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NEBRASKA CENTER FOR MATERIALS AND NANOSCIENCE
2013 SEMINAR SERIES PRESENTS

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Synthesis and properties of size selected Pd, Pd alloy and Pd-graphene nanoparticles

The unprecedented research interest in the area of nanotechnology stems from the potential to fabricate devices at nano scale with improved characteristics and the possibility of studying novel low dimensional physical phenomenon. In this presentation, results of the experiments carried out in our laboratory on size selected Pd, Pd alloy, Pd-graphene core-shell nanoparticles will be discussed.

A nanoparticle deposition facility comprising of material ablation, particle charging, differential mobility analyzer based size selection, in-flight sintering, nanoparticle deposition in clean vacuum conditions along with on-line size distribution measurements has been established. Gas sensing characteristics of Pd nanoparticles have been studied as a function of nanoparticle size. Our research shows that by controlling the nanoparticle size and separation, geometrical effects due to lattice expansion during hydride formation and electronic effects due to H incorporation can be controlled and separated. These results set the foundation for a new type of H sensor device having a pulse like response.

The integrated deposition set up has been modified to grow alloy nanoparticles. Important co-relationship between valence band spectra and hydrogenation properties in Pd alloy nanoparticles is established. Size induced shift in Pd4d centroid results in enhanced hydrogenation with H/Pd ratio of 0.57 and 0.54 in Pd-Ag and Pd-Cu nanoparticles in comparison to reported bulk values of 0.2 and 0.1, respectively. The observed reduced embrittlement and higher hydrogen reactivity of Pd-alloy nanoparticles is important for a number of hydrogen related applications.

Based on novel modifications in the above mentioned set up, a general method for a continuous gas-phase synthesis of size-selected graphene-metal nanoparticles for direct deposition onto any desired substrate is reported. The growth takes place via an intermediate state of alloy nanoparticle (graphene-Pd) or composite nanoparticle (graphene-Cu), depending upon the carbon solubility in the metal and relative surface energy values. It has been also shown that graphene-metal nanoparticles can be converted to graphene shells. This study will have a large impact on how graphene or graphene based composite nanostructures can be grown and deposited in applications requiring controllable dimensions, varied substrate choice, large area and large scale deposition. The graphene-metal nanoparticles have several advantages in comparison to unprotected metal nanoparticles in biological, plasmonic and magnetic applications. A brief outline of other research activites on resistive memory devices, single nanorod solar cells for leaf on a chip technology will also be presented.

Monday, October 7, 2:00 pm
Room 110 Jorgensen Hall

3:00 pm—Refreshments served in Jorgensen Atrium area

Host:
Prof. David Sellmyer
Department of
Physics & Astronomy

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