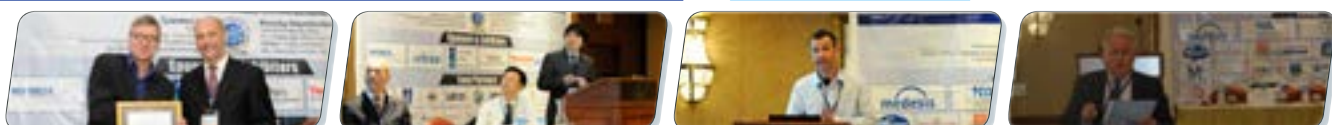


9th Nano Congress for Next Generation

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Posters



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Porous graphene aerogel supercapacitors

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Graphene sheets derived from electrochemical exfoliation have shown more pristine qualities such as better electrical properties than those derived from reduced graphene oxide (rGO). In this work, we developed porous 3D structures using graphene obtained via electrochemical exfoliation and explored their application as supercapacitor electrodes. By adjusting the content of the electrolyte in the exfoliation process, the aspect ratio of graphene sheets and the porosity of the graphene network can be optimized. Furthermore, the freezing temperature in the freeze drying step was also found to play a critical role in the resulting pore size distributions of the porous networks. The optimized conditions lead to meso- and macro-porous graphene aerogels with high surface area, extremely low densities and superior electrical properties. As a result, we have found that the graphene aerogel supercapacitors exhibit a specific capacitance of 325 F/g at 1 A/g and an energy density of 45 Wh/kg in 0.5 M H₂SO₄ aqueous electrolyte with high electrochemical stability required for the practical usage. This research provides a practical method for lightweight, high-performance and low-cost materials in the effective use of energy storage systems.

Biography

Hyun Young Jung is now an Assistant Professor in the Department of Energy Engineering at the Gyeongnam National University of Science and Technology in Korea. His ongoing researches focus on energy conversion and storage devices of engineered nanomaterials and composites, aerogel for energy and environment, and optoelectronics. He has published more than 33 papers in reputed journals.

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A new fluorescence/PET probe for intracellular human telomerase reverse transcriptase (hTERT) using Tat peptide-conjugated IgM antibody

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Human Telomerase Reverse Transcriptase, hTERT, is expressed in most cancer cells, and considered as an important tumor biomarker. However, targeting hTERT is difficult due to its cellular location. We developed a new dual probe for optical and nuclear imaging to visualize intracellular hTERT proteins using Tat peptide-conjugated IgM antibody. Monoclonal IgM antibodies for hTERT were conjugated with the Tat peptide, fluorescence dye (FPR648) and ⁶⁴Cu-NOTA. HT29 (hTERT+) and U2OS (hTERT-) cells were imaged by confocal microscopy and analyzed by Tissue-FAXS. To visualize nuclear transport of hTERT, tumor cells were irradiated with 4 Gy of ionizing radiation. Tumor xenografts were visualized using Maestro and PETBOX. Cellular penetration was improved by Tat peptide and retention time was prolonged with IgM antibody as compared to IgG antibody. More fluorescence signals were detected in HT29 cells than in U2OS cells after 24 hr. Strong positive fluorescence signals were observed in 78.54% of total HT29 cells. Interestingly, this probe could visualize nuclear transport of hTERT after irradiation. Fluorescence and PET images of the mice clearly showed higher fluorescence signals and radioactivities in HT29 tumors than in U2OS tumors. In tissues, fluorescence signals were only detected in HT29 tumors. We developed a new fluorescence/PET probe for visualizing the intracellular hTERT using the Tat conjugated antibody which improved cellular penetration. This system can be applied to visualize other intracellular proteins and also can be used to target intracellular biomarkers for therapeutic applications.

Biography

Kyung Oh Jung has completed his PhD in 2016 from Seoul National University College of Medicine, studying about the concepts of molecular imaging and tumor biology. He is a Post-doctoral fellow from Stanford University School of Medicine from September 2016.

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New approach to biomolecular self-assembly through formation of peptide architectures by artificial supersaturation

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Biomolecular self-assembly is a bottom-up approach to form nano/microstructures through non-covalent interactions of biomolecules. Construction of desired functional structures by self-assembled growth is of fundamental interest for applications in fields such as biosensors, biodevices, tissue repair and for promising platforms in next-generation devices. Therefore, a deep understanding of the growth mechanism is required. However, growth process from nanoscale aggregations to hierarchical microstructures still remains unclear. Here, we report a new method of controlling and analyzing biomolecular self-assembly using a methanolic solution of short dipeptide diphenylalanine (FF), which has been known as a core recognition motif of Alzheimer's b-amyloid polypeptide. The *in situ* observation of its growth gives unique information to understand growth mechanism of simple microtubes and "diatom-like" porous microspheres, which are produced through the formation of a small nucleus in the artificial local supersaturation. Although it is a simple model system, the method and interpretation will pave the way for controlled growth of more complicated biological nano/microstructures.

Biography

Makoto Sakurai got his PhD from Keio University on the topic "Magnetism and Structure of Magnetic Superlattice". He studied mechanism of atom-manipulation using scanning tunneling microscope (STM) and also developed a new technique of STM-induced light emission from atomic structures with the atom-resolved spatial resolution, as a researcher at RIKEN and NIMS. He is studying new functionality caused by dynamic defects-manipulation in wide-band-gap oxide nano/microstructures to achieve new-type computing architectures from 2007 and is also investigating for controlled self-assembly of peptide/molecules from 2013, as a Senior Researcher at NIMS.

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The molecular mechanism of antimicrobial properties of laser processed nano-particles

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Multi-drug resistant pathogens have become a global health problem in recent years. Nanoparticle (NP) is a promising alternative to be used against bacteria. One way of producing NPs is the laser technology which is considered a clean method without relying on chemical reactants. In this study, Ag and Ag-TiO₂ NPs were produced using laser ablation in deionised water. The aim of the study is to characterize the antibacterial activity of the laser NPs, the molecular mechanisms behind and the potential risk to human. The antibacterial activities of laser Ag and laser Ag-TiO₂ NPs have been determined on the gram negative bacteria, *E. coli* and *Pseudomonas aeruginosa* and the gram positive bacteria, *Staphylococcus aureus*. Results showed that both types of NPs exhibited strong antibacterial activity against all of the bacterial strains in this study. Laser Ag NPs induced significant amount of dose-dependent ROS generation which is associated with bacterial cell death. Increased cell permeability was observed when *E. coli* were co-cultured with the laser Ag NPs. The cytotoxicity of laser Ag and Ag-TiO₂ NPs was determined using MTT assay on five different human cells including lung adenocarcinoma cell line (A5 49), endothelial cells (HEMC-1), kidney epithelial cells (HEK), dermal fibroblast (HDFc) and hepatic cells (HepG2). We found that laser Ag and Ag-TiO₂ NPs had no significant cytotoxicity to the human cell types used in this study except for endothelial cells, which were more susceptible to the toxic effect of both laser Ag and Ag-TiO₂ NPs. In conclusion, laser generated Ag and Ag-TiO₂ NPs have strong bactericidal effect and low toxicity to human cells which could be a type of promising antibacterial agents for future hygiene and medical applications.

Biography

Peri Ahmad Korshed has completed her BSc in Biology and MSc in Biology/Microbiology from the University of Tikrit/Tikrit-Iraq. She served for about three years as a Lecturer at the University of Kirkuk-Iraq, and then moved to the University of Koya. She has two published papers in Koya University; one of them under the name, "Bacteriological study of some pathogens causing urinary tract infection" and the other, "The effect of some plant extracts on the activity of some pathogenic bacteria". She is now working towards her PhD in School of Medicine, University of Manchester, UK. She has two papers ready for publication.

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Nanocomposites of layered clays and graphene/graphene oxide for drug delivery

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Layered Double Hydroxides (LDHs) and graphene (G) and graphene oxide (GO) are combined to prepare a hybrid nanocomposite to use in drug delivery. These composites combine the useful properties of both types of structures: high interacting surface area, controlled release and biocompatibility, useful for good drug loading capacity and sustained drug release system. These nanocomposites were tested for the loading and release of alendronate sodium, an osteoporotic drug with gastrointestinal adverse effects and low bioavailability (<1%). The prepared hybrid nanocomposites incorporated 2% w/w of G or GO with a 3:1 M^{2+}/M^{3+} ratio of Zn-Al LDH in its nitrate form. Alendronate sodium was loaded into the hybrid nanocomposites as well as the pristine LDH by co-precipitation and ion exchange and all samples were characterized by powder x-ray diffraction, infrared spectroscopy and zetasizer analysis. The amount of drug loaded and released was determined by UV/Vis spectroscopy. The co-precipitation samples showed successful intercalation of the drug in a bi-layered arrangement within the LDH interlayer space. In spite of the intercalation of the drug in the pristine LDH by ion exchange, hybrid nanocomposite samples with G or GO did not exhibit drug intercalation. Drug loading for these samples seems to have been limited to surface adsorption on the LDH. Drug loading amounts ranged from 22.4% to 50.5% w/w, with noticeable increase in nanocomposites with G or GO prepared by co-precipitation. This increase is due to the additional surface area provided by the G or GO for drug loading. A significant loading amount was observed for the pristine LDH sample prepared by ion-exchange due to the longer contact time with the drug during preparation. The drug release was highly sustained over 24 hours with minimum amounts released, and total release percentages at 24 hours ranging from 2.5% and 4.2%. This sustained release behavior is due to the strongly attached drug anions, embedded in the interlayers of the positively charged brucite-like layers. The observed variations in drug loading and release behavior is explained in terms of the charge on the brucite layers of the LDH and the different interactions between the drug and the G and GO present.

Biography

Nada Mahmoud Hegazy has completed her Master's degree in January 2016, from the American University in Cairo, in Nanotechnology, and in the process of publishing the thesis work, and a Bachelor's degree in May 2009 from the Faculty of Pharmacy, Cairo University. He has received a Diploma in Total Quality Management (TQM), in February 2011 from the American University in Cairo and a Clinical Diploma from Cairo University. He has been a former Research and Development Specialist in a pharmaceutical company for one year, and currently a Quality Control Analyst in the National Organization for Drug Control and Research.

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Semiconductor quantum cones: Unique source of photons and electrons

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Nanostructures are one of the most investigated objects in semiconductor physics, especially due to quantum confinement effect in quantum dots (0D), quantum wires (1D) and quantum wells (2D). A new laser technology elaborated for quantum cone formation in semiconductors is reported. A cone possesses the following unique properties: A small cone with angle $\alpha=60^\circ$ at the top of the cone is a quantum dot – 0D, when $\alpha=0^\circ$ is transformed to a quantum well – 2D and when a long one with $\alpha<60^\circ$ is transformed to a quantum wire – 1D with the gradually decreasing diameter from the base till the top of the cone. Luminescence of such a quantum cone resembles rainbow. Where radii in cone are equal or less than Bohr's radius of electron, exciton or phonon Quantum Confinement Effect (QCE) takes place. Quantum cones on the surface of elementary semiconductors Si and Ge single crystals, and Si_{1-x}Ge_x ($x=0.3$ and $x=0.4$) solid solution were formed by fundamental frequency and second harmonic of Nd:YAG laser radiation. Strong change of the optical, mechanical and electrical properties of the semiconductors after irradiation by Nd:YAG laser are explained by the presence of QCE in quantum cones. "Blue shift" of photoluminescence spectra and "red shift" of phonon LO line in Raman spectrum are explained by exciton and phonon QCE in quantum cones, correspondently. Asymmetry of the photoluminescence band in the spectrum of Si quantum cones is explained by formation of graded band gap structure. Experimental data on quantum cones formation on a surface of Si, Ge crystals and their solid solution and their optical and electric properties are presented. Two-stage model of quantum cones' formation on the irradiated surface of the semiconductors is proposed. The first stage of the cones formation is characterized by the formation of a thin strained top layer, due to the redistribution of point defects in temperature-gradient field induced by strongly absorbed by laser radiation. As a result, p-n junction and hetero junction are formed in Ge crystal and SiGe solid solution, correspondently. The second stage is characterized by mechanical plastic deformation of the stained top layer leading to arising of quantum cones due to laser heating up of the top layer. Si quantum cone possesses the lowest work function of electron field emission due to graded band gap structure.

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Self-construction from 2D to 3D: One-pot layer-by-layer (LbL) assembly of Graphene Oxide (GO) sheets held together by coordination polymers

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For further development of functional materials, a smart construction of functional 2D materials to well-defined 3D constructions is crucial. The best strategy in this line is a layer-by-layer (LbL) assembly that can provide well-designed alternate layered structures in nanoscale precision from a variety of functional components. Here, we demonstrate a novel synthetic strategy which entails deposition of Ni-based cyanide bridged coordination polymer (NiCNNi) flakes on the surface of Graphene Oxide (GO) sheets, and allows precise control of the resulting lamellar nano-architecture by *in-situ* crystallization. GO sheets are utilized as nucleation sites promoting the optimized crystal growth of NiCNNi flakes. The NiCNNi-coated GO sheets then self-assembled and are stabilized as ordered lamellar nanomaterials. This approach might be applied to many other inorganic-organic hybrids for ordered layer-by-layer (LbL) architectures. Regulated thermal treatment under nitrogen yields Ni₃C-GO composite with a similar morphology to the starting material. The Ni₃C-GO composite exhibits outstanding electro catalytic activity with strong durability for the oxygen reduction reaction.

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Molecular strategies towards efficient small-molecule photovoltaic materials

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Bulk-heterojunction organic solar cell (BHJ-OSC) utilizes a nanostructured electron donor and electron acceptor blended film to capture and convert solar photons into electrons. Recently, much attention has been focused on non-fullerene organic acceptors, which are used as acceptor materials to replace the traditional fullerene acceptor materials. The exciton-type photon-to-electron conversion efficiencies such as exciton generation and charge separation and transport are largely dependent on the material absorption, frontier molecular orbitals and film-morphology. In this report, I will show our results on the molecular strategies towards efficient small-molecule photovoltaic materials. The results include: (1) The photovoltaic properties from the twisted perylene-dimide dimer acceptors, (2) the photovoltaic properties from BODIPy based small molecule donor and acceptor, and (3) the photovoltaic properties from Diketopyrrolopyrrole (DPP) and quinoidal methyl-dioxycano-pyridine based small molecule donors, in particular, the effects of the end units capping on the DPP main chain and the influence from the anchoring groups terminated on the flexible alkyl chains.

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Nanocrystalline hydroxyapatite-phosphonate composites

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Two new hybrid compounds apatite-phosphonate are prepared by hydrothermal method. For that, vinyl or methyl phosphonic acid variable quantity is added during apatite synthesis. X-ray diagrams confirmed the apatite structure conservation and permitted to evaluate crystallite sizes. The values are in nanometric range (25 - 2.5 nm). IR and Raman spectroscopy showed apatite characteristic bands and also phosphonate bands. ³¹P MAS-NMR spectra present the apatite isotropic signal and new signals attributed to phosphonate organic phosphor. ¹³C MAS-NMR reveals vinyl or methyl characteristic signals. Thermo gravimetric analysis shows a weight loss between 200 and 600°C attributed to the organic moiety decomposition. Differential thermal analysis (DTA) confirms the exothermic effect. The value of this loss increases with the increase of grafting, in good agreement with the results of the ¹³C chemical analysis. Specific area measurements show obtaining porous hybrid apatite-phosphonate compounds whose porosity is controlled by the rate and the nature of the graft. The observation by Transmission Electron Microscopy (TEM) and Atomic-force microscopy (AFM) powders of these new materials shows that the crystallite size is in the nanometer scale and decreases with the amount of graft added during synthesis.

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Chitosan a potent nanoparticle for nutrient delivery into plant systems

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Fertilizers are organic compounds applied to plants to enhance growth and are applied either to the soil directly or by foliar spreading. Thus applied fertilizers contribute to provide macro nutrients (NPK) to the plant. NPK helps in leaf growth, enhances root elongation, fruiting & flowering, etc. According to Saigusa et al., 40-70% of Nitrogen, 80-90% of Phosphorous, 50-70% of Potassium are lost to the environment but not absorbed by the plant, increasing the intrinsic economic loss and heavy environmental pollution. Hence usage of bio fertilizers may be very much helpful in reducing the problem to major extent. Plants easily absorb bio fertilizers and as they are from an organic source they may not harm the environment. But the absorption rate of bio fertilizers by the plants is very low so, to enhance it certain facilitators are used which in conjugation with nutrients may help in easy absorption of the nutrients. Recent studies have revealed that nanoparticles are one of the best mediators for delivering nutrients to the plants. There are several inorganic mediators like silver nanoparticles, nanotubes, nano beads etc., and among them chitosan is found to be a potent mediator for nutrient delivery. Studies have discovered that chitosan nanoparticles have controlled release of NPK fertilizer to the plants. Chitosan is a polysaccharide derived from chitin a skeletal material of crustaceans. Due to its poly cationic nature, chitosan reacts with negatively charged molecules showing a favourable reaction. Thus the ability of its controlling nanoparticle size it is highly favourable for most of nanotechnology applications.

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Synthesis and characterization of ZnO–TiO₂ nanocomposites co-doped with Dy³⁺ and Eu³⁺ ions

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Down-conversion in nanomaterial phosphors doped with Rare Earth (RE) ions is currently being explored for solar cell applications. This is inspired by the ability of RE elements to luminescence over a wide range, from the near-infrared, through visible to the ultra-violet wavelength energy regions, whilst exhibiting only weak interactions with the host lattice. Titanium dioxide (TiO₂), zinc oxide (ZnO), europium (Eu³⁺) and dysprosium (Dy³⁺) individually show excellent luminescence properties. In this report, ZnO and TiO₂ nano-based composite phosphor was activated with different concentrations of Eu³⁺ and Dy³⁺ fabricated using the sol-gel method of synthesis such that, ZnO-TiO₂: xDy³⁺ and yEu³⁺ (x=0.4 and y=0.05 to 0.75 mol). The prepared phosphors were characterized by X-ray Diffraction (XRD) technique for confirmation of the formation of the desired product, crystallinity and product phase purity. The XRD patterns confirmed crystallization of wurtzite hexagonal ZnO and tetragonal TiO₂ (anatase and rutile) phases. In addition, the XRD data confirmed that secondary phases of ZnTiO₃ and Zn₂TiO₄ were also formed. Morphological analysis was carried out using scanning electron microscopy (SEM), and formation of nanoflake-like structures, nanorods and uniformly distributed structures was confirmed. Photoluminescence characterization of the as-prepared phosphors was carried out under UV excitation at 248 nm and the prominent emission bands were observed in the visible region at 496, 584, 593 and 614 nm, corresponding to transitions of Dy³⁺ and Eu³⁺ ions. The energy transfer mechanism between the ZnO-TiO₂ host and dopants (Dy³⁺ and Eu³⁺) is discussed.

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New-PEGylated PbS quantum dots for water-based applications

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Colloidal nanochemistry has received tremendous interest over the past decade, especially the synthesis of nanoscale semiconductor crystals capped with surfactant molecules and dispersed in solution (quantum dots (QDs)). Among them, near-infrared emitting lead-based QDs have gained considerable attention since they exhibit attractive properties for the development of various emerging applications, from optoelectronic-devices to photovoltaic cells and to fluorescence-based optical imaging. Most of these applications require water as dispersion medium, whereas QDs synthesis is normally carried out in organic solvents, thus giving quantum dots soluble in organic phases but insoluble in polar solvents. A ligand exchange process after the synthesis is the common route to obtain water-soluble quantum dots. This two-steps method brings usually a decrease of the quantum yield, a possible emission shift and an inhomogeneity in the particle size distribution, with many drawbacks for the final applications. This is more evident for the near infrared and infrared emitting nanocrystals, whose optical quality even in organic phases is still not as high as for the visible emitting QDs. We have developed a new kind of synthesis for water soluble PbS QDs, based on norbornene click-chemistry. This new synthesis method eliminates the need of ligand exchange and confers a very high quantum yield and a high optical stability over months in water. Finally, a hybrid system as model for solar energy devices has been physico-chemically and optically studied, by coupling a supramolecular self-organization system with aqueous dispersions of PbS QDs.

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Novel biocompatible nanoparticles: Generation and size-tuning by the formation of self-assembly templates obtained from thermo-responsive monomer mixtures

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We have developed new biocompatible, non-degradable, nano particles (NPs) well tolerated both *in vitro* and *in vivo* with particularity peptide synthesis can be carried out on their surface. Although the NPs have a large range of well-defined sizes ranging from 20 to 400 nm, they are all composed of the same monomers. Their shell composition, in contact with the biological media, is uniformly composed of polyethylene-glycol, thus their biocompatibility remains high along different sizes. A proposed peculiar mechanism of formation allowed maintaining their shell composition uniform. The conjugation of molecules to the NPs was a real challenge since they are nano-hydrogels with high colloidal stability that can only be dialyzed for eventual removal of reagents. Therefore, we have designed and proved a novel solid phase peptide synthesis method for Merrifield synthesis on nanoparticles based on the embedding of the NPs in a permeable and removable magnetic matrix. Overall, the platform composed of the NPs and the synthetic peptide is a useful tool for developing imaging methods for intracellular localization of the NPs using microscopy as we have shown *in vitro* for PC-3 cells, and for *in vivo* tracking using the Zebra fish model.

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Magnetite nanoparticles on paper: A platform for the diagnosis of dengue fever by magnetic-ELISA

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Enzyme-linked immunosorbent assays (ELISAs) are the most widely used methods to detect antibodies. However, they have some drawbacks. As a result, in recent years magnetic nanoparticles or beads (e.g. magnetites) have been combined with ELISAs to improve their analytical performance. On the other hand, despite paper-based ELISA are less sensitive than conventional ELISA, they emerge as suitable platforms to develop disposable devices for point-of-care diagnostic. A novel “magnetic-ELISA”, based on core-shell magnetite@polydopamine nanoparticles supported on Whatman paper was developed to detect IgM-dengue antibodies. An affordable procedure to deposit magnetite nanoparticles on paper surfaces (Whatman type-1 and Whatman type-ss903) and, to conjugate such nanoparticles with anti human-IgM antibodies using polydopamine as linker, is reported. Structural features, magnetic behavior, coating homogeneity, as well as, the nanoparticles/linked antibodies ratio were determined. The analytical performance of “magnetic-ELISA” supported on paper surface was 100 times more sensitive with a 700 times lower limit of detection than traditional ELISA or using magnetic beads without depositing on paper to detect IgM-dengue antibodies. Additionally, the new system showed low background, acceptable reproducibility, low-cost, easy manufacturing and effortless and easy handling which are very important, considering the large number of biological samples to be processed by a laboratory in case of dengue epidemics.

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Graphene-edge probes for scanning tunneling microscopy

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Fabrication of freestanding graphene-edge probes for scanning tunneling microscopy was demonstrated. Graphene was prepared by thermal chemical vapor deposition (CVD) from solid carbon sources. A Cu wire acted as the substrate for graphene growth. As the freestanding graphene probes were fabricated, the process was monitored using a micromanipulator and an optical microscope. Our previous study of electron emission patterns from a field emission microscope demonstrated the layered structure of the graphene edge. A single-layer of graphene emitted electrons from a limited number of atoms. We found that the graphene emitters required careful conditioning to achieve a stable emission current. In this research, such activated graphene probes were applied for use in scanning tunneling microscopes for surface morphology detection. The preconditioned, multi-layer graphene probe presented resolution that was comparable to conventional probes. Our study generated a practical method for applying individual freestanding graphene for surface probe microscopy.

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Use and therapeutic application of nanocarriers (smart drugs) for prevention and remediation of cardiovascular diseases

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This work focuses on the potential of nanotechnology in nanomedicine, mainly cardiovascular pharmacology discipline, including the highlighted rational approaches in design, manufacturing, development, and applications of nanodevices (smart drugs) containing nanoparticles that acts as nanocarriers to control and direct for site-specific targeted smart drug delivery into human body using artificial receptors and unique nanoparticle systems for diagnostics, screening, medical imaging, prevention, and correction of cardiovascular pathologies therapy after administration routes. Our aim is to develop the most efficient pathways for nanomedicine so that biomolecular and cellular techniques, tools and method with the nanotechnology knowledge base can be merged, as it specifically relates to the development of nanoparticles for enabling and improving targeted delivery of the therapeutic agents and; developing novel and more effective diagnostic and screening techniques to extend the limits of molecular diagnostics providing point-of-care diagnosis and more personalized medicine.

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Influence of Mg²⁺, Ca²⁺ and Sr²⁺ ions doping on the band gap energy of ZnO nanoparticle

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Nanocrystalline materials have attracted a wide attention for application in nanodevice fabrication due to their unique properties and immense potential. Among various nanocrystalline materials ZnO nanoparticles have shown great potential for numerous applications. Owing to the unique properties of the ZnO nanoparticle, this study was conducted to investigate the lowering of the band gap energy and optical property doped with Mg²⁺, Ca²⁺ and Sr²⁺ ions. ZnO nanoparticle was synthesized by adding zinc acetate to aqueous NaOH solution and subjected to ultrasonic irradiation for 2 hr, after that a white precipitate was obtained which was filtered and washed with ethanol and de-ionized water, and dried in an oven at 600C for 3 hr. The dried white powder was then calcined at 400C for 2 hr and subjected to UV-Vis spectrophotometer to characterize the synthesized ZnO nanoparticle. The band gap energy of ZnO undoped and doped with Mg²⁺, Ca²⁺ and Sr²⁺ ions was determined. From all dopants 0.006 M Mg²⁺ doped ZnO nanoparticles was found to be narrowing band gap more. A significant change in optical property was also observed in synthesized ZnO nanoparticle.

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Fabrication of high performance electron beam with carbon nanotube cold cathode and its applications

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We developed novel carbon nanotube electron beams with Carbon Nanotube (CNT) cold cathodes. The electron beam shows more than 90% electron transmission ratio through gate electrode, resulting higher anode current and lower thermal damage on gate electrode. The electron beam shows anode current more than 100 mA with DC pulse driving at less than 1 cm² area. Also, life time of the beam shows more than 300 hrs in DC driving. We fabricated electron beam modules with the CNT cold cathode and applied for medical and solid state devices. For medical devices, we fabricated glass sealed x-ray tubes with the electron beam and evaluated its performances, resulting high resolution x-ray. For solid state devices, we irradiated the electron beam on semiconducting, and insulating thin films. Then, we observed phase changes on those thin films and generation of luminescence from those films by phase changes. Detail of electron beam fabrication process with CNT cold cathode, performance of electron beam, characteristics of x-ray tubes with the beams and beam irradiation will be presented.

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Fabrication of silver nanoparticles from mycological flora and their importance against agro-pathogens: Towards green nano-pesticides

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The synthesis of nanomaterials has received more attention due to the increasing need to develop safe, cost-effective and environment friendly technologies for nano-material synthesis. Herein, we report the fabrication of silver nanoparticles (AgNPs) via green synthetic approach using aqueous extract of mycological flora including *Aspergillus Niger*, *Aspergillus flavus*, *Fusarium oxysporum*, *Penicillium*, *Acremonium*, *Rhizoctonia solani*, *Pythium*, *Rhizopus stolonifera* and *Trichoderma harzianum* isolated from different soil samples. Their aqueous extract was treated with different concentrations of silver nitrate (AgNO₃) solution at various pH levels. Generally the reaction was carried out for 72 hours and a visible change in color of reaction mixture from clear to dark brown was considered a positive indication. The synthesis of AgNPs was confirmed by UV-Vis spectrum which showed distinct peak around 420 nm -430 nm regions. Scanning electron microscopic imaging confirmed the size and shape of AgNPs, size ranged from 18 nm-69 nm. We found that the concentration of silver salt plays vital role in controlling the size of nano particles while the aqueous extract from different fungal strains is responsible for the difference in shape of NPs. Each fungi is known to produce different metabolites that act as reducing as well as capping agents during the synthesis of AgNPs hence giving them different shapes. Furthermore, the synthesized AgNPs were tested for their antimicrobial potential against pathogenic bacterial strains including *Xanthomonas*, *Clavibacter*, *Agrobacterium*, *E Coli*, *Staphylococcus aureus*, *Bacillus* and *Klebsiella*. The *in vitro* antibiotic activity was carried out using disk diffusion assay and was compared against standard known antibiotic as positive control and aqueous AgNO₃ and mycelial extract as negative control. We found some of our synthesized AgNPs even more potent than known antibiotics. The results from our lab clearly open a new avenue for the green synthesis of nanoparticles using fungal extract and their importance against agricultural pathogens.

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Multifunctional oxides: Smart bulk and ordered sub nanostructures

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The results of experimental and theoretical study of bulk and ordered nano-structures on surface of directly changed in stoichiometry composition oxides over plasma flow have been discussed in this report. Tested samples, such as γ - Al_2O_3 , MexOy single crystals (oxide of iron group elements) samples with garnet structure, $\text{A}_3\text{B}_2\text{C}_3\text{O}_{12}$ and perovskite one, ABO_3 as perfect or doped with Me or/and RE ions were grown under special conditions. Pure and doped perfect or near stoichiometry samples were studied with optical/spectroscopy methods, ESR, high resolution X ray spectroscopy, XRD, dielectric, conductivity, AFM, SEM, TEM techniques, before (after) annealing in oxidizing and reducing atmosphere or/and γ - or e- irradiation affect and over high density plasma flow. Strong change in the ground properties of the samples was fitted and discussed. Ordered and quasi-ordered one- and multi-level nano and sub-nanostructures were discovered on the surface of the oxides after intensive plasma treatment. Exemplary SEM-AFM showed two-level ordered nano-structures on the surface of SrTiO_3 and sapphire single crystals over plasma affect. Distorted surface layers of perovskites are polycrystalline in opposite to amorphous ones for sapphire or garnet crystals. The initial and treated samples were tested by standard and original methods of determination of the doped ions concentration, oxidation state of the host and impurity ions, stoichiometry, and crystallographic parameters, too.

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Quantum nanoparticles doped polymer waveguides for light propagation

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High-refractive-index polymer hybrid materials, such as OrmoClear show interesting properties for a variety of potential applications. When doped with quantum nanoparticles, this hybrid polymer promotes enhanced optical properties that can have huge advantage in photonic applications. The particle size and composition of these quantum nanoparticles can be tuned in order to introduce new properties to the materials. For an experimental evaluation, the comparative studies of different quantum nanoparticles, such as dots, rods and plates were made. The continuous films of all three kinds of quantum nanoparticles were produced and the fluorescence spectra were measured. In comparison between different quantum nanoparticles, the quantum rods showed brightest emission. Afterwards, these quantum nanoparticles were embedded into a high-refractive-index photocurable OrmoClear in order to produce waveguide structures by photolithography technique. The lasing potential of the doped polymer was evaluated by investigating the efficiency of the light propagating through the waveguide. The optical properties were evaluated based on the concentration of the quantum nanoparticles as well as the structural parameters of the polymers.

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Biosynthesis, optimisation and characterisation of gold nanoparticles using fungal extracts

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The development of techniques for the synthesis of nanoparticles of well-defined size, shape and composition is a challenge and an important area of research in nanotechnology. Many microorganisms have the ability to produce inorganic nanostructures and metal nanoparticles with properties similar to chemically synthesized materials and are a good alternative approach to chemical synthesis. In the present study, extracellular synthesis of gold nanoparticles (AuNPs) in the presence of fungal extracts has been successfully demonstrated to manipulate the size and shape of gold nanoparticles by alteration of key growth parameters (Temperature, pH, incubation period, and sodium citrate concentrations) and reaction conditions (Supernatant: HAuCl₄). Production of nanoparticles was confirmed by the colour change from yellow to violet-blue after ~72 h of reaction. The synthesis of the AuNPs was monitored by UV-visible spectroscopy which showed an absorbance peak at ~530 nm which was specific for gold nanoparticles. The particles thereby attained were characterized by Transmission electron microscopy (TEM), dynamic light scattering (DLS), Fourier transform infrared (FTIR) and energy dispersive X-ray (EDX) analysis. TEM images revealed that the nanoparticles were spherical, triangular, rod-shaped, polygonal and irregularly shaped with indefinite morphology in the range of 3-460 nm in size. The most promising results were obtained when the fungus was grown at pH 3, 40°C and the best parameters for the synthesis of gold nanoparticles were pH 3, 32°C, 40 h, 5 mM sodium citrate concentrations and ratio of 1:100. The GNPSs were monodisperse, spherical and found to be 3-53 nm in size. FTIR absorption spectrum showed the presence of bonds due to O-H stretching (around ~3,430 cm⁻¹). This peak indicates the presence of proteins and other organic residues, which might have been produced extracellularly during the growth of the fungus. An elemental composition analysis employing EDX showed the presence of a strong signal from gold atoms. However, there were other EDX peaks for C, O, Cr, Cu and Fe, suggesting that they were mixed precipitates from the fungal extracts and the copper disks. This study represents an important advancement in the use of fungal enzymes for the biosynthesis of highly stable gold nanoparticles by a greener approach and this proposed mechanistic principal might serve as a set strategy for the synthesis of nanostructures with desired morphology and can be amenable for large scale commercial production and technical applications.

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Influence of deposition parameters on formation of cobalt nanowires

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To understand the mechanism for formation of fcc-cobalt nanowires in electrodeposition, we have systematically studied the effect of deposition potential, pH, deposition temperature and electrolytic cell concentration on the formation of fcc Co nanowires by X-ray diffraction (XRD), transmission electron microscope (TEM) and scanning electron microscope (SEM). The Co nanowires deposited at the potential of -1.6V are pure hcp phase. When increasing the value of potential to -2.0 V, there are hcp Co and fcc Co crystals in the deposited nanowires. The fraction of fcc Co crystals in the nanowires increases with increasing the potential value. At -3.0 V, the nanowires are pure fcc Co. The pH of the solution has little effect on formation of fcc Co nanowires. We have also seen that high concentration and low temperature favors fcc phase whereas low concentration and high temperature favors hcp phase. However, at 35°C the co-occurrence of hcp and fcc phases were also observed. These experimental results can be explained by the classical electrochemical nucleation theory. The formation of fcc Co crystals can be attributed to smaller critical clusters formed at a higher potential value since the smaller critical clusters favor formation of fcc nuclei.

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Rapid detection of microcystin-LR in biological fluids by functionalized magnetic gold nanoparticles and surface enhanced Raman spectroscopy

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Rapid, selective, sensitive and cost effective label free SERS method has been developed for the selective isolation and determination of Microcystin-LR (MC-LR) toxin in biological sample. MC-LR antibody fragments were used as a recognition layer onto magnetic core gold nanoparticles to extract MC-LR from horse plasma matrix within 30 minutes. The purified MC-LR was quantitatively determined by surface enhanced Raman spectroscopy (SERS) and the results were cross validated by ELISA technique. The new SERS method showed high selectivity and sensitivity down to the femtomole detection limit. The new method has strong potential for the rapid screening of MC-LR in the field.

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Extraction of cellulose nanofibrils from pulp using enzymatic treatment and evaluation of their papermaking potential

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Cellulose nanofibrils (CNF) have shown potential of their extensive use in various fields, including papermaking, due to their unique characteristics. In this study, CNF's were prepared by fibrillating the pulp obtained from raw materials e.g. bagasse, hardwood and softwood using enzymatic pretreatment followed by mechanical refining. These nanofibrils, when examined under FESEM, show that partial fibrillation on the fiber surface has resulted in production of nanofibers. Mixing these nanofibers with unrefined and normally refined fibers shows their reinforcing effect. This effect is manifested in observing improvement in the physical and mechanical properties e.g. tensile index and burst index of paper. Tear index, however, was observed to decrease on blending with the nanofibers. The optical properties of the paper sheets made from blended fibers showed no significant changes in comparison to those made from only mechanically refined pulp. Blending also showed increase in °SR and consequent decrease in drainage rate. These changes observed in mechanical, optical and other physical properties of the paper sheets made from nanofibrils blended pulp have been tried to explain considering the distribution of the nanofibrils alongside microfibrils in the fibrous network. Since usually, paper/boards with higher strength are observed to have diminished optical properties which are a drawback in their quality, the present work could lead to developing a new technology of making paper with improved strength along with undiminished optical properties utilizing the concepts of nanoscience and nanotechnology.

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