Tuesday Evening Poster Sessions

Nanometer-scale Science and Technology
Room: Hall 3 - Session NS-TuP

Nanometer-scale Science and Technology Poster Session

NS-TuP1 Characterization of Nanodiamonds with Nitrogen Vacancy Centers for Optically Detected Magnetic Resonance in Biological Applications, ***Molly May***, University of Colorado at Boulder, *K. Briggman*, National Institute of Standards and Technology (NIST)

The unique chemical, optical, and spin properties of nitrogen vacancy centers in nanodiamonds make them a promising new material for biological sensing. They exhibit strong, stable fluorescence at room temperature and can be used to interrogate the spins of local molecules via optically detected magnetic resonance (ODMR) in biological environments. Successful implementation of ODMR requires control of the size and surface chemistry of the nanodiamonds as well as determination of the numbers and locations of the nitrogen vacancy centers. We report a process for disaggregating commercially available detonation nanodiamonds and we characterize and modify their surface chemistries. Furthermore, we measure the fluorescence and spin properties of the nitrogen vacancy centers and describe our progress toward constructing a multimodal (optical with microwave) platform for performing ODMR using nanodiamonds in living cells.

NS-TuP2 Understanding the "Click Chemistry" Approach to Achieve High-Coverage, High-Precision Nanostructures Deposited on Solid Surfaces, ***Mackenzie G. Williams***, *A.V. Teplyakov*, University of Delaware

The use of layered nanostructures as a platform for surface reactions requires the ability to maintain precise control over the architectural structure and surface chemistry. The use of a copper(I)-catalyzed cycloaddition between azide and alkyne moieties to build such structures has been amply reported. This "click reaction" allows selective covalent attachment but the development of a layered structure in which each layer consists of a single layer with a coverage close to 100% has yet to be reported. In the present work, gold substrates were functionalized with terminal azide groups and silica nanoparticles of different sizes were functionalized with either alkyne or azide groups. This approach allows for a simple verification of a full monolayer deposition via microscopy. In a sonication-assisted "click reaction", a monolayer of the alkyne-terminated nanoparticles was attached to the substrate. The formation of the monolayer was confirmed by scanning electron microscopy (SEM) and the calculated surface coverage, close to 95% compared to the absolute maximum, was much higher than those reported in literature for similar systems. Atomic force microscopy (AFM) was used to verify that a single layer of nanoparticles was produced instead of a well-ordered stack of multiple layers. A focused ion beam (FIB) was used to cut into the sample and confirm the nanoparticle layer height by SEM. Subsequent "click reactions" with alternating alkyne- and azide-modified silica particles formed high-coverage multilayer structures. In a separate set of experiments, iron oxide nanoparticles were modified with alkyne groups and were "clicked" onto a gold substrate. The chemical attachment was followed by attenuated total reflectance infrared (ATR IR) spectroscopy and X-ray photoelectron spectroscopy (XPS) and compared to predicted spectra obtained through density functional theory (DFT) calculations to confirm completion of the "click reaction". The improved control and surface coverage over previously-reported systems is thought to result in part from the sonication-assisted attachment, in contrast to typical procedures that include stirring or dip-coating to promote attachment. The mechanism of attachment, specifically the catalyst intermediate, is also thought to play a role in the nanoparticle attachment density. DFT investigations into the stability of the intermediate were used to determine how the functionalization scheme of the starting materials may affect surface coverage. This work outlines modifications to a commonly-practiced attachment procedure that provide unparalleled surface coverage and control over individual layers of the nanostructures produced.

NS-TuP3 FIB Technique for PVTEM Sampling of MESH Capacitor, ***Sungho Lee***, Samsung Electronics, Republic of Korea, *C.W. Yang*, Sungkyunkwan University, Republic of Korea

As the semiconductor device feature size continues to be scaled down, the aspect ratio of the capacitor becomes higher to satisfy the high capacitance requirement for cell operation. The higher the height of capacitor, the more storage node bent. Therefore, we adopt the Mechanically Enhanced Storage node for virtually unlimited Height (MESH) [1] process to prevent storage node's bending nowadays. However, even with this process, there are failure problems and the yield is still less than 100%. To find methods to prevent these problems, the failures should be analyzed. Normally physical failure analysis (PFA) needs a site specific transmission electron microscopy (TEM) sample which is vertically cross-sectioned by using focused ion beam (FIB) [2], but sometimes a plan-view TEM (PVTEM) sample [3] is also required to clarify the exact cause of failure .

The nodes do not stand in a line after conventional FIB work for PVTEM sampling. The node may fall off a TEM thin foil sample in the worst case. In order to overcome this problem, we developed new FIB technique for PVTEM sampling of MESH capacitor. The new FIB technique comprises four major steps:

Step 1 : '1' shape marking at the target height

Step 2 : milling a top part of capacitor

Step 3 : carbon deposition to fill the space between nodes

Step 4 : milling a bottom part of capacitor

Conventional FIB work consists of step1, 2, and 4. We add a carbon deposition step right after the 2nd step of the top part milling. We found that the nodes seem to move during the 3rd step milling (mill a bottom part) because of the void between nodes.

We adopted this modified milling method to the TEM sampling of a real failure case and obtained a PFA result of a 2 bit failure using plan-view TEM image. The new modified milling method turned out to be very effective and can be adopted in a mass production.

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NS-TuP5 A Simple Fabrication of Nano-Pillar Structures by Contact Block Copolymer Technique, ***Hwasung Kim***, Samsung Electronics, Republic of Korea, *J.W. Park*, *D.H. Yun*, *G.Y. Yeom*, Sungkyunkwan University, Republic of Korea

Recently, the formation methods of nano-structured materials are intensively investigated for next-generation devices such as chemical sensor, optical sensor, field effect transistor, and solar cell. The diameter, spacing, and shape of the nano-structured materials are very important in the devices because they control the device performance such as the electrical and optical properties. In this study, the silicon nano-pillar structures were fabricated by a contact block copolymer (BCP) technique which is a potential technique for the fabrication of self-aligned nanoscale structures. For the contact BCP technique, a nanometer scale BCP pattern such as hole and line pattern was formed on the silicon surface and the BCP masked silicon was exposed to nitrogen ion beam for the surface nitriding. Using the nitride surface, after the removal of the BCP mask, the silicon nano-pillar structures could be successfully fabricated using chlorine-based ion beam. This technique provided a method of forming a silicon nanostructure using simplified process steps by removing additional step of the mask deposition and etching. Especially, due to the extremely low thickness of the nitride mask layer, precise transfer of the mask dimension to silicon was possible. The use of low-energy ion beam could minimize the damages on the nano-pillar silicon surface in addition to the increase of etch selectivity.

NS-TuP6 A Calculation of the Virtual Source Size of Electron Gun using Digital Image Processing Techniques, ***Cheolsu Han***, Korea Basic Science Institute, Republic of Korea, *B. Cho*, Korea Research Institute of Standards and Science, Republic of Korea, *J.-M. Jeong*, *J-G. Kim*, Korea Basic Science Institute, Republic of Korea

An electron microscope (EM) such as a scanning electron microscope or a transmission electron microscope are powerful tools in nanometer science and technology.[1,2] There are important parameters such as a resolution and a probe current in the EM.[2] The optical parameters of an electron source such as a virtual source size and a brightness are strongly relate to the parameters and a performance of the EM. These parameters can be used to design the optical system of EM such as a condenser and an objective lenses and calculate a magnification and a probe current. In order to design an optical system, we have to find the optical parameters of the electron gun. In this work, we describe how to calculate the virtual source size.

To calculate the virtual source size, a homebuilt electron gun testing system (HEGTS) have been developed. Electron beam images have been obtained

by the HEGTS which includes an electron gun with tungsten hairpin filament, a movable aperture, and imaging system with CCD camera. Digital image processing techniques such as a noise rejecting filter, a binary image, a pixel operation method, and etc. have been used to calculate the virtual source size.[3] And a shadow-image technique also have been used.[4] An apparent edge sharpness of the shadow image is determined by the source size. A distance between 25% and 75% of a maximum intensity of electron beam profile can be used to calculate the size.

To obtain the electron beam images by CCD camera (1,600x1,200 pixels), we used a W hairpin filament at a vacuum pressure of $5.5x10^{-5}$ Pa. In order to accelerate the generated electron beam, the electron gun system is floated at -10 kV and the filament is heated by adjusting the current flow. A virtual source position was obtained by the movable aperture (100 um) and the beam images. Finally, we calculated the virtual source size of 44.2 um under the conditions.

We demonstrate how to calculate the virtual source size using the homebuilt electron gun testing system without a scanning coil and a secondary electron detector.

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NS-TuP7 Transport Properties of Ge Nanocrystals Embedded within a SiO_2 Matrix Produced by RF Sputtering, *A. Hernandez-Hernandez*, Universidad Autonoma del Estado de Hidalgo, Mexico, *A. Garcia-Sotelo, E. Campos*, ***Salvador Gallardo-Hernandez***, Cinvestav-IPN, Mexico, *J.L. Enriquez-Carrejo, P.G. Mani-Gonzalez, J.R. Farias-Mancilla*, Universidad Autónoma de Ciudad Juárez-IIT, Mexico, *M. Melendez-Lira*, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mexico

The characteristics of germanium, mainly its compatibility with silicon technology, and the sensitivity of its band structure to confinement confer a high attractive to the synthesis of germanium nanostructures. The samples were prepared on p-type Si (1 1 1) substrates by reactive sputtering. Structural characterization was carried out by grazing angle X-ray diffraction. Surface roughness was quantified by atomic force microscopy and correlated with micro Raman spectroscopy imaging. X-ray diffraction showed the amorphous characteristics of the heterostructures. Micro-Raman mapping allow to obtain the Ge nanocrystals distribution. XPS indicates that there is a transition layer with a gradual composition around Ge nanocrystals. SIMS results are well correlated with the Ge depth distribution observed by micro-Raman imaging. IvsV and spectral response results are correlated with the size and spatial distribution of Ge nanocrystals.

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NS-TuP8 Nanoparticles Produced by Laser Ablation in Liquid Enviroment, ***LuisAlberto Hernández-Hernández***, Instituto Politécnico Nacional, Mexico, *A. Hernández-Hernández*, Universidad Autónoma del Estado de Hidalgo, Mexico, *F. De Moure-Flores*, Universidad Autónoma de Querétaro, Mexico, *J.G. Quiñones-Galván*, Universidad de Guadalaja, Mexico, *M. Meléndez-Lira*, CINVESTAV-IPN, Mexico

The formation of ZnS, ZnO, Ge, Si and SiGe alloy nanoparticles under laser ablation of solid targets in liquids environment is reported. The use of an Nd:YAG laser allow high rate of nanoparticles formation as a solution. The nanoparticles are characterized by X-ray diffraction (XRD), UV-Visible transmission spectroscopy and transmission electron microscopy (TEM). The nanoparticles size dependence on both the laser fluence and the nature of the liquid is studied. In some cases, nanoparticles of compounds are formed via reaction of the target whit the liquid.

NS-TuP9 Enhanced Photoresponse of a Metal-Oxide-Semiconductor Photodetector with Germanium Nanocrystals Embedded in the Silicon Oxide Layer, ***Arturo Hernández-Hernández***, Universidad Autónoma del Estado de Hidalgo, México, *L.A. Hernández-Hernández*, Escuela Superior de Física y Matemáticas del Instituto Politécnico Nacional, Mexico, *F. De Moure-Flores*, Universidad Autónoma de Querétaro, México, *J.G. Quiñones-Galván*, Universidad de Guadalajara, Mexico, *B. Marel Monroy, G. Santana-Rodríguez*, Universidad Nacional Autónoma de México, *M. Melendez-Lira*, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mexico

In this work we report a two-terminal metal-oxide-semiconductor photodetector for which light is absorbed in a capping layer of germanium nanocrystals embedded in a silicon oxide matrix grown on p -type silicon substrates. Operated at direct and reverse bias photoresponse from 900 to 1300 nm was observed. Also, we report on the effect of nanocrystal size on the photocurrent. The highest optoelectronic conversion efficiency was observed in samples with smaller germanium nanocrystals. This effect were explained by a transistorlike mechanism, in which the inversion layer acts as the emitter and trapped positive charges in the dielectric layer assist carrier injection from the inversion layer to the contact, such that the primary photocurrent could be amplified.

NS-TuP11 Clarifying the Role of Surface Chemistry in Fabrication of Large Nanostructured Surfaces using Ion Irradiation, ***Kayla Steeves Lloyd***, *I.L. Bolotin, M. Majeski*, University of Illinois at Chicago, *M. Schmeling*, Loyola University Chicago, *L. Hanley, I. Veryovkin*, University of Illinois at Chicago

Formation of hexagonally ordered nanodots on GaSb surfaces during ion sputtering in the late 1990s has invigorated interest in using low energy ion irradiation for nanostructuring and functionalization of material s surfaces. However, the underlying physical phenomena behind this technique remain poorly understood, leaving many questions about the mechanisms of nanostructure formation via ion irradiation unanswered. This dearth of understanding stems in part from the fact that research in this area has focused thus far primarily on surface structure, and not surface chemical composition. A surge of interest toward the role chemical processes play in forming morphology of surfaces irradiated by ion beams is evidenced by a series of recent works on surfactant sputtering and silicide induced ion beam patterning. In view of this growing interest, we report herewith experimental results on surface nanostructuring of Si via irradiation by low energy inert gas ions in various arrangements featuring co-deposition of impurity atoms on irradiated surfaces in order to "seed" the formation of nanostructures. These atoms were sputtered from smaller targets of various geometries placed close to Si samples. Such arrangements allow for controllable variation of the fluence, impact energy, and incidence angle of bombarding ions as well as of the surface concentration of impurity atoms. Instead of focusing on previously well studied fine nanoripple and nanodot patterns, this work concentrates on courser surface morphologies obtained at fluences nearing 10^{19} ions/cm^2. These ion-irradiated nanostructured samples have been comprehensively characterized by structure-sensitive (SEM, AFM and XRD) and composition-sensitive (XPS and TXRF) experimental techniques in order to better understand the interplay between chemical composition and structure of their surfaces. It has been confirmed that the nanostructured surfaces were much easier obtainable via the "seeding" approach. Moreover, using Si as the "seeding" target failed, in contrast to Cu and stainless steel targets that helped produce feather-like arrays of tilted amorphous nanopillars/nanocones homogeneously covering large surface areas exceeding 100 mm^2. This necessity of using certain metal surfactants for nanostructure formation proved the importance of surface chemistry in formation of the surface structure under ion irradiation. Experimental results on surface processing with low energy ion beams and compositional-versus-structural characterization obtained in this work will be discussed and interpreted in our presentation at the Meeting.

NS-TuP13 Nitrogen Vacancies in Nanodiamond As Nanoscale Probes in Complex Environments, ***Margaret Robinson***, *J. Ng, H. Zhang, Z. Ma, R. Goldsmith, R.J. Hamers*, University of Wisconsin-Madison

The unique optical properties of nitrogen vacancies (N_V^-) in nanodiamond offer an opportunity to probe charge, spin, and other local properties in complex environments at the single-particle level. The intensity of fluorescence from N_V^- centers can be modulated by the application of a microwave field. In complex, heterogeneous systems this ability to selectively modulate the intensity of N_V^- centers using microwaves can be used to discriminate between fluorescence due to nanodiamonds and fluorescence arising from other sources. Here, we describe experiments aimed at understanding the factors that control the ability to read out N_V^- center fluorescence and reject background fluorescence. We have characterized the optical response of N_V^- centers in diamond nanoparticles having different diameters and bearing different numbers of N_V^- centers using photoluminescence, fluorescence lifetime, and single-particle

microscopy. Results of N_v-center modulation via applied microwave fields will be described, along with an analysis of the signal-to-noise parameters for optimization of N_V^- centers as probes of the charge, spin, and other local properties in complex materials systems.

NS-TuP14 Dielectrophoresis (DEP)-Aligned Carbon Nanotubes for Fabricating Electronic Devices, ***John Elike***, *Z. Xiao*, Alabama A&M University

We report the fabrication of carbon nanotube field-effect transistors (CNTFETs)-based inverter and ring oscillator electronic circuits. The dielectrophoresis (DEP) method was used to align and deposit single-walled carbon nanotubes for fabricating the electronic devices. The electrical property of fabricated CNTFET-based devices was measured. The CNTFET-based inverter shown excellent electrical transfer characteristics, while the CNTFET-based ring oscillator demonstrated oscillation characteristics, denoting that the CNTFET-based circuits can function well for the application of electronic circuits.

NS-TuP15 Preparation, Characterization, and Optical properties of Al Doped Vanadium Pentoxide Nanowires, ***Chen-Chuan Chang***, National Tsing Hua University, Taiwan, Republic of China, *M.W. Huang*, Chinese Culture University, Taiwan, Republic of China, *H.C. Hsih*, National Chung Hsing University, Taiwan, Republic of China

Al doped Vanadium pentoxide nanowires were synthesized via a rheological phase reaction on Si (100) substrate by self-assembled process using solid precursors of vandium powders (V2O2 99.5%) in an Ar atmosphere ($5x10^{-2}$ Torr, 10 sccm) at 800 ^oC in a horizontal quartz tube furnace. The nanowires with high yields were obtained in the whole substrate, have a length of several micrometers and diameter of 50 and 100 nm. XRD and TEM analysis show an orthorhombic crystal structure growing along direction [020] with sharp diffraction peaks at (010) and (020). XPS patterns showed three conspicuous binding energy peaks of nanorods is characteristics of vanadium in the +5 oxidation state which is well consistent with the value of V2O5 structure. Micro-Raman spectroscopy was also used to investigate the vibrational modes of the nanowires. Thermal CVD process can be expected to serve as a practical and general method to synthesize metal oxide nanowires in a large scale.

NS-TuP16 Formation of Ag Nano-net for Application to Flexible Electronics, *J.W. Fang, J.K. Wu,* ***Dung-Ching Perng***, National Cheng Kung University, Taiwan, Republic of China

Electronics built on flexible substrate creates a wide range of exciting consumer products. Many of the developed or under developed flexible electronics, such as displays, sensors, solar cells and artificial electronic skin, are based on very thin organic or polymer substrates and some may suitable for roll-to-roll manufacturing. The ability of bending, rolling, and elastically stretching defines the electronics' degree of flexibility. The structure of a generic electronics is composed of a substrate, back-electrode, active layers, front-electrode, and encapsulation. To make the structure flexible, all components must bendable to some degree without losing their function. However, in-organic thin film materials used for building the device layers are rigid and brittle. They often result in peeling, cracking or rupture when devices are subjected to mechanical strain and/or thermal stress. In the case of flexible CuInSe2-based solar cells, one of the challenge tasks is to improve cracking or rupture issues of the Mo back-contact. In our previous studies, the Mo layer deposited on polyimide (PI) substrate showed that the Mo layer will not crack until the PI substrate curving to 20 mm in diameter either tensile or compressive stress applied.

Silver possesses the highest electrical conductivity of any element and the highest thermal conductivity of any metal. Silver is also a very ductile and malleable element. Its plasticity properties capable of extent or deform without fracture. Embedded Ag nanowires (NWs) into transparent conducting oxide (TCO) films, such as AZO or ITO, has been intensively studied recently. However, the Ag NWs are just stacked together, the junction resistance of the two Ag NWs is larger than 1G ohms. Lower junction re-sistance and junction reliability need to be further improved for its application to reliable flexible electronics.

Ag atoms can migrate easily from (100) to (111) surface to lower its surface energy upon annealing. The Ag NWs are fused at the junctions after thermal annealing. The surface migration can happen as low as 90^{o}C. The Ag NW splits into several dome-shaped Ag nano-particles if over-annealing is performed. Conditions for forming Ag nano-net (NN)with fused junctions are studied using tube furnace and rapid thermal annealing systems. NW density, temperature, and annealing time are the key factors affecting Ag NN's formation. When embedding in Al2O3-doped ZnO film, a 40-80% (dep. on NW density) further reduction in film resistivity can be achieved as compare fused NW junctions to that of non-fused junctions. Developing of Ag NN and all other detailed results will be presented in the conference.

NS-TuP17 Nichrome Nano-Pillars formed by using Plasma-Assisted GLAD, ***Dean Walters***, Argonne National Laboratory

Glancing angle deposition has already made a place for itself by being a simple process for making 1-D nano-structures such as rods and pillars. Since the structures are formed as an array built up on a substrate they can be directly applied to applications such as battery anodes, electron emitters, and gas sensors. Why this technique is applicable to a variety of metals and compounds this study focuses on Nichrome A which is an alloy of 80% nickel and 20% chromium which has useful deposition characteristics at room temperature.

The resulting structures that are made by using magnetron sputtering with the addition of plasma assistance will be presented. The purpose of the plasma assistance will be to assess its ability to alter the surface migration of adatoms with the goal of changing the width of the pillar by a means other than temperature. SEM and other results comparing nano-pillars made with and without plasma assistance will be presented.

NS-TuP18 A New Alternative for Silicon Thinning using NH_4OH Solution Wet Etching for 3D MOS Transistors, *G.M.B. Soares, A.R. Silva, F.H. Cioldin, L.C.J. Espíndola, J.G. Filho,* ***Ioshiaki Doi***, *J.A. Diniz*, University of Campinas, Brazil

Tetramethylammonium hydroxide (TMAH) aqueous solutions, which are the silicon orientation-dependent wet etching, have been used for silicon thinning to get silicon nano (SiNWs) or sub-micron (SiSMWs) wires. These wires can be used as the conduction channel for three-dimensional (3D) Metal-Oxide-Silicon (MOS) transistors, such as FinFETs and JunctionLess, respectively. In this work, instead of TMAH, ammonium hydroxide (NH_4OH) solutions (concentration of 9% wt) are used to get SiNWs and SiSMWs, because also these solutions are silicon orientation-dependent wet etching. Furthermore, NH_4OH solutions are cheaper and fully compatible with CMOS technology. Silicon wafers with (100) crystallographic orientation were used. On these wafers, after RCA cleaning, 330 nm thick SiO_2 layer was grown using thermal oxidation. Lithography, SiO_2 etching (using HF solution) and organic cleaning (to remove photoresist) steps were carried out to define lines of SiO_2 (masking oxide) with width of 3 μm and spacing of 7 μm between lines. Reactive Ion Etching with SF_6 plasma was carried out, resulting in silicon three-dimensional (3D) mesa structures under SiO_2 lines. The 3D mesa sidewalls are the <110> planes and the Si surface between the mesa structures are the <100> plane. After anisotropic etching using NH_4OH solution, Optical (OM) and Scanning Electron (SEM) Microscopy analysis were used to get images of top and side views of samples. The results presented that the <111> planes of Si surface with (100) crystallographic orientation between the mesa structures (spacing of 7 μm) were exposed, resulting a V-groove shape, while, the lateral etching under SiO_2 of <110> plane mesa sidewalls occurred, with consequent thinning of these 3D structures. Using the etching process time and 3D structure measurements extracted from OM and SEM , the lateral etch rate under SiO_2 of <110> plane mesa sidewalls of 110 nm/min was obtained. It is important to notice that the sidewalls are smooth, which is a mandatory requirement to fabricate SiNWs and SiSMWs for 3D conduction channel for FinFETs and JunctionLess transistors. Thus, using our method to get silicon thinning with NH_4OH solution, both devices have been fabricated on Si and SOI wafers, with (100) crystallographic orientation surfaces, respectively. On both wafers, the lateral etch rate under SiO_2 of <110> plane 3D mesa sidewalls of 110 nm/min was repeated and SiNWs and SiSMWs were obtained, indicating that our NH_4OH solution is a new alternative to get 3D nanostructures on Si substrates. The electrical characteristics of these devices are going to present in the conference.

NS-TuP19 Design and Development of a Microfluidic Device for the Synthesis of Bioconjugated Lipidpolymer Hybrid Nanoparticles, ***Eri Takami***, San Jose State University

In recent years, lipid -polymer hybrid nanoparticles have gain attention as an efficient drug delivery device to treat various diseases, including cardiovascular disease, tuberculosis, and cancer. To synthesize lipid-polymer hybrid nanoparticles in a simple, efficient manner, we designed and developed a microfluidic device that utilizes a three channel pathway and a mixer channel. We prepared the microfluidic wafer using soft lithography techniques; with a negative masked designed with AutoCAD, we exposed UV light onto photoresist on a silicone wafer to outline the channels of the device. We then molded the microfluidic device using polydimethlsiloxane (PDMS) as the primary material for the fluid flow channels. The PDMS mold of the device was bonded to glass using plasma bonding in a vacuum chamber. The prepared microfluidic device can be customized to synthesize nanoparticles of different size, different encapsulated drug, and different surface functionalization. The production of higher quality nanoparticles in an efficient manner using our microfluidics device can expedite the research and development process of drug delivering lipid polymer hybrid nanoparticles.

NS-TuP20 Integration of Fe3O4 Nanoparticles on Graphene Oxide Assisted by Ultrasound for Electrochemical Supercapacitors, ***Jeseung Yoo***, *Y.-S. Seo*, Sejong university, Republic of Korea

Fe_3O_4-reduced graphene oxide (rGO) composite has been developed for electroactive materials for supercapacitor due to its synergistic effects between them. Integration of Fe_3O_4 nanoparticle on GO has been usually done based on by precipitation, chemical binding, and charge interaction. In the process, oxygen-containing functional groups on GO act as a template for binding the nanoparticles. Therefore rGO prepared by low temperature or chemical methods for supercapacitor electrodes applications would inevitably possess some part of oxygen, which reducing supercapacitor performance because of charge transfer resistance. Here we developed an integration method assisted by ultrasound where hydrophobic nanoparticle forms hydrophobic bonding to hydrophobic part on graphene oxide. Chemical structure of the composite was confirmed by UV-vis spectrometer, FTIR, and Raman scattering, and its morphology was monitored by TEM, SEM, and XRD. We tested the stability of the composite by cathodic potential cycling and defined the specific capacitance.

NS-TuP21 Graphene Quantum Dot-Titania Nanoparticle Composite As Photoanode in Photoelectrochemical Cells, ***Sowbaranigha Chinnusamy Jayanthi***, *R. Kaur*, *F. Erogbogbo*, San Jose State University

A composite material is synthesized using graphene quantum dots (GQDs), titania nanoparticles (TiO2) and Polyvinyl alcohol (PVA) as the binder. A thin film of the hybrid paste is spin coated on an ITO substrate. The GQDs are synthesized by wet chemical method using bird charcoal and are non-toxic and inexpensive. The effect of concentration, pH, and size of the GQDs on the photo catalytic properties of titania are studied. GQDs exhibit optical absorptivity; photoluminescence and band gap tunability depending on the size and have the potential to enhance the photocatalytic properties of titania. In particular the hybrid combination is expected to decreases the recombination of charge carriers, increases mobility of the charge carriers and helps to improve the overall photo-conversion efficiency. The size and structure of the composite material are studied using analytical characterizations techniques such as Scanning Electron Microscope (SEM) image, Atomic force microscope (AFM) and X-ray diffraction patterns (XRD). Electrical/electronic performance of the composite photocatalyst is studied using photocurrent density measurements that are obtained from Photoelectrochemical cell (PEC) experiment. Photoluminescence (PL) spectrum, and UV-vis transmission spectrum results aid in understanding the optical-electrical properties. The use of this combination of materials is novel in photo electrochemical (PEC) water splitting application and has implications for efficient and cost effective solar fuel cells.

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