amoxicillin by plant extracts cocktail-mediated nanosilver against some multidrug resistant bacterial pathogens

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In this study, nanotechnology was explored to re-examine the biological properties of already known antimicrobial agents with reduced activity against infectious bacterial pathogens. The agar well diffusion technique was used to investigate the activation of amoxicillin by cocktail mediated-nanosilver against multidrug resistant *Escherichia coli*, *Klebsiella pneumoniae*, *Micrococcus luteus* and *Clostridium difficile*. Cocktail mediated-AgNPs were synthesized by reacting 9 ml of 1 mM of silver nitrate with 0.5 ml each of *Citrus limon* juice and aqueous

Newbouldia laevis extracts under bright sunlight for 10 min. The biosynthesized AgNPs were characterized using UV-vis spectroscopy, high resolution transmission electron microscopy (HRTEM), electron diffraction spectroscopy (EDS) and surface area electron diffraction (SAED). The cocktail mediated-AgNPs colloidal solution was dark-brown in colour with maximum absorbance at 441 nm. The HRTEM micrograph showed the varied shaped AgNPs with an average size of ≈ 7.5 nm. Similarly, EDS highlight the dominance of the metallic silver in the biogenic AgNPs. At 150 µg/ml, cocktail mediated-AgNPs induced 24.5±3.54, 24.0±1.41, 21.5±0.71 and 18.0±5.66 mm inhibition zone against *E. coli, K. pneumoniae, M. luteus* and *C. difficile* respectively. The combined effect with amoxicillin produced 34.0±1.41, 40.5±0.71, 29.0±1.41 and 26.0±1.41 mm inhibition zones against the isolates respectively. The results obtained in this study, indicated that the biosynthesized AgNPs could be used to activate antibacterial potency of amoxicillin in resistant pathogenic bacterial isolates.

Keywords: *Newbouldia laevis, Citrus limon*, cocktail, silver nanoparticles, nanotechnology, amoxicillin, bacterial pathogens

NANO 2019/P009
Perception of senior secondary schools' students towards the integration of nanotechnology in computer science curriculum

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The roles of technology in today's world cannot be over-emphasized at all levels of human endeavours. The nanotechnology is a platform where scientific theories can be applied to solve specific problems. The students remain pillars for the present and future national growth and development. Therefore, emphasis on the students' capacity building towards the acquisition of nano-technological skills must be acknowledged. This research investigates the perception of students towards the integration of nanotechnology in the secondary school's computer science curriculum in Nigeria. This research will use a survey design to gather and analyze data. The population will comprise all senior secondary schools in Federal Capital Territory, Nigeria. A questionnaire will be developed, validated by the experts in educational technology, measurement and evaluation, and used as instrument for data collection. A reliability co-efficient will be determined to ascertain the suitability and reliability of the instrument. The research questions will be asked to guide the conduct of the research and analyzed using mean and standard deviations. There will be null hypotheses as follow-up to the research questions and will analyzed using t-test and ANOVA statistical tools at 0.05 level of significance. Findings will be logically presented and based on these findings, recommendations will be made.

Keywords: Nanotechnology, education, computer science, curriculum, students

NANO2019/P010
Application of nanotechnology: implementation of a contactless water level controller

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The principal knowledge of nanotechnology involves the manipulation of matter towards achieving desired results. A contactless water level controller system will be developed as a demonstration of nanotechnology application and the controller will work on the principle of signals transferred or received by the ultrasonic sensors. The ultrasonic sensor will be installed outside the water tank. The sensor will switch ON the motor pump when the water level is below 45cm and again switch OFF the motor pump when the water level is above 45cm. This implies that 30cm will a threshold level that determined when the motor pump ON or OFF, thereby controlling the flow of water in the water tank. The proposed contactless system will have a low maintenance and installation cost will be more efficient when compares to the others existing systems. The contactless technology makes the water in the tank safe for human consumption unlike many commonly found water level controller with the insertion of copper wires which contaminates water. Also, electrical power wastage will be successfully managed as the motor pump shut down when the water level reaches the desired level thereby reducing the cost of electricity bills for the user. Significantly, the proposed systems will be designed and implemented to allow the students of computer science acquire relevant skills towards nanotechnology.
Keywords: Nanotechnology, contactless controller system,

NANO2019/P011
Synthesis and characterization of CZTS thin films from compound target deposited by RF sputtering method

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A potential way to improve the quality of Copper-Zinc-Tin-Sulfide (Cu_2ZnSnS_4CZTS) absorber thin film by one step process of RF sputtering using a single compound target is proposed for thin film solar cells. CZTS thin films of 550 nm thickness were deposited on bare corning 7059 glass substrates at a substrate temperature of 100 ^oC and annealed under nitrogen atmosphere for 30 min at 250, 350 and 450 ^oC. Structural and optical characterizations were carried out using X-ray diffractometer, Raman spectrophotometer and UV-vis spectrophotometer. The X-ray diffraction analysis showed *hkl* planes of [002], [110], [112] and [212]. Raman results confirmed the existence of secondary phases of SnS, $Cu_{2-x}S$ and CTS. The optical absorption coefficient of the thin film was found to be greater than 10^4 cm^{-1} indicating a direct band gap nature of the

samples. The optical band energy was calculated and found to be in the range of 1.51 eV to 2.4 eV. The band gap energy obtained is more appropriate for photovoltaic applications, where the materials can be used absorber layer of solar cell.

Keywords: Film thickness, annealing temperature, RF sputtering, compound target, XRD, absorption coefficient

NANO2019P/012

Synthesis of the cubic phase of ZrO_2 nanotubes using anodization method

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The synthesis of vertical array of zirconia (ZrO_2) nanotubes was achieved by anodisation of zirconium (Zr) foils in a fluorine contained electrochemical bath. The anodic oxidation was conducted in a two-electrode glycerol bath containing varying amount of NH_4F at pH of 5 for 60 minutes. The formed ZrO_2 nanotubes (ZNTs) were characterized using several methods, such as UV-vis spectroscopy, Fourier- Transform Infrared Spectroscopy (FTIR), Transmission Electron Microscopy (TEM), Energy Dispersive X-Ray Signal (EDX) and X-ray Diffraction (XRD). It appears that optimized result was obtained when 30 V was used as the anodisation voltage. TEM images indicate that the majority of the products are vertical and self-aligned having diameter and thickness in the range of 32.9 to 38.8 nm and 3.0 to 7.3 nm, respectively. The diffraction pattern obtained from the XRD indicated that the ZNTs obtained are crystalline textured along [111] direction, which confirms their cubic phase. Also, the synthesized ZNTs had a length-to-width ratio of 235, which is comparable to 240 that was obtained in a similar work where anodisation was not used.. This study has shown that a specific phase of zirconia nanotubes can be synthesized which have potential for application in catalysis and other areas.

Keywords: Zirconia, cubic phase, nanotubes, anodization, catalysis

NANO2019/P013

Nanostructured DNA-templated polyimidazole nanowire-synthesis, chemical, morphological and electrical characterization

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In this work, we report the synthesis of nanostructured DNA-templated polyimidazole nanowires created using a simple and low-cost fabrication method that applied DNA as a template on which to carry out the polymerization. The chemical properties of the nanowires were probed using different spectroscopic techniques such as X-ray Photoelectron Spectroscopy (XPS), Ultra-Violet Visible (UV-vis) spectroscopy and Fourier Transform Infrared (FTIR) spectroscopy. Atomic

force (AFM) and electron microscopy (SEM and TEM) were used to characterize the dimensions of the nanowires. These techniques together demonstrated the formation of a supramolecular hybrid polymer containing DNA and imidazole polymers. Morphological results exhibit different morphologies with agglomerate nanostructures for the diluted film, while dense rope-like network of nanostructures were observed for undiluted templated polymers with diameter of 2-13 nm. Activation energy (Ea) including the uncertainty on it for the Plm/DNA bulk nanowires calculated was $10.6 \pm 0.5 \times 10^{-3}$ J mol^{-1} equivalents to 0.110 ± 0.005 eV which is not surprising because the process is thermally assisted tunneling between localized sites. The electrical conductivity of the nanowires indicates their potentials in sensing.

Keywords: Nanowire, imidazole polymer, template, DNA, characterization

NANO2019/P014
Properties of tin oxide and tin oxide-gold nanoparticles composite prepared by sol-gel technique

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Tin oxide particles were successfully prepared by using sol-gel technique. The sol-gel obtained was calcinated at 400 ^{o}C to obtain the tin oxide particles. The characteristics of the tin oxide nanoparticles and the functionalized tin oxide were examined. The FTIR result for the two samples confirms the formation of tin oxide with the O-Sn-O vibration localized at 596.00 cm^{-1} and 657.77 cm^{-1} for tin oxide (TO) and tin oxide-gold nanoparticles composite (GTO) respectively. The optical properties of the materials were studied and the transmittance observed to be high and the absorption was low within the visible region (400-800 nm) of the electromagnetic radiation. The composite was observed to have a higher absorption of visible light compared with the tin oxide nanoparticles alone. The energy band gaps of the tin oxide only and the tin oxide-gold composite were around 3.6 eV and 3.75eV, respectively. The average grain sizes of the TO and GTO obtained from the XRD pattern are 3.66 nm and 3.89 nm, respectively. The morphology of the samples is of homogenous and smooth nanoparticles as revealed by the scanning electron microscopy. The results show that the composite has a good transparency in the visible region and also of wide band gap which made it suitable for use as transparent front contact in the fabrication of photovoltaic devices and a good photocatalyst.

Keywords: Tin oxide, sol-gel, photovoltaic devices, nanoparticles, composite

NANO 2019/P015

2^k Optimization approach for the sorption of lead (II) ions from contaminated water of oil-well drilling point on to MWCNTs

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The release of Pb^{2+} into the surrounding ecosystem has adverse effects on man and animals, hence, removing such harmful heavy metal from water system calls for urgent attention. The adsorption of lead (II) ions present in a contaminated water body, onto carbon nanotubes has been studied and optimized in a batch reactor system. The potential application of multi-walled carbon nanotubes, MWCNTs, towards the sorption of lead (II) ions from oil polluted water body was studied and optimized via a 2^k factorial experimental approach, where speed (rpm), absorbent dosage (g), temperature (^oC) and time (min) were studied. The homogenized water sample was 'wet digested' and analyzed to ascertain initial concentration of 0.275 mg/l of lead ions present. Adsorbent mass of 0.2 g and speed of 600 rpm have the highest positive impact on the adsorption of Pb^{2+} while considering single effect as studied using atomic absorption spectrophotometer. After estimating the main effects, the interacting factors affecting the removal of Pb^{2+} were determined by performing the analysis of variance (ANOVA) with $R^2 \geq$ 68%. Thus, the highest percentage removal of lead ions by the MWCNTs from the oil-polluted water body was 99.5 %. Hence, this study has demonstrated that Fe-Co/kaolin MWCNTs has high affinity for lead ions sorption, and can be applied in the remediation of lead-polluted water.
Keywords: Optimization, lead adsorption, oil-polluted water, MWCNTs

NANO 2019B/016

Calcium nanoparticles improved mineral nutrient accessibility and reduced oxidative stress in *Moringa oleifera* via soil characteristics modification and heavy metal sequestration

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Proficiencies of zero-valent calcium nanoparticles (CaNPs) as nano-enhancers for soil texture, minerals and nutrient accumulation, sequestrating agents for heavy metals, oxidative stress modulators were investigated in *Moringa oleifera*. Soil in 40 buckets were amended and watered for three weeks with water (group A), 100 mg/l $Ca(NO_3)_2$, 100, 75 and 50 mg/l CaNPs to achieve

final concentrations of 100 mg $Ca(NO_3)_2$/kg soil (group B), 100 mg CaNPs/kg soil (group C), 75 mg CaNPs/kg soil (group D), and 50 mg CaNPs/kg soil (group E). Significant ($p < 0.05$) improvements were obtained for physiological indices, polyphenol contents, crude protein, crude fat, ash, carbohydrate, antioxidant activities, photosynthetic pigments, Cu, K, Ca, Zn, energy contents with concomitant significant ($p < 0.05$) reductions in malondialdehyde, percentage moisture, Pb, Ni, Cd, Cr, and Na contents. Scanning electron micrographs and energy dispersive X-ray of soils treated with CaNPs exhibited larger cavities, smaller soil sizes, richer content of nitrogen, organic carbon and phosphorus. Thus, CaNPs can be useful in agriculture to improve plant growth and sequester heavy metals.

Keywords: Calcium nanoparticles, proximate analysis, oxidative stress, energy dispersive X-ray, organic carbon

NANO 2019B/017

Diagnostic techniques of *Helicobacter pylori* DNA in human faeces and water with different levels of faecal pollution in Gashua town and potential control via nanotechnology

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This study was carried out to determine the role of water in the faecal transmission of *Helicobacter pylori* by detecting the DNA in human faecal samples and environmental water samples with a range of faecal pollution from the Gashua town. Semi-nested PCR was used to detect *H. pylori* in stools and water, both matrices with a complex biota. DNA was detected using highly specific primers of the ureA gene fragment. In addition, antigens were used to detect the bacteria in stools. *Helicobacter pylori* were detected in 53 % of 150 human faecal samples, 66 % of wastewater samples, and 11% of river samples, but in none of the spring water samples. Faecal pollution of the aquatic environment was tested by analyzing the presence of microbial indicators. This study reveals higher positive samples obtained in the more faecally polluted waters. These data indicate that water may be a vector of *H. pylori* in its faecal-oral route. Our future research will focus on antibiotic resistance of *H. pylori* and application nanoparticles-like liposomes and various inorganic nanoparticles as effective vehicle for drug delivery to enhance the therapeutic effectiveness of existing antibiotics which faces significant challenges, particularly the emergence of antibiotic resistance in treatment of *H. pylori* infection.

Keywords: Faecal sample, indicators, *H. pylori*, PCR, sewage water, nanotechnology

NANO 2019/B018

Free radical scavenging activity, reductive potential, total phenolics and total flavonoids contents of silver nanoparticles biosynthesized from methanolic leaf extract of *Blighia sapida*

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Synthesis of nanoparticles by biological methods using microorganisms, enzymes or plant extract has been suggested as possible ecofriendly alternative to chemical and physical methods which involves the use of harmful reducing agents. In the present study, silver nanoparticles (AgNPs) were synthesized by green approach from methanolic leaf extract of *Blighia sapida*. The synthesized AgNPs were characterized by UV-visible spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy and Scanning Electron Microscopy (SEM). The antioxidant activity was evaluated using DPPH radical scavenging assay, determination of total reductive potential, total phenolics content (TPC) and total flavonoids content (TFC) of the synthesized AgNPs. SEM analysis showed that the size of the synthesized silver nanoparticles ranged from 50-70 nm with maximum absorbance at 413 nm. DPPH radical scavenging activity, reducing power, total phenolic and total flavonoid contents of the synthesized AgNPs increased in a dose dependent manner as compared to the standard antioxidant ascorbic acid. These results confirmed that *B. sapida* is a potential biomaterial for synthesizing AgNPs which can be exploited commercially for its antioxidant activity.

Keywords: *Blighia sapida*, antioxidant activity, silver nanoparticles, DPPH radical scavenging activity, free radicals

NANO 2019P/019

Enhancing thermal performance of solar collectors using nanofluids

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Solar energy remains the most ubiquitous and inexhaustible source of energy. This energy can be utilized by several approaches including the use of solar collectors. Several studies have demonstrated that the efficiency of solar collectors can be tremendously improved by

incorporating nanofluids which has shown improved thermal conductivity up to 160 % with subsequent reduction in greenhouse gases such CO_2. To produce nanofluids, nanoparticles such as Al_2O_3, hybrid $ZnO+Al_2O_3$ and metals (Al, Cu) particles are dispersed into the based fluids such as water, glycerol and bio-fluids. The added nanoparticles enhance the viscosity, absorption rate, convective heat transfer coefficient and heat losses of the fluid. Performance of solar collectors can also be modulated by using different nanofluids at varying concentrations. This review details the applications and effectiveness of different nanofluids in four types of solar collectors - parabolic trough, flat plate, direct absorption and evacuated tube solar collector. In addition, the paper also sheds light on the future trend and challenges of nanofluids (including toxicity) in solar collectors. Regardless of its toxicity, researchers have shown more interest with nanofluids use in solar collectors because of its strong sustainability to a safe environment and the exploration of hybrid nanofluids to better enhance solar collectors.
Keywords: Nanofluids, solar collectors, parabolic trough solar collector, flat plate solar collector (FPSC), direct absorption solar collector (DASC), evacuated tube solar collector (ETSC), thermal efficiency

NANO 2019P/020

Comparative study of gamma-ray attenuation parameter calculated analytically using Matlab and XCom computer program

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Radiation protection is a very important field and many researchers have tried to approach the best methods for protection from radiation during the last centuries. This paper reports the comparative study of X-ray and gamma attenuation using different materials consist of micro and nano components which can be utilized to design radiation protection shields. Therefore, this study developed a MATLAB program that provides a user friendly interface to evaluate different composites in a shorter time and predict the results with reasonable accuracy without experimental cost of fabricating and testing the samples. The mass attenuation coefficients (μ/ρ), linear attenuation coefficients and half value layer of a compositeover a range of photon energy, percentage composition and thicknesses were calculated analytically using Matlab code. The output of this code is validated by comparing the results with the values obtained from widely used XCom computer program to determine percentage of error and analyse the accuracy of the code.
Keywords: Attenuation, shielding, radiation,WinXCom software, MATLAB software

NANO 2019/P021
Estimation of blood viscosity at different share rate and molecular communication in nanonetworks

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Molecular communication permits nanomachines to communicate using molecules instead of electromagnetic waves as a communication carrier and this provides many new solutions in the fields of biomedical sciences. In this paper, simulation of probability density of delay in blood molecules propagation in terms of viscosity as a function of temperature from transmitter to receiver and latency are presented. The simulation results show that the blood viscosity increase with increase in temperature and decreases with shear rate. The mean blood viscosities as a function of temperature at different shear rate (1 s^{-1}, 20 s^{-1} and 50 s^{-1}) are 0.0409, 0.0174 and 0.0082 kg/m/s respectively. It was also discovered that the probability of an individual molecules with latency, that is, the time between the initiations of molecules is a function of distance. When the distance between the sender and the receiver of the nanomachine increases, the PDF decreases. It was also noted that, the hit probability reduces and tends towards zero for$t = \infty$, which is due to the chemical reactions between the propagating molecules.
Keywords: Biomedicine, blood viscosity, latency, molecular communication, nanotechnology

NANO 2019/B022
Characterization and antimicrobial activities of silver nanoparticles synthesized from *Blighia sapida*

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Plant mediated synthesis of nanoparticles is gaining importance due to its simplicity, rapid rate of synthesis of nanoparticles of various sizes. In this work leaf extract of *Blighia sapida* was employed to synthesize Silver nanoparticles (AgNPs). The AgNPs were characterized using UV-vis spectroscopy, Fourier transform infrared (FTIR) spectroscopy, and scanning electron microscopy (SEM). The antibacterial activities of AgNPs, cold and hot water leaf extracts were assessed using Gram positive and Gram negative clinical isolates by agar well diffusion method. The combination of extract and silver nitrate solution changed from light yellow to dark brown in colour after incubation, with maximum absorbance at the wavelengths of 789 and 415 nm respectively for cold and hot extract nanoparticles. The FTIR spectra of the nanoparticles showed several peaks that explained the mechanisms behind the formation of AgNPs. SEM image showed clear spherical morphology of AgNPs of sizes 10-50 nm. The highest antimicrobial inhibition was observed in *Staphylococcus aureus* by the nanoparticles of cold extract of *Blighia*

sapida at a concentration of 50 µg/ml. It can be concluded that the synthesized AgNPs using *Blighia sapida* contained bioactive compounds with antimicrobial potentials.
Keywords: *Blighia sapida*, antimicrobial activity, SEM analysis, AgNPs

NANO 2019/B023
Synthesis, characterization and application of different sizes of gold nanoparticles

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Gold nanoparticles (GNP) are known to be the most stable metal nanoparticles, which exhibit many unique and interesting physical and optical properties with profound potentials in wide applications but are highly delimited in terms of size distribution. In this work, different sizes of gold nanoparticles were synthesized via two approaches. The nanoparticles were characterized using zetasizer nano series particle size determining machine and ultraviolet-visible spectrophotometer. The gold nanoparticles were used to modify screen printed carbon electrodes and electrochemical characterization was conducted as well as the determination of quinoline. The synthesized GNP sizes range from 42.54-1730.00 nm. The smaller sized GNP displayed better outcome in the determination of quinoline. The fabricated electrode, GNPspe is indeed a promising electrode for detecting and quantifying quinoline.
Keywords: Gold nanoparticles, quinoline, zetasizer, screen printed carbon electrode, spectrophotometry

NANO 2019/P024
Preparation and characterization of sorghum husk ash for silica potentials

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Extraction of nano silica from Sorghum husk ash (SHA) was carried out in this study. Silica xerogel was produced by dissolving SHA with alkali solution to form sodium silicate solution and lowering the pH to 7.0 by adding hydrochloric acid to form silica aqua gel followed by drying to form silica xerogel. The silica xerogel was characterized using XRF, XRD and FTIR techniques. Silica and mineral contents of SHA and xerogel were determined by XRF. X-ray diffraction patterns revealed amorphous nature of the extracted silica. Fourier transform infrared (FTIR) data showed the presence of siloxane and silanol groups. Findings of this research work

showed that silica obtained from SHA and its characteristic moisture content could make it a very promising pozzolanic material for the production of mortar and concrete.
Keywords: Sorghum husk ash, amorphous silica, xerogel, aquagel, siloxane, silanol, pozzolanic materials

NANO 2019/P025
Influence of nanosilica particles on early age strength of rice husk ash and calcium carbide waste as a binder for cementitious applications

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In the recent time, effort has been made to replace Portland cement (PC) wholly, thus producing an alternative binder. This innovation may be due to the green-house gas emission, energy consumption and environmental degradation associated with PC production. The use of rice husk, ash and calcium carbide waste (CCW) as a binder in the production of mortar/concrete has revealed a positive result. Even though, the study yielded an encouraging result, features such as workability and early age strength were adversely affected. This study therefore target at inclusion of nanosilica particles and super plasticizer in RHA-CCW with a view to improve on the deficiencies of these materials. Cementitious materials were mixed in the proportion of 60/40 i.e. RHA/CCW with a constant wc/b ratio of 0.4. Nanosilica particles were added to the mix as 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5 and 5 %. Physico-chemical analysis of the binders were determined, fresh and early gain strength properties of specimen were studied and evaluated for the nanosilica particle influence on performance of the new eco-friendly binder.
Keywords: Rice husk ash, calcium carbide waste, early age strength, slow hydration, nanosilica particles

NANO 2019/B026
Peptide (p.L) conjugated gold nanoparticles induced a transient acute toxicity in rats after a single intravenous injection

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Peptides play important roles in the diagnosis, prognostic predictors and treatment of various kinds of cancer. Peptide (p.L), derived from the phage display peptide libraries, specifically binds to colorectal cancer (CRC) cells (HT-29). Gold nanoparticles (AuNPs) can be conjugated with p.L to allow tumour specificity and selectivity, for *in vivo* diagnosis of CRC. It is important to investigate the toxicological behaviour *in vivo* before developing this novel tool. Gold nanoparticles (14 nm) were conjugated with p.L using 1% polyethylene glycol (PEG)-biotin as a linker, via the biotin-streptavidin interaction. Male Wistar rats were intravenously injected with a single dose of the conjugated AuNPs (p.L-PEG-AuNPs). Animals were monitored for behavioral changes, and sacrificed 14 and 84 days after injection. Biochemical assays, including liver function and damage markers, kidney function markers, hematological parameters, oxidative stress and inflammation markers were assessed. Although no mortality was noted in rats, p.L-PEG-AuNPs caused significant toxicity ($p<0.05$) 14 days post-exposure when compared to the control group, as evidenced by increased relative liver weight, increased malondialdehyde levels, and total white blood cell counts. These changes, however, returned to normalcy 84 days post-injection. It can be concluded based on these findings that p.L induced immediate toxicity in rats after a single intravenous injection, and can therefore be considered non-toxic long-term after a single intravenous injection. Further studies on the investigation of various organ toxicities, and the receptors on CRC tumours responsible for the specificity should be performed.

Keywords: Colorectal cancer, diagnosis, gold nanoparticles, peptides, polyethylene glycol

NANO 2019/P027
Spectroscopic, microscopic and electrical characterizations of nanoscopic Polyindole DNA-templated nanomaterials

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This research work is concerned with the synthesis, spectroscopic, microscopic and electrical characterization of hybrid polyindole (Pln) DNA-templated nanowires. Polyindole (PIn) has been templated on λ-DNA via oxidative polymerization of indole using $FeCl_3$ to produce conductive PIn/DNA nanowires. The formation of PIn/DNA nanowires were verified by FTIR,

UV-vis and XPS spectroscopy techniques. AFM, SEM and TEM techniques were used to characterize the nanowires dimensions. AFM studies revealed an average height of 1.60 nm for free DNA and the Pln/DNA nanowires have diameters in the range 2-15 nm with the dominance of 3-4 nm mean diameter range. The electrical properties of Pln/DNA nanowires as drop-cast films were investigated by two-terminal current voltage (I-V) measurements on a probe station. The nanowires were drop-cast (5 μL of as-prepared nanowire dispersion) onto platinum microband electrodes (10 μm gap, 10 μm width). The conductance of these films at 20 ^{o}C was of the order of 10-100 μS. In addition, the conductance of PIn/DNA nanowires exhibits Arrhenius behaviour (Ea = 0.80 + 0.06 eV) as a function of temperature. The above results have revealed the potentials of the Pln/DNA nanowire in nanoelectronic applications.

Keywords: Polyindole, DNA-templated, nanowire, nanoelectronics, characterization

NANO 2019/P028
Setting time and standard consistency of quaternary binders containing rice husk ash, calcium carbide and metakaolin blended with Portland cement

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In the cement industry, in order to reduce carbon dioxide (CO_2) emissions and increase the strength and durability of mortars and concrete, the use of pozzolanic materials has received increased interests in the last decades. This study presents three pozzolanic materials that were used to produce quaternary binders; Rice husk ash (RHA), Calcium carbide waste (CCW) and Metakaolin (MK) as partial replacement of Portland cement (PC) at 5 %, 10 % and 20 % in the quaternary binders with PC so as to investigate the effect of setting times (initial and final) and standard consistency on the quaternary pastes. The Department of Environment (DOE) approach for mix proportions was employed. The mixes are in five groups consisting of control PC, binary, ternary and quaternary mixes respectively. Test results shows that RHA significantly influenced the standard consistency of the quaternary binders as compared with CCW and MK. Water requirement in the paste increases with increase in percentage replacement level of RHA within the paste due to its porous nature. At 5 % replacement level, it was 9 % higher than control value, 21 % at 10 % replacement level and 39 % at 20 % replacement level respectively. Similarly, the initial and final setting times at the aforementioned replacement levels are 27 % higher than the control value for initial setting time and 6 % higher than control value for final setting time. For 20 % replacement level, it was 24 % higher than control value for the initial setting time and 38 % higher than control value for the final setting time respectively. This is due to reduction in PC content leading to less content of Tricalcium silicate Aluminate (C_3A) and the degree of purity (amount of carbon content) of the pozzolanic materials which retarded the rate of reactions. By and large, the effect of the pozzolanic materials on consistency and setting times in quaternary binder is retardation of the setting time which can be overcomed by activation. However, they are useful in the production of concrete structural elements or structures that requires longer time for placement.

Keywords: Portland cement, ozzolans, rice husk ash, calcium carbide waste, metakaolin, consistency, initial and final setting times

NANO 2019/B029
Effects of *Cymbopogon citratus* extract-mediated silver nanoparticles on germination of *Celosia argentea* seeds

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This study aimed at synthesizing *Cymbopogon citratus* (lemon grass) extract-mediated silver nanoparticles (AgNPs) and investigating their effects on germination of *Celosia argentea* seeds. AgNPs were synthesized from aqueous extract of lemon grass leaves and were identified using UV-vis spectrophotometry and Fourier Transform Infra-Red (FTIR) spectroscopy. At the end of a seven-day trial, the seedlings were evaluated for germination/growth parameters, oxidative stress parameters, antioxidant enzyme activities and non-enzyme antioxidants. The AgNPs absorbed maximally at 400 nm in the visible spectrum, in the typical range of AgNPs and had FTIR peaks at 3446.91, 2359.02, 1635.69, 1384.84 and 669.32 cm^{-1} indicating the involvement of amide, phenolics, alkenes and aromatic compounds, among others. At 0.03, 0.06 and 0.125 µg/l, the AgNPS significantly ($p < 0.05$) reduced germination time and increased root and shoot lengths compared to $AgNO_3$ control. The AgNPs also significantly ($p < 0.05$) reduced nitric oxide and malondialdehyde, while there was significant ($p < 0.05$) increase in the antioxidant enzymes (superoxide dismutase, catalase and glutathione *S*-transferase) and reduced glutathione compared to $AgNO_3$ control. Protein concentration was also increased in relation to $AgNO_3$ control but significantly ($p < 0.05$) lower than distilled water control. Overall, the results indicated that the AgNPs can be synthesized from *C. citratus* aqueous extract and the synthesized AgNPS were able to break seed dormancy, reverse $AgNO_3$-induced oxidative stress, and prevent lemon grass extract-mediated phytotoxicity.

Keywords: Allelopathy, antioxidant enzymes, seed germination, silver nanoparticles, *Cymbopogon citratus*, *Celosia argentea*

NANO 2019B/030

A comparative analysis of antimicrobial effect of cold aqueous extract and silver nanoparticles of *Citrus sinensis* (sweet orange) on oral bacteria

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Oral health is a key indicator of overall health, wellbeing and quality of life. Nanoparticles are increasingly used to target bacteria as an alternative to antibiotics but there are so many sources unrevealed through research. This study was conducted to assess and compare the antimicrobial potential of *Citrus sinensis* peel and peel biosynthesized silver nanoparticles on oral bacteria. Aqueous extract of peel of *C. sinensis* and its AgNPs were screened for *in vitro* antimicrobial activity against *Corynebacterium xerosis*, *Staphylococcus aureus*, *Lactobacillus casei*, and *C. kutscheri* using agar disc diffusion method. The UV/-vis, FTIR and SEM analyses were carried. Zones of inhibition were observed at a concentration of 25 µl of the AgNPs on two of the test organisms, *S. aureus* (15 mm) and *L. casei* (20 mm). The FTIR result showed functional groups, OH, alkenes and an aliphatic compound. The SEM analysis showed that nanoparticles were formed, while the EDAX showed the presence of carbon, oxygen, silver and calcium. Although, *C. sinensis* peel contains some bioactive components that can inhibit the growth of oral bacteria, AgNPs proved more effective than the cold aqueous extract.
Keywords: Disc diffusion assay, silver nanoparticles, oral bacteria, *Citrus sinensis* peel extract

NANO 2019B/031

Antimicrobial activities of chitosan-silver nanoparticles on some bacterial isolates

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Chitosan has attained increasing commercial interest as suitable resource materials due to their excellent properties including biocompatibility, biodegradability, adsorption and ability to form films and to chelate metal ions. Antibiotics resistance has become rampant and nanoparticles are increasingly used to target microorganisms as an alternative to antibiotics. This research was conducted to produce and synthesize nanoparticles using chitosan for the antimicrobial activity against some selected bacteria. Chitosan was produced by demineralization, deproteinization and deacetylation of oyster shell. The silver nanoparticles was synthesized from Chitosan and screened for *in vitro* antimicrobial activity against selected bacteria using agar well diffusion method. Synthesized nanoparticles were characterized using UV-vis spectrophotometry, FTIR spectroscopy and scanning electron microscopy. Chitosan-AgNPs showed some inhibiting properties against the growth of most of the organisms tested (*Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Salmonella typhi*). Most of the isolates were inhibited by both native chitosan and chitosan-AgNPs. The positive control which was chloramphenicol and gentamycin inhibited the growth of all organisms except *Salmonella typhi*.
Keywords: Chitosan, chitosan-AgNPs, antimicrobial activity

NANO 2019/B032
Green synthesis of silver nanoparticles using aqueous extract of *Dacryodes edulis* seeds and their antibacterial activities

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The emergence of biological method in the synthesisof silver nanoparticles had radically changed the field of nanotechnology because of its outstanding benefits. In this study, the green synthesis of silver nanoparticles (AgNPs) using aqueous extract of *Dacryodes edulis* seeds and its antibacterial activities were investigated against multi-drug resistant pathogenic bacteria. The green synthesized AgNPs were characterized by UV-visible spectrophotometry, Fourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM). Gas chromatography-mass spectrometry (GC-MS) analysis was carried out to determine the phytochemicals in the extract. Antibacterial activities were evaluated against *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus.* The AgNPs particles showed maximum absorbance at wavelength of 415 nm, while the distinct peaks at 3448.84 cm^{-1} on FTIR spectrum indicated that protein molecules in the extract were responsible for the reduction and stabilization of the synthesized AgNPs. The AgNPs were dark brown in colour by visual observation while SEM showed spherical shapes with the size ranging from 10-50 nm. The AgNPs particles also showed remarkable antibacterial activities against the three clinical bacterial isolates. The results obtained in this study suggested that the green synthesized AgNPs of *D. edulis* seeds extract could be relevant in the development of novel antibacterial agents for medical and pharmaceutical applications.
Keywords: *Dacryodes edulis,* AgNPs, multi-drug resistance, nanotechnology, plant extract

NANO 2019/B033
Characterization and biomedical application of gold nanoparticles synthesized from *Datura stramonium* seed

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The biosynthesis of gold nanoparticles (AuNPs) using extract of *Datura stramonium* seed was investigated in this work. The AuNPs was characterized by UV-vis spectroscopy, Fourier

transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM) and evaluated for antifungal, antioxidant, anticoagulant and thrombolytic activities. The AuNPs were nearly spherical, and crystalline in nature with size of 64-95 nm. Energy dispersive X-ray (EDX) analysis showed that gold (Au) was the prominent metal present, while the selected area electron diffraction pattern conformed to the face-centred crystalline nature of AuNPs. The UV-visible spectrum of the AuNPs synthesized displayed clear peak at 638.0 nm. The prominent FTIR peaks obtained at 3890-3727, 3727-3466, 3238-2978, 2275-2068 cm^{-1} alluded to the fact that proteins were involved in the biofabrication and capping of AuNPs. The AuNPs synthesized showed potent antifungal activities through mycelial inhibitions of 57.9, 60.7, 64.5, 69.6 and 80.6 % against *Fusarium solani, Candida albicans, Aspergillus niger A. flavus* and *A. fumigatus* at 250 µg/ml respectively. The AuNPs synthesized showed great free radical scavenging properties (59.424 %) against 2,2-diphenyl-1-picrylhydrazyl at 100 µg/ml. The AuNPs prevented coagulation of blood and also achieved 53.3% lysis of blood clot showing potential nanomedical applications. This study has presented an eco-friendly and economical synthesis of AuNPs from *Datura stramonium* husk for various nanobiotechnological applications.

Keywords: Antifungal, antioxidant, biomedical, gold nanoparticles

NANO 2019/P034

Study, fabrication and characterization of *Telfairia occidentalis* based dye sensitized solar cells

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This paper reported on the study, fabrication and characterization of dye sensitized solar cell (DSSC) using *Telfairia occidentalis* pigment as photosensitizer. The chlorophyll pigment of *T. occidentalis* was extracted using 5 g of leaves soaked in 10 ml of methanol for 72 h. The microscopic glass substrates were dipped into the solution to have the thin film of about 1 µm thickness. The UV-visible spectrophotometry analysis was carried out on the film to measure the percentage transmittance and Beer's Lambert law was employed for the estimation of absorbance at each wavelength in the visible to near infrared region of the solar spectrum. The Fourier Transform Infrared (FTIR) spectrometry and atomic absorption spectroscopy (AAS) analyses were carried out to determine the functional groups and elemental compositions of the photosensitizer respectively. The alkalinity or acidity of *T. occidentalis* pigment was investigated using pH meter. Indium tin oxide (ITO) glass substrate, *T. occidentalis* pigment, titanium dioxide (TiO_2) paste, graphite paste and iodide/triodide electrolyte were used for the fabrication of *T. occidentalis* based DSSC. The pigment had pH of 6.6, with the transmittance of 34-60% and absorbance of 0.2-0.47 a.u in the visible to near infrared region of the solar spectrum. The AAS analysis confirmed the presence of 0.4 mg/l of iron (Fe), 0.01 mg/l of zinc (Zn), 0.1 mg/l of magnesium (Mg) and 0.1 mg/l of sodium (Na). The FTIR analysis confirmed the O-H, C=C, C-N, C-O stretching and C=C bending. The maximum dc voltage generation of 261 mV was estimated for the *T. occidentalis* based DSSC using digital multimeter.

Keywords: *Telfairia occidentalis,* photosensitizer, dye sensitized solar cell, chlorophyll

NANO 2019/P035
Engaging science diplomacy for nanotechnology development in Africa

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The concept of science diplomacy is gaining ground as a method for global approach in addressing issues such as global peace, insecurity, climate change and its environmental impact. In this study, science diplomacy is reduced to an effective means for Africa to strategically develop nanotechnology. A comprehensive literature review was carried out. African nations are currently not encouragingly close to the leading nations in nanotechnology, yet there seem to be extant diplomatic ties with many of these forefront nations. State actors in science diplomacy from Africa such as diplomats have been identified in this study to propose foreign policies that will meet the domestic demand for science and technology development, especially for emerging technologies like nanotechnology. The necessity of inclusion of competent scientists as members of the diplomatic corps is suggested here as one of the ways to develop nanotechnology in Africa. The scientist diplomats will function to foster international scientific collaborations, drive platforms for national research facility development and for non-state actors to thrive in their domestic nano-research. Scientifically informed foreign policies is presented here to have potentials to significantly assist Africa in developing nanotechnology and provide pathways for overcoming the numerous constraints to nanotechnology development in Africa. Institutional international collaboration is discussed to contribute to nanotechnology development. These machineries are shown to also benefit independent individual researchers by leveraging on the international networks.
Keywords: Nanotechnology, science diplomacy, collaboration, foreign policy

NANO 2019/P036
Evaluation of impact and hardness properties of aluminium-silver nanoparticles composites produced by stir cast technique

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Impact and hardness characterization of samples containing homogenous mixtures of Al 6063 matrix and varying amount of silver nanoparticles impregnated with calcium carbonate at 2, 4, 6% weight fractions respectively, produced by method of stir casting were carried out. Measurement of impact energy and hardness of the produced samples at ambient temperature were done by Charpy impact and Brinell hardness testing machine in accordance to ASTM E23

and E384, respectively. The magnitude of impact and hardness increased evidently with increase in percentage weight fraction of the AgNPs. The refined samples were examined under an optical microscope. The fracture surfaces of the impact test samples were further examined by scanning electron microscopy. The use of stir-casting technique influences the homogeneity and microstructure of the composites positively. It is concluded that Al-silver nanocomposites possess better qualities in terms of impact strength and hardness. The composites can replace conventional aluminium alloy in terms of performance and longer life in industrial application.
Keyword: Al6063 alloy, Brinell hardness, calcium carbonate, impact strength, silver nanoparticles

NANO 2019/B037
Biosynthesis and bactericidal activity of silver nanoparticles (AgNPs) using cell-free bioflocculant from domestic wastewater bacteria consortium

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Water bodies are getting more frequently contaminated by chemicals and harmful microorganisms such as bacteria, which cause serious illnesses and at times death. It is therefore pertinent to find a means of purifying waste waters as well as larger polluted water bodies. The aim of this research is to isolate bioflocculant-producing bacteria for the synthesis silver nanoparticles for water purification and antimicrobial activities. Wastewaters were collected from two eateries (A and B) around LAUTECH Ogbomoso, from where the bioflocculant–producing bacteria were isolated. The organisms were characterized to species level using molecular tools and registered in the gene bank database. The flocculating activities of the isolated organisms were investigated using 5 g/l kaolin suspension to measure the flocculating activity at optical density (OD) of 550 nm. The cell-free bioflocculant was used to synthesize silver nanoparticles and its potential to reduce the microbial load of polluted water as well as antimicrobial activities against some clinical organisms were evaluated. The isolated strains are *Bacillus polymyxa* (KY705398), *Pseudomonas fluorescence* (KY705399), *Bacillus alvei* (KY705400), and *Bacillus subtilis* (KY705401) for site A, while *Klebsiella pneumoniae* (KY706100), *Providencia stuartii* (KY706101), and *Acinetobacter* species (KY706102) were obtained from site B. The consortium of the organisms gave flocculating activity of 92.46 and 60% for sites A and B respectively. The UV-vis spectroscopy showed AgNPs with surface plasmon resonance at 332, 574 nm and 330, 570 nm for sites A and B respectively. FTIR peaks of AgNPs (A) (3525, 3284, and 1179 cm^{-1}) and (B) (3611, 3307 and 2492 cm^{-1}), pointed to protein as both capping and stabilizing agent for the synthesized nanoparticles. Synthesized AgNPs exerted total elimination bacteria in a fecal polluted waste water of 14.6×10^{6} CFU/ml at concentration of 20 µg. The results obtained revealed that bioflocculant cell-free AgNPscould be used as efficient water purifying agent.
Keywords: Wastewater, bioflocculant, bacteria, silver nanoparticles, biosynthesis, antimicrobial activity

NANO 2019/B038
Green synthesized silver nanoparticles for optical detection of *Escherichia coli*

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Escherichia coli has been reported as a leading cause of water-borne diarrhoea globally, especially in sub-Saharan Africa. The development of alternative methods, sensitive and accurate for rapid detection of viable *E. coli* cells in water bodies at the point-of-use would play a vital role in public and environmental health. In this study, wet biomass (cell pellets) of *Bacillus subtilis* (NCIB 3610) were exploited for the synthesis of silver nanoparticles (AgNPs) which was confirmed using UV-vis Spectrophotometer and further characterized by scanning electron microscope (SEM), Fourier transform infra-red (FT-IR) and X-ray diffractometer (XRD). Colorimetric and optical detection study was investigated on different strains of *E. coli* (EPEC, ETEC, EIEC, STEC and EAEC) treated with silver nanoparticles solution that has been poly-coated with Poly-L-lysine hydrobromide (PLL) and monitored at 540 nm wavelength. Varying binding affinity were observed for different strains of *E. coli* cell wall due to the specificities in their lipopolysaccharides (LPS) structures towards poly-coated silver nanoparticles, hence, producing a colour change from dark-brown to colourless solution (with brown precipitates), and different absorbance values obtained for each test isolates. This study on microbial monitoring using nanoparticle-based optical biosensors has shown a promising pathway in preventing the use of unsafe water which would help to improve public health especially in the rural communities.
Keywords: *Escherichia coli,* silver nanoparticles, *Bacillus subtilis*, detection diarrhoea

NANO 2019/B039
Green synthesized silver nanoparticles for deterioration sensing in the post-harvest spoilage of fruits

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In the sub-Saharan African countries, post-harvest food spoilage is the main cause of global food shortage, rather than the under-production of food. Tools for the rapid detection of spoilage in fruits like banana (*Musa acuminata*) would help alleviate the losses caused by post-harvest deterioration during the storage period. In the present study, silver colloidal nanoparticles (AgNPs) solution synthesized using the wet biomass (cell pellets) of *Bacillus subtilis* was applied as a colorimetric sensor for the compound released during banana deterioration. The green synthesized AgNPs solution was confirmed by UV-vis spectrophotometer and

characterized by scanning electron microscope (SEM), X-ray diffractometer (XRD) and Fourier transform infrared (FTIR). The initial reddish brown colour of the AgNPs solution changed to light brown after four days and finally turned transparent after ten days of exposure to the deteriorating banana. Concurrent analysis of the resulting solution by UV-Vis spectroscopy agrees with our study of AgNPs as a colorimetric biosensing agent which displayed specificity and selectivity for 1,2-Benzenedicarboxylic acid, bis (2-methyl propyl) ester that was released during the period of banana deterioration. The easy detection of the deterioration of food crops for the control of food spoilage will be helped by applying a colorimetric sensor as demonstrated in this study.

Keywords: *Musa acuminata*, food spoilage, biosensing, silver nanoparticles, *Bacillus subtilis*

NANO 2019/P040
Improved power conversion efficiency in Perovskite solar cell using silver nanoparticles modified photoanode

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Metal nanoparticles have demonstrated outstanding properties in photovoltaic devices through introducing localized surface plasmon effects. The performance of Perovskite solar cell (PSC) by incorporating Ag@P_4VP NPs was investigated systematically. The plasmonic enhancement effects are explored based on the combination of UV-visible absorption spectroscopy and scanning electron microscope (SEM).The performance, especially the short circuit current density (*Jsc*), and open circuit voltage (*Voc*) of the PSC containing Ag@P_4VP NPs was significantly affected. The power conversion efficiency (*PCE*), *Jsc* and *Voc* of the reference device shows a value of 3.80 %, 11.04 mAcm^{-2} and 0.85 V, respectively. Upon the introduction of AgNPs@P_4VP, a *PCE* of 5.69 %, *Jsc* of 12.61 mAcm^{-2} and *Voc* of 0.88 V were recorded, which improved the *PCE* ~ 39.4 % over that of the pristine device. The improvement is attributed to an increase in photocurrent density due to enhanced light harvesting by silver nanoparticles.

Keywords: Silver nanoparticles, photovoltaic devices, Perovskite solar cell, power conversion efficiency, photocurrent density

NANO 2019/B041
Silver-gold alloy nanoparticles biofabricated using fungal xylanases as potential biomedical agents

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The search for biocompatible nanoparticles with vast applicability has impacted on exploration of various biomaterials for the synthesis of mono and bimetallic nanoparticles. Xylanase is widely regarded as an industrially important enzyme but its potentials in nanotechnological applications are yet to be fully explored. The current study investigates the exploit of xylanases of *Aspergillus niger* L3 (NE) and *Trichoderma longibrachiatum* L2 (TE) produced through valorization of corn-cob, to synthesize silver-gold alloy nanoparticles (Ag-AuNPs). Characterization of the Ag-AuNPs involved UV–vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), and field emission scanning electron microscopy and transmission electron microscopy, while their prospective use as antimicrobial, antioxidant, anticoagulant, and thrombolytic agents were studied. The biosynthesized Ag-AuNPs were ruby red and light purple with surface plasmon resonance at 520 and 534 nm for NEAg-AuNPs and TEAg-AuNPs, respectively; while FTIR showed that protein molecules capped and stabilized the nanoparticles. The Ag-AuNPs were anisotropic with spherical, oval, and irregular shapes having sizes ranging from 6.98 to 52.51 nm. The nanoparticles appreciably inhibited the growth of tested clinical bacteria (23.40–90.70 %) and fungi (70.10–89.05 %), and also scavenged 2,2-diphenyl-1-picrylhydrazyl (48.51–53.79 %) and hydrogen peroxide (80.5–95.50 %). Moreover, the Ag-AuNPs displayed outstanding anticoagulant and thrombolytic activities using human blood. This study further emphasizes the significance of xylanases in nanobiotechnology as it has established the potential of xylanases to synthesize Ag-AuNPs, which is being reported for the first time.
Keywords: Silver-gold alloy nanoparticles, xylanases, *Aspergillus niger*, *Trichoderma longibrachiatum*, nanobiotechnology, biomedical applications

NANO 2019/P042
Inhibition efficiency of silver nanoparticles on corrosion of mild steel, stainless steel and aluminium in 1M HCl medium

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Study of corrosion behaviour in metals ccontinues to attract considerable attention because corrosion prevention and maintenance or replacement of products lost or contaminated due to corrosion reactions cost most developed nations about 5% of their GDP. While different inhibitors are used to minimize corrosion rate, addition of nanoparticles have been reported to enhance inhibition efficiency. In this work, inhibition effects due to the addition of silver nanoparticles (AgNPs) on corrosion of mild steel, aluminium and stainless steel in 1M HCl were investigated. Biosynthesized AgNPs were acquired from the Laboratory of Industrial Microbiology and Nanobiotechnology, LAUTECH Ogbomoso. The particles were hitherto characterized using FTIR, UV-vis and TEM. Five concentrations of AgNPs (0, 5, 10, 15, and 20 µg/ml) were added to 1M HCl following previous studies. The corrosion rates of the metal samples and inhibition efficiency of the nanoparticles were analyzed using gravimetric (weight loss), potentiodynamic polarization and gasometric (hydrogen evolution) approaches. Gravimetric study was conducted within 2000 hours of exposure, and the results showed that weight loss increased with exposure time but decreased with increased concentration of AgNPs. In addition, inhibition efficiency was enhanced by the addition of AgNPs; 52% for mild steel, 70% for stainless steel and 62% for aluminum. Gasometric results revealed that the volume of hydrogen gas evolved reduced with exposure time and concentration of AgNPs. Furthermore, potentiodynamic polarization results showed that the presence of AgNPs modified the mechanism of anodic dissolution and cathodic hydrogen evolution. These results indicated that AgNPs can be incorporated into existing inhibitors towards minimizing corrosion rate.

Keywords: Silver nanoparticles, gravimetric, gasometric, potentiodynamic polarization, corrosion inhibition

NANO 2019/P043
Effect of particle size of rice husk ash on aluminium/graphene composites

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Aluminium/graphene (Al/G) composite has gained wider engineering applications because of its unique properties such as light weight, excellent corrosion resistance, improved strength and enhanced thermal conductivity. However, difficulty in dispersing graphene in molten aluminium remains one of the major challenges for property optimization. This study seeks to develop by stir casting technique, composites of aluminium alloy from recycled aluminium can, 0.4 wt. % graphene (G) and 1.6 wt.% rice husk ash (RHA) with particle sizes of 150, 300 and 600 µm. The tensile, hardness, impact and fatigue properties were analysed using Instron extensometer, Vickers hardness tester, Charpy impact machine and rotating fatigue machine respectively. Furthermore, the cast samples were characterized using scanning electron microscope (SEM) with attached energy dispersive X-ray spectroscope (EDS) and X-ray diffractometer (XRD). The morphology of the microstructure of all composites showed the retention and uniform distribution of G and RHA particles in the Al matrix devoid of presence of harmful aluminium carbide with improved mechanical properties. The study established a new approach of dispersing graphene in molten aluminium through a stir cast method with 150 µm particle size of RHA giving the best mechanical and morphological properties.
Keywords: Graphene, recycled aluminium, rice husk ash, stir cast, microstructure, aluminium-graphite composite

NANO 2019/B044
Assessment of growth performance, nutrient utilization, haematological, and biochemical profile of *Clarias gariepinus* fed different dietary inclusions of nanoselenium formulated diets

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A 63-day experiment was conducted to evaluate effects of dietary supplementation of nanoselenium formulated diets on growth performance, nutrient utilization, haematological and biochemical profile of *Clarias gariepinus*. Fish were acclimatized for 14 days, and 10 fish each were randomly introduced into different troughs. Two diets supplemented with nanoselenium at 2 mg/kg, 4 mg/kg and the control without nanoselenium were fed to triplicate group of fish. The feed intake, weight gain, food conversion ratio (FCR), specific growth rate (SGR), protein efficiency ratio (PER) and survival rate (SR) were determined. Also, the blood, gill and liver of

the reared *C. gariepinus* were analyzed. There were significant differences ($p<0.05$) in the weight gain of fish fed 2 mg/kg of nanoselenium as compared with those fed 4 mg/kg of nanoselenium and the control. Similarly, PER and SR were significantly high ($p<0.05$) when compared with other formulated diets. The WBC, RBC, hemoglobin, and haematocrit significantly increased in fish fed 2 mg/kg of nanoselenium as compared to those fed 4 mg/kg nanoselenium and the control. No significant difference ($p>0.05$) in the activities of aspartate aminotransferase (AST), alanine aminotransferase (ALT) and total protein of the two diets and the control. Glutathione peroxidase (Gpx) and malondialdehyde in the gill and liver of fish fed 2 mg/kg nanoselenium increased significantly, while superoxidase dismutase (SOD) in the gill and liver of fish significantly increased as the concentration of dietary nanoselenium increased. The study indicated that dietary inclusion of nanoselenium at 2 mg/kg may enhance better growth performance and nutrient utilization of *C. gariepinus*.

Keywords: *Clarias gariepinus*, nanoselenium, growth performance, nutrient utilization, haematology, biochemical profile

NANO 2019P/045

Algal-mediated silver and gold nanoparticles as energy tool in microbial fuel cell

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Microalgae are photosynthetic organisms which have the ability to produce energy effectively without the problem of high production cost and environmental pollution. Although microalgal biomass have found application in various areas, but its application in nanotechnology has not been adequately explored especially in the area of renewable source of electricity. In this study, microalgal-mediated nanoparticles were employed for electricity production in microbial fuel cell (MFC). Nanoparticles were synthesized from both *Nanochloropsis* sp and *Coelastrella* sp using 1 M silver nitrate and 1 M gold chloride as precursors. The anode chamber contained both nanoparticles and sterile cassava peel extract, while potassium chloride was used as oxidizing agent at the cathode. One kΩ resistor was used to close the circuit and the current-voltage characteristic was monitored. The maximum current density (CD_{max}) and power density (PD_{max}) were determined for each of the MFCs from the current-voltage measurements. The MFCs based on silver nanoparticles of *Coelastrella* sp resulted in CD_{max} of 60 mA/m^2 and PD_{max} of 50 mW/m^2 while the respective CD_{max} and PD_{max} of gold nanoparticles-based MFC were 40 mA/m^2 and 30 mW/m^2. The silver nanoparticles of *Nanochloropsis* sp gave CD_{max} of 120 mA/m^2 and PD_{max} of 150 mW/m^2 compared to CD_{max} of 70 mA/m^2 and PD_{max} 60mW/m^2 from the gold nanoparticles. The silver nanoparticles of both microalgae were more productive and sustainable than the counterpart gold nanoparticles. The performance of the algal based nanoparticles has

established the potential of microalgae based nanoparticles as energy producers in microbial fuel cell.

Keywords: Nanoparticles, *Coelastrella* sp, *Nanochloropsis* sp, bioelectricity, cassava peel extract, microbial fuel cell

NANO 2019/P046
Evaluation of microalgal-based nanoparticles in the adsorption of heavy metals from wastewater

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Bioremediation remains one of the most eco-friendly and cost effective methods employed in getting rid of the toxic compounds like heavy metals present in wastewater. Different microorganisms are being used for adsorption of heavy metals in wastewater but microalgae have a high affinity for heavy metals. In this study, nanoparticles from microalgae were evaluated for the potential to absorb lead and zinc from pharmaceutical effluent. Silver (AgNPs) and gold nanoparticles (AuNPs) were synthesized from *Neodesmus pupukensis* (NP), *Coelastrella* sp (CO), *Nanochloropsis* sp (NN) and *Chlorella vulgaris* (CV). The nanoparticles were introduced into a pharmaceutical effluent and the mixture was allowed to interact for 48 h after which the concentration of zinc and lead was determined using atomic absorption spectrophotometer. The AgNPs from *Nanochloropsis* sp (NN-AgNPs) had the highest percentage reduction of 68.86 % for zinc, while the lowest of 49.15 % was obtained by that of CO-AgNPs. Similarly the NN-AuNPs had the highest percentage reduction of 66.53% for zinc, while the lowest was 36 % from NP-AuNPs. The concentration of lead was reduced by CV-AgNPs with percentage reduction of 74.62 % , while the least was 26.88 % by NP-AgNPs. The optimal percentage reduction of lead was achieved by CV-AuNPs (66.83%), while the lowest was 24.37% by AuNPs-NP. The nanoparticles of the four microalgae had higher adsorption potential than the extract of each microalga. This study has established algal-based nanoparticles as adsorbent with affinity for heavy metals and can be adopted for bioremediation of wastewater.

Keywords: Heavy metals, microalgae, nanoparticles, pharmaceutical effluent, adsorption

NANO 2019/B047
Antimicrobial and antioxidant activities of algal-mediated silver and gold nanoparticles

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Microalgae are rich sources of biologically active metabolites and the nanoparticles could be useful antimicrobial agents. This study focused on the synthesis of nanoparticles from microalgae and their application as antimicrobial and antioxidant agent. Cell free extracts of *Chlorella vulgaris, Coelastrella* sp, *Nanochloropsis* sp, and *Neodesmus pupukensis* were employed in the synthesis of both silver and gold nanoparticles. The nanoparticles were investigated for their antibacterial properties against five clinical isolates (*Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Serratia marcescens*), antifungal properties against five fungi (*Aspergillus niger, Aspergillus fumigatus, Aspergillus flavus, Fusarium solani*, and *Candida albicans*) and free radical scavenging properties against stable free radical (2,2-diphenyl-1-picrylhydrazyl). The zones of inhibition obtained by the silver nanoparticles of the four microalgae showed an improved activity when compared with the commercially available antibiotics. On the other hand, the gold nanoparticles of the four microalgae showed poor antibacterial activity against the test pathogens. Both the silver and gold nanoparticles of the microalgae were highly potent against test fungi. The gold nanoparticles of the four microalgae showed good antioxidant properties compared to their silver counterparts. The antioxidant properties of gold nanoparticles of *C. vulgaris*, *Neodesmus pupukensis* and *Coelastrella* sp were 68.95 % 62.16%, and 58.52 % respectively, while that of *Nanochloropsis* sp was the lowest at 46.4 %.
Keywords: Microalgae, nanoparticles, antimicrobial activity, antioxidant activity

NANO 2019/P048
Strength characteristics of lateritic soil stabilized with XL-bond nanochemical

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Lateritic soil is one of the major construction materials in road pavement. However, obtaining lateritic soil with sufficient strength is difficult and stabilization with cement is expensive. Stabilization with cement and lime has been well reported but there is paucity of information on stabilization with XL-bond nanochemical. In this study, the strength characteristics of stabilized lateritic soil with XL-bond nanochemical were investigated. Lateritic soil samples were collected from Bariga and Mushin borrow pits; (A: Latitude 6.5391º, longitude 3.3849°) and (B: Latitude 6.5273º, longitude 3.3414°), respectively. The geotechnical properties which include moisture content (MC), particle size analysis (percentage passing sieve no 200), plastic index (PI), optimum moisture content (OMC), maximum dry density (MDD), unconfined compressive

strength (UCS) and California bearing ratio [CBR] (soaked) of lateritic soils were determined at natural state. The lateritic soils were stabilized at 2, 4, 6, and 8% of XL-bond nanochemical by dry unit weight of the soil samples. The PI, MDD, CBR (soaked and unsoaked) and UCS of stabilized laterite soil samples were determined in accordance with standard methods. One-way analysis of variance (ANOVA) at 5% level of significance was used to determine the effects of varying percentage of XL-bond on CBR. The MC, percentage passing sieve no 200, PI, OMC, MDD, UCS and CBR (soaked and unsoaked) of soil samples A, B were (45.6%, 38.98%, 5.0%, 10.5%, 2420 g/m^3, 59 kPa, 12.0% and 10.0%); (41.1%, 54.52%, 2.0%, 12.50%, 1960 g/m^3, 72 kPa, 4.0% and 20.0%), respectively. The PI, MDD, CBR (soaked and unsoaked) and UCS of stabilized soil with XL-bond varied from (3-7%; 2.30-2.35 g/cm^3,12-23%, 23-50% and 64-83 kPa) and (3-6%; 1.44-1.50 g/cm^3,6-20%, 21-40% and 79-8 kPa), respectively. There is significant effect of varying percentage of XL-bond on CBR of stabilized samples (P = 0.1004>0.05). In conclusion, stabilization of laterite soil with XL-bond nanochemical enhanced its compressive strength. The stabilized soil can be used as subgrade materials in highway construction.

Keywords: Laterite soil, XL-bond, strength characteristics, California bearing ratio, subgrade material, highway construction

NANO 2019/B049

Bio-fabrication and characterization of silver nanoparticles using *Streptomyce* sp. HDW7 and *Nocardia* sp. OX5 bioflocculants: its flocculating and antibacterial efficiency

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The challenges in wastewater treatment and increasing scourge of waterborne diseases necessitated the search for effective bioflocculating antimicrobials in nanoparticles with a new paradigm shift to nanotechnology. In this study, bioflocculants produced by *Streptomyce* sp. HDW7 and *Nocardia* sp. OX5 were used for AgNPs (SBAgNPs and NBAgNPs) biosynthesis. The AgNPs were characterized using UV-vis spectrophotometry, FTIR and SEM and their flocculating and antibacterial activities were evaluated. The purified bioflocculants were proteoglycan containing 93.95 and 85.76% polysaccharides and 6.05 and 14.24% protein. The bioflocculants bio-reduced $AgNO_3$ for AgNPs biosynthesis. Surface plasmon resonance absorption peak was at 600 nm. FTIR spectra show 21 and 23 peaks for the bioflocculants and 16 and 20 for SBAgNPs and NBAgNPs. Functional groups such as carboxyl, hydroxyl, amide and amine corresponding to polysaccharides and amino acids were present. The AgNPs were porous and spherical with sizes of 9.8 nm and 11.8 nm. It was discovered that 10 mM $AgNO_3$, pH 3 and 9 and temperature of 35 and 45 ^oC supported the highest nanoparticle biosynthesis. SBAgNPs and NBAgNPs had 86% and 71% flocculating efficiency in wastewater treatment and good antibacterial activity against some selected water borne pathogens. The biosynthesized AgNPs can serve as potential flocculating and antibacterial agents in water purification and wastewater treatment.

Keywords: Nanoparticles, bioflocculants, flocculating efficiency, antibacterial activity, wastewater treatment

NANO 2019/P050

Recent developments in the photoanodes employed in dye sensitized solar cells

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The emergence of Dye Sensitized Solar Cells (DSSCs) as an alternative device for silicon based solar cell has gained a lot of attention from researchers due to its cost effective, easy fabrication and environmental friendliness characteristics. Photoanodes are semiconductors, and as one of the four components of DSSCs, they play major role for dye loading and electron conduction. A good photoanode should provide a large surface area for dye loading, nanostructure for high light harvesting opportunity, fast electron transport ability and good band gap architecture. Several nanostructure materials have been studied and employed as photoanode in DSSCs. They include TiO_2, ZnO, Nb_2O_5, and SnO_2, among others. The problem associated with photoanodes used in fabricating DSSCs is high recombination rate of electrons that emanate from the number of grains. The dispersed nature of progress reports on developments of photoanodes calls for the summary of activities on DSSCs. Hence this review gives a general summary of the progress made in various materials used as photoanode in DSSCs and the methods adopted in synthesizing them. In this present review, our attention is not only on synthesis and characterization of the materials alone, but also on the effect of parameters influencing photovoltaic characteristics of photoanode for DSSCs application.
Keywords: Photoanode, nanostructure, DSSCs, photovoltaic, conversion efficiency

NANO 2019/B051

Anti-listeria potential of *Bacillu*s spp. metabolites, its silver nanoparticles and the synergetic effect of the nanoparticles and antibiotics against some multidrug resistant (MDR) *Listeria* spp

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Biosynthesis of silver nano-composite using the metabolites of three *Bacillus* strains, their nanoparticles and the synergetic effect of the SNPs and antibiotics against some multidrug resistant (MDR) *Listeria* spp. was investigated in this study. The nanoparticles were characterized by visual examination, Fourier transform infrared (FTIR) and scanning electron microscope (SEM) and energy dispersive X-ray fluorescence (EDXRF). Surface plasmon resonance peak of 500-600 nm was observed. The biosynthesized SNPs were aggregated, rods and crystalline in shape. Carboxylic acid, amino acid alcohol, esters and aldehydes were the functional groups found in SNPs. EDX analysis showed that silver had the highest intensity of 6.0825, 5.3323 and 9.8644. The SNPs had varied anti-listeria activity against the MDR *Listeria* strains. The synergistic effect showed that BsSNPsA1 + Amoxicillin, BlSNPsA7 + Ciprofloxacin

and BmSNPsA20 + Ciprofoxacin had the highest antimicrobial activity against the MDR *L. innoccua* LA22A and *L. ivanovii* LA6. In conclusion, the *Bacillus* strains metabolites and its SNPs exhibit varied anti-listeria activities against the test MDR *Listeria* and combination with antibiotics increased the antagonistic potential. Hence, the SNPs in combination with antibiotics could be used as an alternative to commercial antibiotics against some MDR *Listeria* strains.
Keywords: *Bacillus* strains, anti-listeria, SNPs, antibiotics, MDR *Listeria* species

NANO 2019/B052
Nanobiosensors: Applications in biomedical technology

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Biosensor devices are composed of bioreceptor, transducer and detector that could be used to detect and aid in measuring parameters of some primary metabolites, immunological molecules and many materials. These devices are of various types including piezoelectric which exhibit high efficiency based on sensitivity, response time, selectivity and linearity. Currently, newly developed nanobiosensors help in transduction and are employed to sense biomolecules bearing high sensitivity. Nanobiosensors could be homogeneous or heterogeneous in nature and equally play significant roles in sensing mechanism of the biosensing technology. Thus, different nanobiosensors are widely used to reduce poison in products, for disease diagnostics and in many biomedical applications. In this work, types of nanobiosensors and bioelectrode materials, selection and optimization of nanobiosensors and nanobioelectrodes, fabrication of nanobiosensors and its application, challenges, preferred solution and future research in respect to biomedical technology have been presented.
Keywords: Nanobiosensors, biomedical technology, Biosensing technology, bioelectrode, disease diagnosis

NANO 2019/P053
Isolation and characterization of cellulose nanofibres from three common Nigeria grasses

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Nanocellulose may be in nanocrystal or nanofibre form which may be extracted from purified cellulose by different methods like dual-opposite-spinneret electrospinning, mechanical methods, a combination of chemical and mechanical methods, cryocrushing and enzymatic approaches, but the yield from grasses have not been really quantified. In this study, cellulose nanofibres

(CNFs) were extracted from three common Nigeria grasses (elephant, bermuda and carpet) by enzyme and mechanical grinding. The microgram of CNF of each grass was obtained. From the results, TEM revealed uniform CNF with width of 3.5 nm and length of 2-5 microns for all the grasses. The yield of CNF was found to be over 80% for the three grasses. Thus, it can be concluded that elephant, bermuda and carpet grasses are good eco-friendly sources of CNF for potential applications.

Keywords: Nanocellulose, nanofibres, Nigerian grasses, eco-friendly sources, application

NANO 2019/P054

Effect of low-temperature synthesized CNT and its nanocomposite on the photovoltaic performance of anode buffer layer in polymer solar cells

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Today's solar cells are simply not efficient enough and are currently too expensive to manufacture for large-scale electricity generation. However, potential advancements in nanotechnology may open the door for the production of cheaper and slightly more efficient solar cells. This research is based on the study of the photovoltaic properties of low temperature synthesized CNT nanocomposite as an anode buffer layer for the PEDOT:PSS based polymer solar cells. CNT was synthesized using simple and cost effective method at low temperature. The structural and optical characteristics of prepared samples were characterized using X-ray diffraction (XRD) analysis, Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy (SEM) and UV spectroscopy. The deposition of CNT/PEDOT:PSS nanocomposite buffer layer film devices were prepared on a glass substrate using spin coating machine at different spin coating speed, the prepared films devices were annealed from 100 to 500 ^{o}C, and its optical and electrical properties were analyzed. The XRD of synthesized CNTs nanoparticles shows diffraction pattern which exhibit tetragonal structure and FTIR shows functional group of synthesized carbon nanotube. The SEM image showed that the obtained sample maintained tubular structure, cluster at 20 nm but properly dispersed at 100 nm. The optical studies of the films indicated an increase in absorbance as the annealing temperature increases. The photovoltaic performance of the polymer solar cells had improved efficiency of 6.44 % for optimized device. It was deduced from this work that low temperature synthesized CNT nanocomposite demonstrated better performance as anode buffer layer for high efficient polymer solar cells.

Keywords: Polymer solar cells, CNT, PEDOT:PSS, nanocomposite, anode buffer layer

NANO 2019/P055

Experimental study, phenomenological and adaptive neuron analysis of creep property of *Momordica augustisepala* L nanofiber reinforced polyvinyl alcohol polymer film composite

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In the postharvest management of food, adequate knowledge of viscoelastic property is important to processing, handling, packing, shelving, transportation and storage. The packaging material used also affects the postharvest management, and active packaging material is essential to the biophysical quality preservation of food. This study investigates the viscoelastic or creep property of neat polyvinyl alcohol film and polyvinyl alcohol film reinforced *Momordica augustisepala* nanofiber composite. The applicability of Burger phenomenological model for the analysis of creep data of produced neat and composite film was investigated. The comparison of Burger model prediction efficiency to that of adaptive neuron model applied to the experimental creep data was also investigated. The instantaneous modulus and creeping speed of neat and reinforced polyvinyl alcohol is 7.53710, 10.27580 and 3.00590, 2.85391, respectively. The coefficient of determination of Burger model prediction is 0.99889 and 0.99972 for neat and composite polyvinyl alcohol film, while the coefficient of determination of adaptive neuron model is 0.99993 for both neat and reinforced polyvinyl alcohol film. The *Momordica augustisepala* nanofiber improved the viscoelastic property of polyvinyl alcohol film and adaptive neuron model shows superiority in prediction of experimental data. The result is important in material design, life prediction and usage prescription.
Keyword: *Momordica augustisepala* L, viscoelastic property, composite, nanofibre, polyvinyl alcohol film, adaptive neuron model

NANO 2019/B056

Green synthesis of silver nanoparticles from leaf extract of *Tetrapleura tetraptera* and its antimicrobial activity

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Plants have very high potential of serving as alternative source of bio-reducing and caping agents in the synthesis of nanoparticles (NPs). Silver nanoparticles (AgNPs) were synthesized from aqueous leaf extract of *Tetrapleura tetraptera*. The UV-vis spectrophotometer was used to monitor the formation of the NPs at different time intervals and ratios of plant extract to $AgNO_3$ solution. The properties of the synthesized NPs were characterized by FTIR and scanning electron microscope (SEM) equipped with energy dispersive X-ray (EDX). The antimicrobial

activity of the NPs was investigated against ten human pathogens using agar well diffusion method. The rate of formation of AgNPs was observed to increase with respect to time and ratio of plant extract to $AgNO_3$ solution. The EDX result showed signal of energy peak for silver atom at 38.27 KeV. The AgNPs displayed FTIR peaks around 3280 cm^{-1}, 1620 cm^{-1}, 1400 cm^{-1} and 1040 cm^{-1} (assigned to O-H, C-C, C–O–H and C-O groups absorption bands) as possible stabilizing and capping groups. The AgNPs showed maximum inhibitory activity against *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Penicillium notatum* and *Rhizopus stolonifer* at all concentrations.

Keywords: Silver nanoparticles, green synthesis, *Tetrapleura tetraptera*, antimicrobial activity

NANO 2019/P057

Thermophysical properties of nanoparticles of metal oxides in carboxyl methyl cellulose water mixture for heat enhancement applications

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In this work, a comparison of the thermophysical properties of three metal oxides namely titanium oxide (TiO_2), aluminium oxide (Al_2O_3) and copper oxide (CuO) dispensed in carboxyl methyl cellulose (CMC) water mixture were investigated. Maximum of 0.4 volume fraction of the nanoparticles of each of the oxides in less than 0.4 of CMC concentration in water was considered. The governing equations obtained were simplified to a set of Ordinary Differential Equations which were solved numerically using Runge Kutta Scheme (order 4) along with shooting method. Results obtained showed that the metal oxides enhanced the heat capability of the dispersing medium. Besides, the conductivity enhancement is least with CuO and maximum with TiO_2. Viscosity increased with increasing volume fraction of the nanoparticles. These results were compared with existing literature and found to be in good agreement.

Keywords: Carboxyl methyl cellulose, metal oxide, nanoparticles, Runge Kutta scheme, thermophysical properties, volume fraction

NANO 2019/B058

Biological activities and safety evaluation of chicken feather mediated silver nanoparticles

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In attempt to turn waste to wealth, this study investigated the potentials of Chicken feathers, often considered as waste, for the synthesis of silver nanoparticles (CF-AgNPs). The biological activities and safety of CF-AgNPs were then evaluated. Chicken feather (1g) was hydrolyzed with 100 ml of 0.1M NaOH at 90^{o}C for 1h. It was cooled and then centrifuged at 4000 rpm for 30 minutes. The extract (1 ml) was added to 1mM $AgNO_3$ (40 ml) to reduce Ag^{+} to CF-AgNPs. The CF-AgNPs was characterized using UV-vis spectroscopy, Fourier-transform-infrared spectroscopy (FTIR), transmission electron microscopy (TEM) and energy dispersive X-ray (EDX) analysis. Larvicidal, antioxidant, anticoagulant and thrombolytic potentials of CF-AgNPs were evaluated. Cytogenotoxicity test was evaluated by exposing 20 onions each to 0.01, 0.10, 1.0, 10.0 and 100.0 µg/ml of CF-AgNPs and $AgNO_3$ solutions. Distilled water was used as control and diluent. Chromosomal aberrations (24, 48 and 72 h) and growth inhibition (72 h) were assessed. The CF-AgNPs was greyish with surface plasmon resonance at 416 nm. Protein molecules served as capping and stabilization agents as revealed by FTIR. The CF-AgNPs had size range of 7.61-27.45 nm, caused 80-100% mortality of exposed *Anopheles* mosquito larvae in 6 h, and scavenged DPPH (33-60%) and hydrogen peroxide (84-97%). The CF-AgNPs had potential as anticoagulant and thrombolytic agent on human blood and with 32% lysis compared to 15% obtained for only extract. Cytogenotoxicity study revealed mitotic index less than half the values of the control in almost all concentrations and also induced various chromosomal aberrations. Chicken feather extract can be used for the green synthesis of nanoparticles with high biological activities. However, environmental friendliness needs further assessment.

Keywords: Chicken feather, green synthesis, silver nanoparticles, biological activities, cytogenotoxicity

NANO 2019/B059

Ecofriendly production of silver nanoparticles from the seeds of *Carica papaya* and its larvicidal and antibacterial efficacy against some selected bacterial pathogens

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Carica papaya seed extract (CPE) was used in AgNPs synthesis in this study. For the characterisation of biosynthesized particles, UV-vis spectroscopy, FTIR, FESEM and EDX were used. Antimicrobial and larvicidal efficacies of the synthesized AgNPs were assessed in the fight against certain pathogens and the *Aedes aegypti* 4th instar larvae. The absorption spectrum peaked at 433 nm in the synthesized AgNPs. With a broad peak of 3000 to 3800 cm^{-1}, different functional groups on the AgNPs surface were present in the FTIR analysis. A FESEM evaluation found a number of spherical particle structures with an average of 59.6 nm. With zones between 10-24 mm, The AgNPs synthesized inhibited selected microorganism growth. After 12 h, the nanoparticles had a 50% (LC_{50}) and 90% (LC_{90}) lethal concentration on the *Aedes aegypti* larva at 14.56 and 33.89 µg/ml, respectively. *Carica papaya*'s seed extract has biomolecules that helped to bioreduce, form and stabilize the AgNPs.This study hence demonstrates that it is possible to use *Carica papaya* seeds in AgNPs synthesis.

Keywords: *Carica papaya*, silver nanoparticles, larvicidal, antimicrobial, green synthesis

NANO 2019/B060

Synthesis, bioactivities and cytogenotoxicity of animal fur mediated silver nanoparticles

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Animal waste materials are rarely used in the synthesis of nanoparticles compared with microorganisms and plant materials. The use of animal fur (goat) in synthesis could assist in turning waste to wealth. Thus, potential of animal fur in the synthesis of silver nanoparticles (AF-AgNPs),its biological activities and safety were investigated. Animal fur (1g) was hydrolyzed with 100 ml of 0.1M NaOH at 90 ^{o}C for 1h, cooled and centrifuged at 4000 rpm for 30 minutes. The extract (1 ml) was added to 1mM $AgNO_3$ (40 ml) to reduce Ag^+ to its nanoparticles (AF-AgNPs). This was characterized using UV-vis spectroscopy, Fourier-transform-infrared spectroscopy (FTIR), transmission electron microscopy (TEM) **and** energy dispersive X-ray (EDX) analysis among others. Larvicidal, antioxidant, anticoagulant and thrombolytic potentials of AF-AgNPs were studied. Onion bulbs (20) were exposed to 0.01, 0.10, 1.0, 10.0 and 100.0 µg/ml of AF-AgNPs and $AgNO_3$ solutions for its cytogenotoxicity study with distilled water used as control. Microscopic (24, 48 and 72 h) and macroscopic (72 h) assessment of the onion cells were also studied. The AF-AgNPs was brownish with surface plasmon resonance at 419 nm. Evaluation of FTIR spectra showed that protein molecules were used as capping and stabilization agents. The AF-AgNPs had size range of 11.67-31.47 nm, caused 60-100% mortality of exposed *Anopheles* mosquito larvae in 12 h, and scavenged DPPH (40-59%) and hydrogen peroxide (75-94%). The nanoparticles also exhibited anticoagulant and thrombolytic potentials on human blood with 25% lysis compared to 13% observed for only extract. Various chromosomal aberrations and growth inhibition were induced by AF-AgNPs especially at 72 h of 100 µg/ml. Extract from animal fur was explored in biogenic synthesis of nanoparticles and found to have high biological activities though with potential to induce chromosomal aberrations.

Keywords: Animal fur, green synthesis, silver nanoparticles, larvicidal, antioxidant, cytogenotoxicity

NANO 2019/P061
Green synthesis of silver nanoparticles for optical and photocatalytic applications: a review

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Nano-size particles of silver (Ag) whose diameter falls within 1-100 nm range possess an exceptional physico-chemical, biological and antimicrobial properties. Because of their unique properties, silver nanoparticles (AgNPs) have become vigorously investigated. In the last decade, several attempts have been made to heighten the green methods of formulating AgNPs to reduce the danger of the byproducts from chemical methods. A clear understanding of AgNPs properties is absolutely necessary in other to make the best use of these nanoparticles in various fields while their effect on man and environment is reduced to the least achievable. This review aims to discuss the green synthesis method of preparing AgNPs and its numerous applications in the area of opto-electronics and environmental remediation. Many natural biomolecules in plants and microorganism were involved in formation, stabilization and bio-reduction of AgNPs. Over the years, several discoveries have reiterated that the optical and catalytic properties of AgNPs are dependent on the shape, size and size-distribution, which show variation by differing their synthetic routes, reducing agents and stabilizers. In this review, AgNPs have been reported to produce a desired result as a promising photocatalytic material and with a viable application in opto-electronic device. Thus, AgNPs are considered useful for having wide range of applications for human benefits.
Keywords: Green synthesis, silver nanoparticles, stabilizers, reducing agents, photocatalyst, opto-electronic device

NANO 2019/P062
Enhancing microhardness and minimizing coefficient of thermal expansion of Gr-Al composite with Si_3N_4 and SiC nanoparticles

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Thermal management remains an active area of research especially for applications such as automobile pistons, dies in furnaces and heat sinks in electronics where higher thermal conductivity and lower coefficient of thermal expansion are required. This study is aimed at improving the thermal conductivity while reducing coefficient of thermal expansion (CTE) of

Gr-Al composite by incorporating silicon nitrate (Si_3N_4) and silicon carbide (SiC). Si_3N_4 and SiC particles (average size of 72 nm) were obtained after 30 and 50 h of ball-milling, respectively. Gr-Al composite reinforced with four fractions of Si_3N_4 particles (4, 8, 12 and 16%) was sintered at a temperature of 560 ^oC, pressure of 50 MPa, heating rate of 50 ^oC/min and dwelling time of 10 min using spark plasma sintering system. The sintered samples were characterized for morphology, microhardness, relative density, coefficient of thermal expansion and electrical conductivity. Addition of 16 wt% Si_3N_4 reduced relative density to 89.47% indicating lower densification. Also, CTE decreased with increased Si_3N_4 fraction reaching minimum value of 12.37 x $10^{-6}/^oC$ (which is 42.5% reduction) upon addition of 12wt% Si_3N_4. However, addition of 8wt% SiC + Si_3N_4 lead to composite with negative CTE (-21 x $10^{-6}/^oC$). While the hardness was marginally increased with Si_3N_4, addition of 16wt% SiC + Si_3N_4 raised the hardness by 37%. These results are indications that thermal expansion can be minimized while enhancing microhardness of Gr-Al by addition of SiC + Si_3N_4.

Keywords: Silicon nitrate, silicon carbide, thermal expansion, Gr-Al composite, microhardness

NANO 2019/B063

Antidiabetic properties of gold nanoparticles synthesized from *Datura stramonium* seed

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The green synthesized gold nanoparticles (AuNPs) from *Datura stramonium* seed was investigated for its antidiabetic properties in this study. A total number of 42 healthy male albino rats with body weight ranges of 150-200 g were purchased and acclimatized for 7 days after which they were randomly selected into 7 groups (A-G) of 6 animals each. Group A, the control were not induced, while the other six groups (B-G) were induced with 150 mg/kg of Alloxan by intraperitoneal administration and after 72 h, hyperglycemia was confirmed by measuring the tail vein blood glucose with an Accu-Check sensor comfort glucometer. Only the animals with fasting glucose levels (5.6-6.9) were considered diabetic. Group B received no treatment, group C was treated with 1500 µg/kg of *Datura stramonium* seed extract, group D was treated with 500 µg/ml of synthesized AuNPs, group E was treated with 750 µg/ml of synthesized AuNPs, group F was treated with 1000 µg/ml of synthesized AuNPs and group G was treated with 1000 µg/ml of standard drug (glibenclamide). The treatments were administered every day for 21 days. The result of the experiment showed that the weight of the experimental animals reduced after diabetes induction, but after 21 days of treatment the weight of the treated groups increased as compared to the untreated group. Furthermore, it was observed that after the treatment with 500 and 750 µg/ml AuNPs, the blood sugar was down regulated unlike the untreated groups. Due to the alloxan induction, there were increase in aspartate aminotransferase

(*AST)*, alanine aminotransferase (ALT), *alkaline phosphatase* (ALP), urea and creatinine levels in the serum of experimental rats, which were significantly reduced after the treatment with *Datura stramonium* seed extract and the synthesized AuNPs at 500 µg/ml, 750 µg/ ml and 1000 µg/ ml. The histopathology of the pancreas of alloxan induced rats showed severe fibrotic interlobular connective tissues with severely diffused, degenerated and necrotized islets of langerhans which were also normalized by treatments with AuNPs. It was established in this study that AuNPs could be embedded in drugs or folk medicine aimed at reducing blood sugar levels.

Keywords: Nanoparticles, antidiabetic, alloxan, blood sugar, diabetics, histology

NANO 2019/B064
Effects of biogenic silver and zinc oxide nanoparticles on growth and biochemical composition of soybean (*Glycine max*)

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Green synthesis of silver and zinc oxide nanoparticles was carried out using *Chrysophyllum albidum* leaf extract as the reducing agent and the effects of the nanoparticles on growth and biochemical composition of soybean (*Glycine max*) were studied. The synthesized nanoparticles were characterized through UV-vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). Dry seeds of soybean were soaked in different concentrations (5, 10, 15, 20, and 25%) of the biogenic nanoparticles before planting and also irrigation of the plant with the nanoparticles was done at 14-day interval before the onset of flowering. Data were taken on growth (vegetative and yield parameters) and biochemical composition of the seeds. The UV-vis absorption maxima showed peak absorbance at 440 and 344 nm which is characteristic of silver and ZnO nanoparticles respectively. There were positive effects of the nanoparticles on some of the parameters such as plant height (36.31 cm), leaf length (6.18 cm), leaf breadth (4.45 cm) and number of pods per plant (10.87) when compared with the control using SPSS. However, there was an inhibitory effect on number of branches per plant. The study revealed the possible application of nanoparticles on improvement of crop plants.

Keywords: Green synthesis, *Chrysophyllum albidum*, *Glycine max*, silver nanoparticles, zinc nanoparticles, plant growth

NANO 2019/B065
Removing the recalcitrant nature of Africa star apple seed using silver nanoparticles

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Silver nanoparticles (AgNPs) was synthesized biogenically using *Chrysophyllum albidum* fruit extract as the reducing agent and the effects of the nanoparticles on seed germination and seedling growth of an indigenous and endangered fruit tree; *Chrysophyllum albidum* investigated. The synthesized nanoparticles were characterized through UV-vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), and scanning electron microscopy (SEM). Dry seeds of the tree were soaked in different concentrations (10, 20, and 40%) of the synthesized AgNPs, for different time interval of 1, 4 and 8 days respectively before planting. Data taken include germination percentage, number of days to germination, and seedling height. The UV-vis absorption showed peak absorbance at 438 nm. Higher percentage (50%) of seed germination was found in treated seeds when compared with the control (27%) using SPSS statistical package. The possible use of AgNPs in breaking of seed dormancy is hereby revealed and its application in conservation of the genetic resources of endangered plant species.
Keywords: Green synthesis, *Chrysophyllum albidum*, dormancy, recalcitrance, silver nanoparticles, Africa star apple

NANO 2019/B066
Surface sterilization of *Ocimum* seeds and tissues with biosynthesized nanosilver and its effect on callus induction

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Plant tissue culture is a basic and fundamental component of plant biotechnology and nowadays, nanomaterials especially nanosilver (NS), are being used as an antimicrobial agent for the surface sterilization of explants in tissue culture. In this study, biosynthesized nanosilver (BNS) was used for the surface sterilization of *Ocimum* seeds and tissues and its effects on callus induction were also evaluated. The seeds and tissues were exposed to different concentrations of BNS (10, 50 and 100 mg/l) as well as 5% Clorox for five different exposure times (5, 10, 20, 30 and 60 min) and their effects on germination, callus induction and surface sterilization were determined.The BNS was found to be very effective on surface sterilization as 100% decontamination were achieved with no adverse effect on explant viability and callus formation but rather has stimulating effect on callus formation. On the basis of the data obtained, the study concluded that BNS can be used as an antimicrobial agent in surface disinfection of explants

therefore extending the frontiers of the potential application of biosynthesized nanosilver in tissue culture.

Keywords: Tissue culture, *Ocimum,* explants, callus, nanosilver, disinfection, plant biotechnology

NANO 2019/P067

Green synthesis and characterization of zinc oxide nanoparticles using Siam weed (*Chromolaena odorata*) extract and evaluation of its properties for photoanode of crystalline solar cells

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Effort has been intensified in the field of research for nanomaterials to bridge the gap for energy supply in this century. A plant-based material that may provide solutions to the current energy crises may be found in nanomaterials. Green synthesis of nanoparticles using plant extract is gaining importance as an alternative to conventional chemical and physical methods of synthesis, because of its simplicity and environmental friendliness. Bitter bush leaf extract was used to synthesize zinc oxide nanoparticles **(**ZnONPs). Optical properties of fresh leaves aqueous solution extracted were characterized immediately after extraction and characterization was carried out for some days after to study the effect of time on the optical properties. The ZnONPs was deposited by spin-coating method to form anode film device. The film was characterized using UV-vis spectroscopy, Fourier transform infra-red spectroscopy, scanning electron microscopy, and energy dispersive X-ray. The result showed that day 1 extracted solution had the highest optical absorption of photon energy. FTIR observation showed that absorption number occurred at 3448.04, 2524.85, 1437.15, 880.59, 729.06 and 433.44 cm^{-1}. SEM images of nanoparticles were flower-like. The surface morphology showed large grain size. The fabricated device under illumination has efficiency of 0.9% at temperature of 100 ^{o}C. From the morphology, optical, and electrical properties of the fabricated film device based on synthesized ZnONPs, the device could be suitable for photoanode of crystalline solar cell.

Keywords: Zinc oxide nanoparticles, *Chromolaena odorata*, photoanode, solar cell, optical properties

NANO 2019/P068

Influence of synthesis parameters on the morphology, purity and phases type of nano-CuO particle

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In this study, copper oxide nanoparticles were produced using an environmentally friendly method involving the mixing of copper salt precursors and aqueous leaf extract of *Khaya senegalensis.* The influence of pre and post synthesis parameters such as solution pH (5, 9, 11, 13), copper salt types (chloride, nitrate and sulphate), calcination temperature (300-550 ^{o}C) and holding time (1-3 h) on the morphology, sizes and phase structure of CuO nanoparticles were examined. The synthesized materials were characterized by energy dispersive spectroscopy (EDS), high resolution scanning electron microscope (HRSEM), Brunauer Emmett Teller (BET) N_2 adsorption-desorption, X-ray photoelectron spectroscopy (XPS), and X-ray diffraction (XRD). The HRSEM/XRD analysis of the calcined CuO nanoparticles showed the formation of spherical and crystalline stable tenorite phase at optimum calcination temperature (550 ^{o}C), and optimum holding time (3 h) for all the salt precursors except for cupric acetate at pH of 7 and 13 with no defined shape. The XRD results also revealed that the average crystallite size of CuO nanoparticles increased with increasing temperature and holding time. The optimum condition to prepare CuO nanoparticles was using copper sulphate salt and solution pH 11. This study demonstrated that the shape, size and phase of CuO nanoparticles were dependent on the nature of the copper precursor, solution pH, calcination temperature and holding time.

Keywords: Synthesis parameters, CuO nanoparticles, green method, phase types

NANO 2019/P069

Preparation of flamboyant pod (*Delonix regia*) activated carbon modified with multi-walled carbon nanotubes for simultaneous removal of iron (Fe^{2+}), zinc (Zn^{2+}) and phenol from oil refinery wastewater

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Oil refinery wastewater consists of organic and inorganic pollutants which constitute both health and environmental hazards, thus their removal before being discharged to the environment is imperative. Adsorption had been found to be an effective wastewater treatment method due to its cost-effectiveness, flexibility and ease of operation. Tremendous research efforts have been geared towards finding an efficient and cost-effective adsorbent for pollutants removal from wastewater. This work evaluated the removal efficiency of pod of flamboyant tree (*Delonix regia*) activated carbon (FPAC), multi-walled carbon nanotubes modified flamboyant pod activated carbon (MWCNT-FPAC) and multi-walled carbon nanotubes (MWCNTs) on the simultaneous uptake of phenol, Zn^{2+} and Fe^{2+} from refinery wastewater via batch adsorption process. A low-cost activated carbon was prepared from flamboyant pod and then modified with MWCNTs. The synthesized adsorbents were characterized using BET, SEM, and FTIR for surface area, morphology, and functional groups determination, respectively. Effects of contact time, adsorbent dosage and temperature on the removal of phenol, Zn^{2+} and Fe^{2+} from oil refinery wastewater were investigated. The BET results revealed that the BJH surface areaof the adsorbents were 869.25, 471.27 and 464.95 m^2/g for (MWCNTs), (FPAC), and MWCNT-FPAC, respectively. SEM showed that the adsorbents have excellent morphology which could enhance the uptake of pollutants from wastewater. The maximum removal efficiencies at optimum conditions were Fe^{2+} (88.35, 98.7 and 99.7%), Zn^{2+} (89.1, 92.94 and 99.1%) and phenol (69.07, 77.35, 81.62%) using FPAC, MWCNT-FPAC and MWCNTs, respectively. The results showed that MWCNT modification of FPAC improved its performance as a cost-effective treatment of refinery wastewater.

Keywords: Flamboyant pod, *Delonix regia*, multi-walled carbon nanotubes, activated carbon, adsorption, oil refinery, wastewater, Zn^{2+}, Fe^{2+}, phenol

NANO 2019/P070
Sol-gel synthesis of kaolin/TiO_2 nanocomposites for adsorption of zinc and chromium ions in tannery wastewater

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In this study, a TiO_2 immobilized on kaolin was synthesized by sol-gel method. The chemical and phase composition, particle morphology and surface area of the nanocomposites were investigated using X-ray diffraction (XRD), scanning electron microscope (SEM) and N_2 adsorption/desorption isotherm. The activity of these nanocomposites was studied in the adsorption of zinc and chromium ions in tannery wastewater. The specific surface area of kaolin/TiO_2 nanocomposites (53.80 m^2/g) exhibited a significant increase compared to kaolin (17 m^2/g). The adsorption activities of the nanoadsorbents were found to be depended on the surface area, thus influencing the adsorption properties of the nanocomposites such as rate, efficiency and capacity. Thus, the synthesized kaolin/TiO_2 nanocomposites showed promising technical advantages for wastewater treatment and also paved a way to immobilize other nanoparticles on kaolin.
Keywords: Kaolin, sol-gel, nanocomposites, adsorption, surface area, TiO_2, wastewater treatment

NANO 2019/P071
Optical studies of silver/gold/titanium dioxide (Ag/Au/TiO_2) nanocomposites as photoanode in dye sensitized solar cells

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In dye-sensitized solar cells (DSSCs), the performances of the photoanodes depend on the band gap of the semiconducting nanomaterials. Large band gap of titanium dioxide (TiO_2) usually used in preparation of photoanode limits its absorption to the ultraviolet part of the solar spectrum. Another drawback of TiO_2 is low electron mobility through it. In this study, optical studies Ag/Au/TiO_2 nanocomposites as photoanode was carried out in other to test the possibility of improving the efficiency of the DSSCs. Dye molecule was extracted from the leaves of *Mimosa pudica* using ethanol as solvent. Ag/Au/TiO_2 were deposited on a glass substrate using doctor blade method, the deposited thin films were annealed in a furnace at 450 ^oC for one hour after which the annealed thin films were dye loaded for 12 hours with *Mimosa pudica* extract. The dye loaded thin films of Ag/Au/TiO_2 were then characterized with a UV-vis Spectroscopy to

get the transmittance. The absorbance and the optical band gap were calculated. The optical absorption spectra and optical band gap spectra of Ag/Au/TiO_2 thin films were examined. The maximum absorption was observed within the range of the visible region when the positions of Ag/Au/TiO_2 are of equal ratio at 1 mg/$dm^3$and optical band gap of 3.93ev. It is anticipated that the performance characterization with further research on TiO_2 incorporated with Ag/Au nanocomposites using *M. pudica* extract, as a sensitizer will enhance the development of a reliable and competitive dye sensitized solar cell.

Key words: Dye sensitized solar cells (DSSCs), Thin films, *Mimosa pudica*, photoanode, Ag/Au/TiO_2, nanocomposite

NANO 2019/B072
Application of nanotechnology in libraries: Olusegun Oke library, LAUTECH, Ogbomoso in perspective

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This study is an exploratory examination of applications of nanotechnology in libraries with particular reference to its manifestations at the Olusegun Oke Library, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. In today's information world, everybody is experiencing an information overload; even today's scientists experience it on a particularly extreme level. Scientists and policy makers have used several strategies to manage this modern-day glut of data but all to no avail. Now they have begun thinking about "the Nano Library" or "nanoinformatics" and how to manage accumulating information about the nanoworld. Managing information – selecting, organizing, standardizing, sharing and preserving – are the crux of library work from time. The library has been embracing technology and innovation to meet the challenges of information overload, from time immemorial and these could be seen in security of the library materials as well as space conservation and management. The library world over, have been applying technology for acquiring, processing, sharing, preserving and securing library materials for immediate and future usage. Therefore, to further preserve and secure library materials, the library had embraced technologies such as slides production, microforms (microfilms, microfiche), digitization, and of recent, nanofiche technology. Example is the miniaturized Lunar Library launched on the moon in April, 2019 by the Arch Mission Foundation. This study therefore, seeks to explore the developmental applications of technology in libraries, from the past to the present and the manifestations of the applications of nanotechnology at the Olusegun Oke Library. The study concluded by suggesting among others, establishment of universal standards for reporting data by the library.

Keywords: The Nano Library, nanoinformatics, library security, preservation, space management in libraries, Olusegun Oke Library

NANO 2019/B073
Antioxidant, antimicrobial and thrombolytic activities of nano-mycomeat produced through solid state fermentation

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Bacterial deterioration is one of the most critical subjects in the production, processing, transport, and storage of foods. Novel nanoantimicrobials have shown promising effects on safeguarding food deterioration, thereby extending the shelf life of food. In this study, mycomeat samples were produced using cassava pulp (C) and tiger nut aggregate waste (T). The mycomeat extract was used to produce nano-mycomeat. The antioxidant, antimicrobial and thrombolytic activities of the mycomeat extracts were determined using established methods. The nano-mycomeat of both C and T showed increased antioxidant, antimicrobial and thrombolytic activities compared to the extract only. This can find applications in the packaging of food, thereby preventing food samples from deterioration.
Keywords: Nano-mycomeat, antioxidant, antimicrobial, food spoilage, cassava pulp, tiger nut

NANO 2019/B074
Green synthesis of silver nanoparticles using the pod extract of *Cassia fistula* and its antimicrobial activity

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Silver nanoparticles (AgNPs) have been found very useful in biomedical field. This study reports the green synthesis of AgNPs using the pod extract of *Cassia fistula* as the bioreducing agent. The green synthesized AgNPs were characterized using UV-vis spectroscopy and Fourier transform infra-red (FTIR) spectroscopy. The antimicrobial activity of the synthesized AgNPs against some clinical isolates was also investigated. The maximum peak for the synthesized AgNPs was observed at 440 nm. The FTIR result confirms the involvement of biomolecules in the formation of AgNPs. The AgNPs showed zones of inhibition against *Klebsiella pneumoniae* (15±1.0 mm), *Escherichia coli* (16.3±0.73 mm), *Staphylococcus aureus* (15±1.13 mm), but did not show any zone of inhibition against *Candida albicans*. The present study shows that the AgNPs have considerable antibacterial activity that may be useful for the formulation of new drug.
Keywords: Silver nanoparticles, *Cassia fistula*, antimicrobial, green synthesis

NANO 2019/B075
Silver nanoparticles synthesized from laccase obtained from the fermentation of banana peel by *Rhizopus oryzae* AB221

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This study reports the production of laccase towards optimization for the synthesis of silver nanoparticles using *Rhizopus oryzae* AB221 isolated from the soil. Fungi were isolated from the soil, identified and screened for their ability to produce laccase. The selected fungi were characterized. The characterized fungi were used for the production of laccase using banana peel under submerged condition. The crude enzyme was used for the synthesis of AgNPs. Synthesized nanoparticles were characterized by UV-visible spectroscopy and Fourier transform infrared (FTIR) spectroscopy. Antimicrobial activity of the biosynthesized AgNPs from laccase was tested against six clinical isolates. Dye degrading ability of crude laccase and biosynthesized AgNPs from laccase was also investigated. Only *Rhizopus oryzae* and *Aspergillus oryzae* showed abilities to produce laccase by forming reddish brown zone after five days of growth on PDA plate supplemented with 0.02 % guaiacol. *Rhizopus oryzae* was selected for further studies, whereby fermentation was carried out for 8 days under submerged state. Laccase activity of 1.37 U/ml/min was obtained after eight days of fermentation. From this study, pH 5.0 at 30 ^{o}C was found to be the best condition for the production of laccase. UV-visible spectroscopy indicated the formation of AgNPs at absorption band of 422 nm. FTIR result indicated that proteins were responsible for AgNPs synthesis. The biosynthesized nanoparticles revealed effective inhibition against the selected clinical isolates. Biosynthesized AgNPs from laccase showed better ability to degrade the dyes used in this study. This report adds to the growing relevance of *R. oryzae* as potential industrially viable organism, used for diverse biotechnological applications and its ability to produce laccase.
Keywords: *Rhizopus oryzae*, laccase, silver nanoparticles, green synthesis, antimicrobial activity, dye degradation

NANO 2019/P076
Synthesis, characterization and applications of nanoparticles in wastewater treatment: a review

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Water pollution has become a serious problem in many part of the world due to the contamination of available water resources by wide variety of contaminants such as dyes, other organic pollutants (including pharmaceuticals, plastics, and agrochemicals), and inorganic pollutants such as heavy metals, cyanide and organometallic compounds. Most of these

chemicals get into aquatic environment through the discharge of untreated or poorly treated wastewater from textile, metallurgical, food, agrochemicals, pharmaceutical and allied industries. Application of nanotechnology is gaining a lot of interest recently due to the high cost of the already existing technologies. In this article, various methods of synthesizing nanoparticles, their characterization and applications have been discussed. Special emphasis has been laid on the application of nanoparticles in wastewater treatment. Various metallic nanoparticles and composites have been investigated for their potential to remove organic and inorganic pollutants from wastewater. However, many of the applications studied are limited to laboratory scale; they are yet to be employed commercially due to cost on large scale, environmental concerns and technical challenges. The environmental impact of the synthesized nanoparticles should be further examined before it can be considered as a full scale treatment options for wastewater.
Keywords: Wastewater, adsorption, nanotechnology, characterization, green synthesis

NANO 2019/B077
Biosynthesis and optimization studies of iron nanoparticles produced by *Trichoderma* species

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There is an increasing global search for bioresources that allow a commercially and environmentally clean synthesis of noble metal nanoparticles. However, there is paucity of information on the production of iron nanoparticles by filamentous fungi which gives greater yield. This study reports the biosynthesis and characterization of iron nanoparticles by *Trichoderma* species obtained from soil samples from locations in Abeokuta. Filtrates obtained from biomass of pure cultures grown (72 h) in potato dextrose broth were reacted with 1 M ferric chloride solution. A change in coloration monitored by ultraviolet-visible (UV-Vis) spectrophotometer (200-600 nm) as compared with control (ferric chloride solution) indicated a positive result. Nanoparticle in the most reactive filtrate was further characterized using ultraviolet-visible spectroscopy and Fourier infrared spectroscopy (FTIR). The effect of parameters such as agitation, pH and temperature was monitored. The UV-vis spectra revealed the peak of absorbance of synthesized nanoparticles by selected *Trichoderma* species at 275 nm. Nanoparticle biosynthesis measured by absorbance reading at 275 nm increased in production with agitation (0.7) than without agitation (0.25) of cultures. A peak in production (0.72) at pH of 4.5 and a further decrease with increasing pH was also observed. A consistent decline in absorbance values (0.72-0.35) at pH 4.5 was recorded. Results of FTIR for the determination of stability of nanoparticles showed peaks of transmittance between750-3750 cm^{-1}. Characteristics of extracellular iron nanoparticles synthesized by *Trichoderma* species isolated from this study, presents them as stable with potential biotechnological applications.
Keywords: Iron nanoparticles, *Trichoderma* species, biosynthesis, optimization, bioresources

NANO 2019/B078
Growth inhibitory potentials of green-synthesized nanoparticles from cocoa pod and seed on clinical and environmental pathogens

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The return of the pre-antibiotic era remains an increasing fear due to the escalating reports of resistance to last resort antibiotics among critical priority pathogens. There is a growing reputation of green-synthesized silver nanoparticles (SNPs) due to its efficacy, bio-friendliness and cost-effectiveness. This research demonstrated the potentials of silver nanoparticles synthesized from cocoa seeds and pods as antibacterial agents against multidrug clinical and environmental bacterial pathogens. The antibiogram of the test organisms was determined using the disc diffusion method. Subsequently, the assessment of the inhibitory potential of the silver nanoparticles against the MDR strains was performed using agar well diffusion assay and broth dilution technique. Most of the isolates showed notable resistance to penicillins, cephalosporins and carbapenems. Notably, the cocoa seed nanoparticles exhibited a fairly stronger antibacterial activity against the isolates including strains of *Pseudomonas aeruginosa* and *Escherichia coli*, than the cocoa pod and chemically-synthesized nanoparticles. The minimum inhibitory concentration of the nanoparticles against the susceptible isolates was ≤100 µg/ml. The growth inhibitory capacities of these biosynthesized silver nanoparticles on MDR strains at a considerably low concentration project their potentials as a viable approach with explorable antibacterial activities.
Keywords: Green synthesis, nanoparticles, pathogens, multidrug resistance, *Escherichia coli*, *Pseudomonas aeruginosa*

NANO 2019/B079
Optimization studies on biosynthesis of iron nanoparticles using *Rhizopus stolonifer*

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The simple, cost effective, reliable and ecofriendly nature of biological entities have resulted in the continued exploration of relatively new and rapidly growing area of nanotechnology using fungal biomass. This study reports the biological synthesis of iron nanoparticles using *Rhizopus stolonifer*. Pure cultures of *R. stolonifer* were obtained and identified by standard procedures from soil samples. Isolates were aseptically grown in potato dextrose broth to early exponential phase. Filtrates obtained by simple methods were reacted with 1 M Ferric chloride solution to screen for production of iron nanoparticles. Isolate the most reactive filtrate observed from the colour changes in solutions compared, was selected for further studies. Characterization of the synthesized iron nanoparticles was monitored using Ultraviolet-visible spectrophotometry (UV-

vis) and Fourier transform infrared spectroscopy (FTIR). The effects of agitation, pH and temperature in the synthesis of iron nanoparticles by selected *R. stolonifer* were carried out. The spectra of the nanoparticles produced by selected isolate showed peak of absorbance at 325 nm. Peaks of transmittance of biosynthesized iron nanoparticles from selected isolate as shown by the FTIR spectrum were located within 617.4 cm^{-1} to 3908.6 cm^{-1}. An increased production by over 200% occurred when culture of selected isolate was agitated. At 325 nm, peaks of absorbance (3.5) were read at pH 4.5 and 6, while maximum production of the iron nanoparticles was reached at 35 ºC. The wide range of transmittance and pH reported presents the selected *R. stolonifer* isolate as a biological entity for synthesis of stable iron nanoparticles.

Keywords: Iron nanoparticles, *Rhizopus stolonifer*, optimization, biosynthesis, nanotechnology

NANO 2019/P080
Assessment of the interfacial shear bond strength of normal concrete to steel fibrous concrete for retrofitting concrete structure

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This paper presents an experimental study carried-out to assess the interfacial bond strength between normal concrete (NC) and steel fibre reinforced concrete (SFRC) substrate. Steel fibre from binding wire was incorporated as reinforcing agent in the fibre reinforced concrete to investigate its effect on bonding strength. As comparisons, SFRC containing fibre of varying volume of 0.5, 1.0, 1.5, 2.0% were prepared. Two tests were conducted to investigate the bonding between two substrates - slant shear and splitting tensile tests. After critical condition surface (smooth surface) was prepared, the effect of bonding was determined using mohr-coulomb theory. The outcome of the experimental test point out that SFRC incorporating fibre of 1.0% volume fraction improved the bonding to normal concrete. This result indicates that the bonding strength of NC to SFRC at critical condition is affected by self-adhesion of SFRC to the normal concrete. The self-adhesive characteristic of SFRC to normal concrete can be easily identified in mohr-coulomb analysis. Conclusively, the SFRC incorporating fibre of 1.0% volume fractionat a fibre length of 40 mm could improve the bonding to the normal concrete.

Keywords: Steel fibre reinforced concrete, concrete to concrete bond, mohr-coulomb, bonding strength, pure shear strength

NANO 2019/P081
Green concrete production incorporating kenaf fibre and sorghum husk ash

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Due to the growing amount of waste generation from agricultural products, there has been a developing interest in the utilization of waste in producing building materials to achieve potential benefits. This paper highlights the results of an experimental investigation on the performance of concrete incorporating kenaf fibre (KF) and sorghum husk ash (SHA) as partial replacements of ordinary Portland cement (OPC). Five volume fractions of kenaf fibre varying from 0 to 1.0% at an interval of 0.25% with a uniform length of 50 mm was used with OPC concrete mixes. Another five mixes were made that replaced OPC with 10% SHA. The specimens were cured in water and tested for fresh and hardened state properties. The combination of kenaf fibre and SHA decreased the slump values and increased the VeBe time of fresh concrete. The addition of kenaf fibre to either OPC or SHA concrete mixes showed a positive interaction that led to high tensile and flexural strengths, thereby increasing the concrete ductility with higher energy absorption and improved crack distribution. The maximum increases in tensile and flexural strengths compared to those of plain concrete were achieved by the addition of 0.5% kenaf fibre at the age of 56 days. The study showed that the use of KF and SHA in the production of sustainable green concrete is technically and environmentally achievable.
Keywords: Building materials, concrete, kenaf fibre, sorghum husk ash, sustainable green concrete

NANO 2019/P082
Feasibility of improving impact resistance and strength properties of sustainable concrete composites by adding kenaf fibres

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Waste materials utilization is one of the central concerns of waste management approaches in recent years. The developments in cement and concrete technology towards the production of sustainable concrete by using waste materials and cellulosic fibre is gradually attaining acceptance because of its technological, economic and ecological advantages. This paper presents the potential use of a natural fibre known as kenaf fibre and rice husk ash (RHA) from agricultural waste towards achieving a bio fibrous concrete with enhanced impact resistance and strength properties. Four mixes with varying percentages of RHA from 0 to 15% at an interval of 5% without fibre. Another four mixes were made with 50 mm length fibre of 0.5% volume fraction and RHA of 0 to 15% as supplementary cementing material. It was found that the addition of kenaf fibre decreased the slump values and increased the VeBe time of fresh

concrete. At later ages, the compressive strength of the fibrous concrete mixtures containing RHA significantly increased and the obtained values were higher than that mixes with OPC alone. The positive interaction between kenaf fibres and RHA leads to high tensile strength, flexural strengths and impact resistance, thereby increasing the concrete ductility with higher energy absorption and improved crack distribution. It is concluded that waste Kenaf fibre and rice husk ash can be used as building materials in the construction of sustainable concrete.
Keywords: Agricultural waste, concrete, kenaf fibre, natural fibre, rice husk ash

NANO 2019B/083
Morphological assessment of the leaves of *Solanum nigrum* (L.), *Amaranthus hybridis* and *Celosia argentea* cultivated using kola pod extract-mediated AgNPs

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In this study, assessment was made on the morphology of the leaves of *Solanum nigrum, Amaranthus hybridis* and *Celosia argentea* vegetables cultivated using kola pod extract-mediated AgNPs as bio-fertiliser. A pot experiment was conducted to cultivate the three vegetables on soil from botanical gardens, LAUTECH in 5 kg soil capacity pot with the AgNPs used as biofertilizer. The leaves were collected at the onset of flowering stage and prepared for viewing with a binocular light microscope (Olympus) at 100X and 400X magnifications. Photographs were obtained digitally with Android phone using Microsoft image programme for windows. Statistical analysis of variance was done used MINITAB release 17, and means were separated with Fisher's Least significant different at $p<0.05$. Leaves of plant treated with AgNPs have their microorgans (stomata, trichomes and subsidiary cells) bigger in sizes and increased in densities. It can be concluded that kola pod extract-mediated AgNPs influenced the micro-morphological identification of leaves of the three vegetables in this study, and is of taxonomic significance.
Keywords: Micro-morphology, cultivated, vegetables, Kola pod extract-AgNPs, light microscopy

NANO 2019/084
Application of nanoparticles synthesized using edible mushrooms: a review

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Mushrooms today have become one of the most important groups of higher fungi that have attracted great attention because of their biotechnological applications. They have been cultivated and traditionally consumed in different societies where they have been employed in

culinary uses. It is also believed that consumption of some edible mushrooms improves health due to their possession of medicinal and therapeutic properties. Mushrooms are known to contain many different bioactive compounds with diverse biological activity. Enzymes produced by mushroom have also found use in food industry, dye industry, bioremediation and waste treatment/bioconversion. Nanotechnology, a rapidly growing area of research has also found application in the different spheres of science. With nanotechnology, production, manipulation, and use of materials ranging in size from less than a micron to that of individual atoms has been made possible in biological application. The production of nanomaterials of biotechnological applications from edible mushroom has revealed a greater dimension of applicability of edible mushrooms. The present review also provides some information on potential and application of nanoparticles synthesized from some commonly available edible mushrooms in medicine, food industry and dye industry.

Keywords: Nanotechnology, edible mushroom, biotechnology, nanomaterials, applications

NANO 2019/P085
Synthesis and antimicrobial studies of some strontium-hydrazone complexes

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Ligands (hydrazones) and complexes were synthesized for investigation of their antimicrobial activities. Esters were synthesized and hydrazides prepared from each ester. The hydrazides were reacted with benzaldehyde to produce hydrazones which are, benzoylhydrazone, m–nitrobenzoylhydrazone, p–nitrobezoylhydrazone, 3, 5–dinitrobenzoylhydrazone, p–aminobenzoylhydrazone and m–aminobezoylhydrazone in white, off white, light yellow, deep yellow, and light brown colours. Complexes of the ligands were synthesized from strontium chloride and hydrazones which gave off–white, grey, light brown and dark brown colours. The complexes were analyzed through complexometric titration, while both the ligands and the complexes were characterized on the basis of spectra data. Metal to hydrazone stoichiometry of 1:0.5 to 1:3 were proposed for the complexes. Relevant infrared bands in the hydrazones and complexes were used to assign possible points of coordination. Physicochemical measurements of both the hydrazones and the complexes were determined. Antimicrobial activities of the compounds were examined on *Streptococcus faecalis, Clostridium sporogenes, Bacillus anthracis, Pseudomonas fluorescens, Saccharomyces cerevisiae* and *Hansenula anomala* with good performance. There is a possibility of nanohybrid antimicrobial improvement on the synthesized compounds on further research work in future.

Keywords: Aromatic-hydrazone, Strontium-hydrazone complexes, infrared spectra, antimicrobial activities, nanohybrid

NANO 2019/P086 (work-in-progress)
Preliminary investigation of metakaolin blended cement mortar incorporating nanosilica

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The idea of sourcing for innovative construction supplementary cementitious materials (SCM) in concrete or mortar cannot be overemphasized. Metakaolin has always been used to replace cement in concrete or mortar batching on site. This research will investigate the properties of factory produced blended cement using metakaolin from three different sources and consider effects of nanosilica on blended cement mortar. The kaolin sourced from three different sites in Ekiti state will be calcined at 700 ˚C for 1 h and thereafter, characterized using X-Ray fluorescence analyzer (XRF) and X-ray diffraction analysis (XRD). Ordinary Portland Cement (OPC) clinker and 10% metakaolin shall be used to produce blended cement. Liquid nanosilica will be synthesized from cola pod extract and silica precursor in ratio 1:5. A sand-cement ratio of 1:3 and water/binder ratio of 0.5 will be used to produce metakaolin blended cement mortar with addition of nanosilica in varying percentages of 1, 2, 3, 4 and 5% by weight of the binder. The mortar specimens of size 40 x 40 x 160mm produced will be cured in water for 3,7, 14, 28, 56, 90, 180, 270 and 365 days and tested for flexural and compressive strength, water absorption and microstructural properties. The results obtained will be subjected to descriptive and inferential statistical analysis using Analysis of Variance (ANOVA).
Keywords: Blended cement, metakaolin, nanosilica, flexural strength, compressive strength, water absorption

NANO 2019/P087
Optimization of green synthesis of silver nanoparticles by response surface method (RSM)

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In this study, the influence of synthesis parameters such as temperature, pH, volume of precursor and volume of extract on the crystallite size of silver nanoparticles synthesized via plant extract of *Piptadeniastrum africanum* were investigated using 2^4 factorial experimental design. The optimum condition for the synthesis were pH 8, reaction temperature 35 ^oC, the ratio of the volume of extract to the volume of precursor was kept at 1:10, while the concentration of aqueous silver nitrate ($AgNO_3$) was maintained at 1 mM. The synthesized nanoparticles were characterized by X-ray diffraction (XRD) and high resolution scanning electron microscopy (HRSEM) fitted with energy dispersive spectroscopy (EDS). The HRSEM and XRD analysis

showed that the morphology of the nanoparticles is spherical in shape with an average crystallite size of 20-25 nm.

Keywords: Synthesis parameters, crystallite size, nanoparticles, green synthesis, factorial experimental design, characterization

NANO 2019/B088

Spondias mombin leaf extract mediated biosynthesis of Silver-Titanium alloy nanoparticles: its antimicrobial, antioxidant and larvicidal activities

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This study investigated the suitability of *Spondias mombin* leaf (SmL) for the mediation of Ag-TiO_2 alloy nanoparticles. The alloy nanoparticles were characterized by UV-vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy, energy dispersive X-ray (EDX) spectroscopy and X-ray diffraction. The ability to scavenge free radicals was done using 2, 2-dipheny-1-picrylhadrazyl, its antimicrobial activity was determined on some clinical isolates, and larvicidal activities were evaluated. The Ag-TiO_2 absorbed maximally at 400 nm, while -OH, C-H, C=C were the prominent functional groups in the synthesis nanoparticles. SEM-EDX results showed uniform crystals with prominence of silver and titanium, while XRD results showed 2Ɵ with peaks at 22.49, 30.65, and 34.44^o representing [110], [100] and [201] planes indicating phased centred cubic particles. The synthesized alloy nanoparticles effectively inhibited clinical isolates of *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albicans* at a concentration of 40 µg/ml. The antioxidant activities showed a high action against DPPH with 86.8%, while highly potent larvicidal activities against the larvae of *Anopheles* mosquito at 10-100 µg/ml concentration were observed. The study demonstrated for the first time the utility of SmL in the biosynthesis of Ag-TiO_2 with potential applications as antimicrobial and larvicidal agents.

Keywords: *Spondias mombin*, Ag-TiO_2, biosynthesis, antimicrobial activity, clinical isolates, antioxidant, larvicidal activity

NANO 2019/B089
Evaluation of anti-inflammatory activity of silver nanoparticles of *Ehretia cymosa* cream

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Among several forms of metallic nanoparticles used in biomedical applications, AgNPs is the most fascinating and widely used. Therefore, this study was carried out to evaluate the anti-inflammatory activity of different formulations of *Ehretiacy mosa*-AgNPs cream. Different fractions of the plant (methanol, n-hexane and ethyl acetate) were used to synthesize AgNPs. The AgNPs were characterized by UV-vis spectroscopy, atomic force microscopy (AFM) and Fourier transform infrared (FTIR) spectroscopy. The AgNPs were used to prepare creams, and the physical properties of the creams were evaluated. Anti-inflammatory activities of the creams were evaluated by carrageenan induced rat paw edema method on albino rats. The different fractions biosynthesized AgNPs with UV absorption spectra in the range 400-450 nm. The creams had pH of 4.6-5.6 similar to the pH of the skin. They have good spreadability and are easy to wash off the skin. The negative control group- no extract (NO), n-hexane extract (NE), methanol extract (ME) and ethyl acetate extract (EE) cream had 67.57, 93.33, 96.77 and 100% healing respectively at 6 h. The efficacy of the cream formulation of the extracts after 6 h of treatment was in the order EE > ME > NE > NO. However, 100% healing was attained with EE-AgNPs and ME-AgNPs in 4 and 5 h, respectively, while 96.66% healing was attained at 5 h with NE-AgNPs. The rank order of AgNPs cream formulations was EE-AgNPs > ME-AgNPs > NE-AgNPs. For the positive control group, 94.28% healing was attained in 6 h. The study has established that *Ehretia cymosa* synthesized AgNPs cream formulations had a faster healing ability compared with the positive control and *Ehretia cymosa* cream formulations.

Keywords: Silver nanoparticles, *Ehretia cymosa,* cream formulation, anti-inflammatory activity

NANO 2019B/090

Characterization, antioxidant, anti-amylase, anti-glucosidase and cytotoxicity potential against skin cancer cell (HaCaT) of green synthesized silver nanoparticles using *Annona muricata* aqueous leaf extract

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Annona muricata aqueous leaf extract was used to synthesize silver nanoparticles. The nanoparticles were characterized using UV-visible spectrophotometry, Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), selected area electron diffraction (SAED), transmission electron microscope (TEM), energy dispersive X-ray spectroscopy (EDS), and dynamic light scattering (DLS). Inductively coupled plasma atomic optical emission spectrometry (ICP-OES) metal analysis of the leaf showed that it contains Mg (2732 µg/g), Fe (289 µg/g), Na (342 µg/g), Ca (4499 µg/g) and K (19870 µg/g). The aqueous leaf extract of *A. muricata* contained flavonoids, alkaloids, tannins, terpenoids and phenols. The change in colour due to surface plasmon resonance and absorbance at 440 nm confirmed the formation of AgNPs. FTIR showed that phytochemicals with free amide and hydroxyl groups were responsible for the formation and stabilization of the nanoparticles. XRD and SAED confirmed the crystal nature of the particle with face centered cubic (fcc). The zeta potential revealed a large negative potential value of -27.2 mV and average particle size distribution of 35 nm. DLS indicated that the majority of the particles were 86.78 nm size and a polydisperity index (pdi) of 0.329. AgNPs showed 70% inhibitions of DPPH and ABTS at 35 µg/ml. The particles exhibited strong inhibitions of α-amylase and α-glucosidase with IC_{50} values of 0.90 and 3.32 µg/ml respectively. The particles showed IC_{50} cytotoxic value of 57.37 µg/ml against HaCaT cancer cell line. The findings of this work revealed the potential anti-diabetic application of the particles and further work required is to establish its molecular mechanism.

Keywords: *Annona muricata*, green synthesis, silver nanoparticles, antioxidant, anti-diabetic, anticancer

NANO 2019/P091

Characterization of green synthesized zinc oxide nanoparticles thin film as anode buffer layer for efficient polymer solar cells

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Polymer solar cells (PSCs) using organic materials are undergoing intensive research as an alternative to silicon based solar cells due to their flexibility, processibility and low cost. However, the realization of large scale PSCs is still low because of their environmental stability and charge transport across the photoactive medium. This research intends to study thermal annealing stability on the green synthesized zinc oxide nanoparticles thin-film as a buffer layer for improved separation and collection of charge carriers in PSCs. Zinc oxide nanoparticles (ZnONPs) were synthesized using plant extract, characterization were done using UV-vis spectroscopy, X-ray diffractometer (XRD) and scanning electron microscope (SEM). The device was fabricated by depositing prepared nanoparticles on transparent conducting glass substrate under optimized conditions using spin coating techniques. There was intensive absorbance in the ultraviolent band of about 200-400 nm of the prepared nanoparticles. It was deduced from post thermal annealing analysis that as the annealing temperature increases, the absorption increases until optimum annealing temperature of 240 ˚C was reached. The SEM image result of ZnONPs revealed that the particles were spherical and has a granular nature. Also, the XRD pattern of ZnONPs confirmed its hexagonal wurtzite structured. In conclusion, green synthesized ZnONPs showed good performance in the development of low cost photo active PSCs with significant effect of post thermal annealing on antireflection capability of charge carrier separation.

Keywords: Zinc oxide nanoparticles, green synthesis, polymer solar cell, characterization, absorption, renewable energy

NANO 2019/B092
Green synthesis of novel nanoparticles for catalytic application: Potential for industrial revolution

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Recently, the world of sciences recognizes and acknowledges the growing need for more environmentally acceptable processes in the chemical industry. Adoption of green synthesis otherwise known as green chemistry or sustainable technology has necessitated a paradigm shift from traditional concepts of process efficiency, focusing largely on chemical yield to one that assigns economic value to eliminating wastes at source and avoiding the use of toxic and/ or hazardous substances. Catalysis is of tremendous importance in petrochemical and pharmaceutical industries, and in environmental protection to mop-up toxic and hazardous chemicals. Of recent, it was discovered that this technology can be deployed to solving emerging problems associated with alternative source of energy, industrial by-products detoxification, global warming and development of refined and safe pharmaceuticals. This review aimed at exploring green synthesis of various nanoparticles applicable in catalysis and their characterization to unravel their morphologies. Furthermore, discussion will be extended to

possible challenges that may be needed to overcome for their full adoption in various industrial processes.

Keywords: Green synthesis, nanoparticles, biological materials, characterization, catalyses