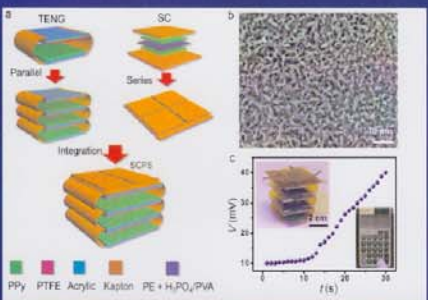
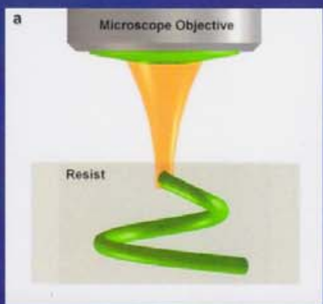
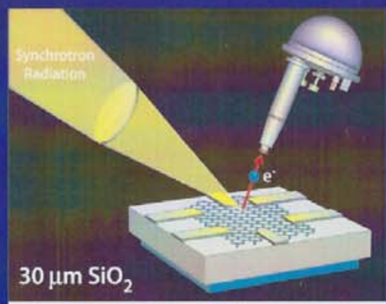
EMN MEETING

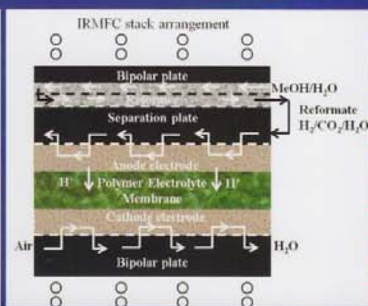
EMN Dubai Meeting
Energy Materials Nanotechnology
April 1-4, 2016 Dubai, United Arab Emirates

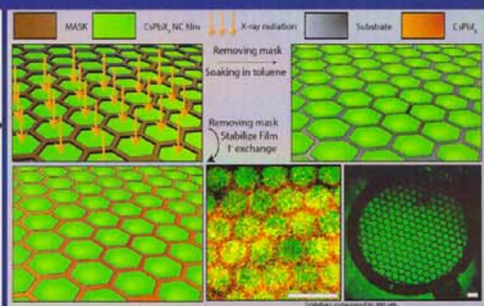
PROGRAM & ABSTRACT









B06: Towards Fundamentals of Catalysis by Metal-Carbon Nanocomposites

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Conductive carbon supports in comparison to conventional metal oxides and zeolites endow the catalysts with a unique, effective electron transfer system towards unexpected activity and selectivity patterns. In addition to impacts of textural properties and confinement effects of carbon nanotubes (CNT), several surface properties of carbon supports (e.g., types and concentrations of heteroatom groups and defects, as well as surface geometric structures) have been suggested for the exceptional catalytic performance of metal nanoparticles. Such complex surface heterogeneity gives rise to a particularly intricate interaction with metal NPs, delaying fine-tuning of the catalysts and maximizing of metal utilization efficiency. Herein, exemplified with Pt-CNT nanocomposites as catalysts for hydrolytic dehydrogenation of ammonia borane, the objective of this study is to engineer the dispersion and electronic properties of the active site atoms by tailor-designed Pt particle size and carbon support surface[1-3] and thus achieve the maximum mass-specific and durable reactivity, aiming to obtain the fundamentals of catalysis by metal-carbon nanocomposites.

We identify experimentally and theoretically that ca. 1.8 nm sized Pt-CNT catalyst is optimum with the highest reactivity arising from the largest amount of active site atoms. The size-dependent durability is principally ascribed to the adsorption of B-containing species and the change in the Pt particle size and shape. The support effects mainly arise from different electronic properties of Pt NPs, different adsorption abilities of B-containing species on Pt surfaces and changes in size and shape of Pt NPs. Defect-rich CNTs are a promising support for the preparation of highly active and durable Pt-CNT catalysts for the reaction. These results demonstrate that engineering of the metal NPs size and surface chemistry of carbon supports is an effective method to maximize the utilization efficiency of Pt catalysts. The methodology revealed here could open new avenues for the rational design of metal catalysts with the maximum mass-specific and durable reactivity.

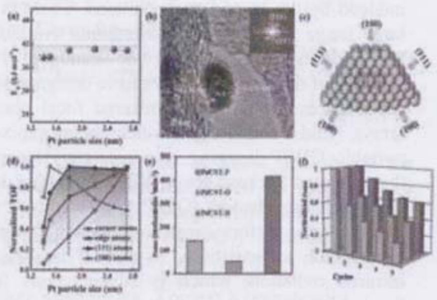

Figure 1. (a)Activation energy as a function of Pt particle size, (b) typical HRTEM image of Pt nanoparticle supported on CNT, (c) schematic diagram of truncated cuboctahedron, (d) plots of normalized TOF with Pt particle size, (e) $r_{initial}$ of Pt/CNT-P, Pt/CNT-O, and Pt/CNT-D catalysts, and (f) normalized $r_{initial}$ as a function of cycle number over the three catalysts.

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2. W.Y. Chen, J. Ji, X.Z. Duan, G. Qian, P. Li, X.G. Zhou, D. Chen, W.K. Yuan, *Chem. Commun.* 50, 2142 (2014).
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B07: Narrow bandgap quantum dot mid-infrared photodetectors

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Nowadays, the development of infrared photodetectors is manly based on the nature of semiconductor nanostructures. Especially, quantum wells (QWs) and quantum dots (QDs) have a great interest for next generation devices. Quantum well infrared photodetectors (QWIP) possess the availability of the mature of III-V fabrication technology and multi-spectral capability. This type of photodetectors has a narrow absorption spectrum that can be tuned by varying the quantum well width and the barrier induced by the layers' compositions. There is a large range of material combinations available for allowing the tailoring of bandgap via stacking of thin layers. QWIPs have designed for superlattices for advanced infrared focal plane arrays, mid- and long-wavelength megapixel portable QWIP imaging cameras, etc. Despite the achieved success for QWIPs, quantum dot infrared photodetectors (QDIPs) are predicted to have superior performances compared to QWIPs [1, 2] such as sensitivity to normal incidence infrared radiation, which is advantageous for focal plane arrays, low dark current which enables high temperature operation, high responsivity and detectivity resulting from the longer carrier lifetimes due to the suppressed electron-phonon scattering in QDs. These and other QDs-based devices are expected to perform well at room or near room temperatures due to their three-dimensional carrier confinement characteristics.

In this work, we report our efforts to grow and investigate InAsSbP QDs. The nanostructures were grown by modified liquid phase epitaxy (MLPE). The grown nanostructures were investigated by atomic force microscope (AFM), transmission electron microscopy (TEM) and scanning tunneling microscope (STM) techniques. An AFM image of unencapsulated InAsSbP QDs grown on InAs substrate is presented in Fig. 1. QD based photodetectors were fabricated in the form of photoconductive cells made of an InAs(100) substrate and unencapsulated InAsSbP QDs grown on it [3]. The cutoff wavelength of 3.9 μm for fabricated QDIP was observed. We have investigated room temperature optical properties of those structures under irradiation of 3.39 μm using He-Ne laser as well. Appling low bias of 8 mV, the current responsivity of the QDIP was found to be 0.2 mA/W at power density of 0.07 W/cm^2. In addition, capacitance and magnetoresistance hysteresis in fabricated QD based structures were detected at both room and liquid nitrogen temperatures.

These results are important not only for better understanding of the physical processes occurring in QD systems, but also for their further application for improving the output device characteristics of InAs-based mid-infrared photodetectors operating especially at room temperature.

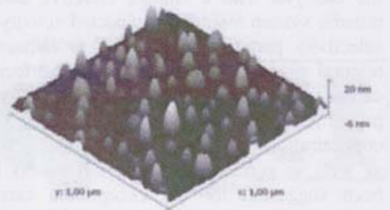

Fig. 1. AFM image of unencapsulated InAsSbP QDs grown on InAs substrate.

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B08: Economic dehydration of isopropyl alcohol by using urea as extracting agent

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Isopropanol (IPA) is a widely used solvent in many processes like in pharmaceutical syntheses. However, dehydration of IPA is not easy because an IPA–water mixture forms a