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Photocatalytic conversion of carbon dioxide (CO_2) to hydrocarbons such as methanol makes possible simultaneous solar energy harvesting and CO_2 reduction, two birds with one stone for the energy and environmental issues. This work describes a high photocatalytic conversion of CO_2 to methanol using graphene oxides (GOs) as a promising photocatalyst. The modified Hummer's method has been applied to synthesize the GO based photocatalyst for the enhanced catalytic activity. The photocatalytic CO_2 to methanol conversion rate on modified graphene oxide is 0.172 μmol g-cat^{-1} h^{-1} under visible light, which is six-fold higher than the pure TiO_2. Meanwhile, we have developed a novel *one-step* and effective electrochemical (EC) method to directly exfoliate graphite into thin reduced graphene oxide (RGO) nanosheets at room temperature. The oxidation degree of the RGOs depends on the switching potentials of the EC synthesis. The high switching potential can significantly increase the C/O ratio of the RGOs. The ability to control the light-absorption of the RGOs by simply adjusting the switching potentials can be further achieved. Moreover, we also construct an RGO–ZnO heterojunction and investigate its photoelectrochemical (PEC) properties. The results show that highly photoactive RGO as a photosensitizer can make H_2 evolution easier and improve the photoconversion ability of ZnO under visible-light irradiation. This approach presents us with a possibility for the environmentally friendly, ultrafast, low-cost, and large-scale production of RGOs and great potential in solar-energy conversion applications of graphene-based materials. Further, Cu and MoS_2 nanoparticles were deposited on GO as co-catalysts to enhanced the photocatalysis reaction. Not only methanol, but also acetaldehyde was detected. Total solar to fuel yield of 6.8 μmole g-cat^{-1} h^{-1} has been achieved, which is 170 times enhancement relative to the commercial P-25 photocatalyst. In all the above-mentioned hybrids, the photo- catalytic performance is always much better than that of constituent component when used alone. Detailed preparation and characterization of the catalysts will be presented. The role and interplay of the constituent components will also be discussed in this paper.

FK-4:L18 **Electrochemical Measurements and Metal Deposition on Graphene Layers at Liquid/Liquid Interface**

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Polarisable liquid/liquid interfaces (ITIES) have been investigated for over 30 years, mainly in the context of ion and electron transfer reactions. The potential drop across the ITIES is developed over a region of 1 to 10 nm. The nucleation of metallic structures, catalytic activity e.g. hydrogen and oxygen evolution, the assembly of nanoparticles or catalytic nanoparticles have received a great interest in the last years.
Graphene nanomaterials were prepared in two ways: exfoliation from natural graphite in 1,2-dichloroethane dispersion and chemical vapor deposition (CVD) on copper foil. Both types of material were assembled at the ITIES. The graphene materials before and after assembly were characterized by Atomic Force Microscopy and Raman spectroscopy.
The electrochemical reactivity of nanostructures was probed by model redox species at the ITIES. In situ electrochemical and spontaneous metal deposition at the interface assembled carbon nanomaterials were studied, and the morphology of the deposited metal was determined using electron microscopy.
Deeper understanding of the behavior of model redox couples on graphene is of primary importance in the exploitation of this material in catalytic processes, such as of the oxidation of low molecular weight alkanes to liquid fuels.

FK-4:L21 **Photo-thermal Desorption of Toluene from Single Walled Carbon Nanotube Adsorbent Pads in Air Samplers**

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Activated Carbon (AC) is widely used to collect volatile organic compounds (VOCs) in air samplers. Laboratory analysis is performed by chemical or thermal desorption. Both these methods present limitations with respect to either sensitivity (chemical) or cost (thermal) and are time consuming. A technique that achieves partial desorption and improves sensitivity over chemical desorption would be desirable. Single Walled Carbon Nanotubes (SWNT) have similar VOC adsorption properties as AC. Camera flash has been used to ignite SWNT; therefore, light flash could be used for desorption. We prepared SWNT adsorbent pads, loaded them with toluene vapors and used light flash to achieve partial desorption.
Methods: Light flash of different energies is applied to AC and SWNT samples. Samples were loaded with toluene and flashed once per minute. Light is absorbed and converted into heat causing desorption. A photo ionization detector was used to quantify desorbed toluene mass.
Results: SWNT-felt desorption was nearly constant across successive flashes whereas SWNT-powder and AC-powder exhibit exponential decrease after first flash. At 435μg toluene and 4.7J flash, first flash and 10-flash desorption was: SWNT-felt 0.86%, 7.71%, SWNT-powder 0.57% and 2.92%, AC-powder 0.34% and 1.37% respectively.
Conclusions: Single flash desorption can deliver more sample to an analytical instrument than chemical extraction. SWTN-felt desorption is additive whereas SWNT-powder and AC are exponentially decreasing.

ABSTRACTS

Session FK-1 - Growth and Processing

FK-1:IL01 **Graphene Growth and Integration in Nanoelectronic Devices**

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In the past decade, the state-of-the art Si-based electronics has gone from devices above 100 nm to the realm of 20 nm and below. As devices have scaled below a gate length of 100nm the performance per power density has not scaled. In order to address the power issues the industry is facing as CMOS devices are scaled, in addition to the introduction of high-k, metal gates, and FinFETs, new materials and devices that take advantage of new state variables to improve performance per power density will have to be studied. Graphene has been the subject of considerable theoretical and experimental interest because of its unique physical properties. New devices taking advantage of the theoretical prediction on the existence of a Bose-Einstein condensate in bi-layer graphene films, graphene based tunnel FETs, Veselago lens based devices, and all spin logic devices have been proposed. In order to demonstrate that any of the proposed can meet the basic device requirements, high quality films will have to be developed and integrated with dielectrics and metal contacts. In this presentation we will review the need for devices beyond CMOS, growth of polycrystalline and single crystal graphene, and integration of dielectrics and metal contacts and their effects on FET characteristics.

FK-1:IL02 **Science and Applications of Doped Nanocrystalline Diamond Films and Particles**

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Nanocrystalline diamond (NCD) is a versatile, granular material usually deposited in the form of a thin film using plasma enhanced chemical vapour deposition (CVD) techniques. While more traditional applications, such as wear resistant coatings, make use of undoped films, most of the currently envisaged applications are based on electrically conductive, doped material.
The first part of this presentation will focus on fundamental aspects of the three main dopant atoms incorporated through in-situ doping during the growth: boron, nitrogen, and phosphorus. The granular nature of the material, partly influenced by the deposition conditions, will greatly influence dopant incorporation, location, bonding structure, and distribution. In turn, such aspects will become evident in several basic properties, including electrical transport, which will be treated in detail.
Then a selection of applications based on doped films will be discussed. These include heavily B-doped membranes acting as beam monitors and piezoresistive elements, and thermionic emitters based on P-doped films.
Finally, to conclude, the use of thick, microcrystalline films as a starting material for the fabrication of doped nanoparticles, their subsequent characterisation, and possible use will be considered.

FK-1:IL03 **Oriented Attachment Growth of Micro-sized Diamond Crystals from Detonation Nanodiamonds**

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We have submitted experimental evidences on formation diamond single crystals (SC) ranging from 50 nm to 1 micron at HPHT sintering of detonation nanodiamonds (DND) particles with grain size of 4 nm. The SC are formed in the thermodynamic stability region of diamond without any metal catalyst.
Results of SEM, TEM, EELS, Raman scattering allow us to conclude that the oriented attachment growth (OAG) mechanism [1] is responsible for the crystals growth. Boundaries between initial 4 nm grains in the crystals are either fully coherent or have only single defects localized in 1-3 carbon layers with sp3-hybridization.
The OAG was known only for oxide systems [1], however we have recently found that X-ray coherent scattering region of DND particles was increased at HPHT sintering [2-4] and that fact can be also related to the OAG. Possibility of OAG diamond SC from DND open a new way for synthesis of perfect micro-sized diamonds with desirable concentration of impurities and defects.
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