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Tuesday, March 14, 2006 2:30PM - 5:30PM – Session K6 COM: Minorities in the Nanosciences Baltimore Convention Center 310

2:30PM K6.00001 Controlling Carbon Nanotube Quantum Devices. NADYA MASON, University of Illinois at Urbana-Champaign — The unique properties of nanotubes make them attractive candidates for a variety of quantum devices. We present transport data on nanotube-based quantum devices that demonstrate both one-dimensional physics and quantum-dot behavior. We show how voltages applied to narrow metallic gates can be used to produce localized depletion regions in the underlying tubes. A single depletion region in a nanotube with ohmic contact electrodes creates a quantum point contact, while a pair of depletion regions defines the quantum dot. Local gate voltages tune the conduction through point contacts, the transparencies of tunnel barriers, and electrostatic energies within single and multiple dots. We will show how this full gate control allows us to measure and control quantum phenomena such as quantized conductance steps and “Honeycomb” charge stability patterns in nanotube devices.

3:06PM K6.00002 Dielectrophoretic gating and phase separation of particles for micro- and nano-fluidic biodetection applications¹, CONRAD JAMES, Sandia National Laboratories — Performance metrics for biological detection systems are significantly impacted by their ability to separate target analytes from background materials, a process that aids in the elimination of false positives. We report here several implementations of an electro-hydrodynamic technique for separating analytes in nanoliter sample volumes. This technique, AC dielectrophoresis (DEP) accompanied by field-induced phase transitions, includes electric field- and shear-induced phenomena to modify local concentrations of suspended particles. This non-optical separation technique relies upon intrinsic electric polarizability, and thus requires no time-consuming and costly labeling steps. We have demonstrated biological and non-biological particle separation, and both batch-mode and continuous flow configurations have been developed. The dielectrophoretic gating technique has been optimized to produce large electric field gradients ($\nabla E^2 \sim 10^{20} V^2/m^3$) and we are currently applying this technique for particle chaperone preconcentration and nucleic acid purification. For the first application, we have achieved 100x preconcentration factors and high efficiency particle valving with no degradation in flowrate. This technique will prove useful for bead-based assay systems utilizing packed beds or high throughput flow cytometry. In the second application, we have preconcentrated dsDNA target molecules, and shown that preconcentration of false-positive inducing ssDNA reporter oligonucleotides is negligible. This method can be integrated on-chip, providing a significant advantage over conventional off-chip purification technologies such as centrifugation and precipitation. We will also present our results in traveling wave DEP, a technique which utilizes phase-quadrature signals to preconcentrate and transport particles without the use of hydrodynamic forces.

¹Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.

3:42PM K6.00003 Enhanced Physical Properties of Quantum-Confined Europium Sulfide Nanocrystals, MARCELA REDIGOLO, DMITRY S. KOKTYSH, SANDRA J. ROSENTHAL, JAMES H. DICKERSON, Vanderbilt University — Synthesis and characterization of sub-2.0 nm europium sulfide nanocrystals is presented. Of particular interest is the behavior of the optical, magnetic, and magneto-optical properties as the nanocrystal diameter decreases, approaching the quantum confinement regime. The physical properties of these materials are dominated by 4f ionic transitions, which are affected directly by the nanocrystal size, due to nearest and next-nearest neighbor couplings. We believe that nanocrystal size, surface strain, and surface passivation will enhance the observable physical characteristics of the nanomaterials. To our knowledge, this would be the first evidence of quantum confinement effects in europium chalcogenide nanocrystals. Calculations of the Bohr radii of the 4f transition establish the upper limit on the nanocrystal size that exhibits blue shifts in the fluorescence and, perhaps, enhancements on the magnetic moment (μ_{eff}). Structural properties are characterized by transmission electron microscopy, selected area electron diffraction, and x-ray diffraction. Absorption and photoluminescence spectroscopy measurements also are presented to describe the optical properties of the nanocrystals.

3:54PM K6.00004 Network Structures in ABC Block Copolymers, THOMAS EPPS, MICHAEL FASOLKA, NIST, Polymers Division, FRANK BATES, University of Minnesota — At mesoscopic length scales interfacial curvature and packing geometry often reflect the self-assembly of molecules with prescribed architectures and directed interactions. It is well known that block copolymers microphase separate into periodic structures controlled by interaction parameters, volume fractions, and degree of polymerization. Some of the most promising morphologies in block copolymers are the periodic network phases, which generally have superior mechanical properties when compared to their one- and two-dimensional counterparts. We investigated the phase behavior of linear poly(isoprene-*b*-styrene-*b*-ethylene oxide) (ISO) triblock melts and discovered three triply-periodic networks. Two cubic network phases were found, along with an orthorhombic network in our bulk studies. It is also important to expand knowledge of free and substrate surface energy effects on triblock films, as the greater surface to volume ratio, relative to bulk materials, increases the influence of these parameters on thin film morphologies. To this end, we studied the effects of surface energy on the structure of the same ISO triblocks mentioned above. These films were examined on gradient substrates using AFM and XPS. Surface energy and PI content were found to influence the polymer nanostructures. The results we obtained demonstrate the importance of exploring both the thin film and bulk behavior of polymeric materials.

4:06PM K6.00005 Local Structure and Photoluminescence Decay Dynamics in Undoped and Mn²⁺ Doped ZnSe Nanoparticles, THADDEUS NORMAN, Lawrence Livermore National Lab, CHRISTIAN GRANT, Rutgers University, EDWARD OLANO, University of California, Santa Cruz, EDWARD CASTNER, Rutgers University, FRANK BRIDGES, JIN ZHANG, University of California, Santa Cruz — Undoped and Mn²⁺-doped ZnSe nanoparticles were synthesized from molecular cluster precursors. The nanoparticles were characterized using UV-VIS, PL, ESR, and XAFS. These studies confirmed the presence of Mn²⁺ dopant in the host ZnSe lattice, and suggested the existence of two distinct Mn²⁺ sites in the ZnSe lattice. Energy transfer dynamics in Mn²⁺-doped ZnSe nanoparticles were also studied using time-integrated and time-resolved spectroscopic techniques. Time-resolved picosecond PL and femtosecond transient absorption studies show that the Mn²⁺ doping substantially shortens the lifetimes of both the band-edge excitonic states and the shallow trap states. Energy transfer from ZnSe to Mn²⁺ likely follows two mechanisms: one that involves mediation through trap states and another without.

4:18PM K6.00006 New Approach Towards Aqueous Functional Nanostructures via Amphiphilic Coordination Networks, JUAN NOVERON, University of Texas at El Paso — The unprecedented use of designed amphiphiles with coordination-capable head groups that allow for the traditional coordination-directed networks to further self-assemble into nanostructures with novel complexity and function will be presented. With this approach the versatile chemistry of transition metals and the properties that amphiphiles exhibit in aqueous media are combined to generate extraordinary materials with interesting functions such as gene-encapsulation and delivery, drug-delivery vehicles, and hydrogen storage materials.

4:54PM K6.00007 Effects of interfacial bonds and strain on the formation of InAs/GaSb Self Organized Nanostructures¹

, DONNA STOKES, University of Houston — Interfacial effects play an important role on the formation of self-organized nanostructures based on the morphological instability of strained semiconductor multilayers. For many III-V systems with a misfit of less than 1%, instability occurs at some critical layer thickness, which is typically large (>150 Å). However, for the non-common anion strained system, InAs/GaSb, the instability is observed at a thickness of a few monolayers. In this presentation, the results of a structural analysis by x-ray diffraction of an InAs/GaSb planar and nanowire superlattice grown by molecular beam epitaxy (MBE) with different interfacial bonds will be presented. Cross sectional scanning tunneling microscopy (XSTM) and atomic force microscopy (AFM) were also used to probe the physical structure of the superlattices. The effects of the strain and interfacial bond on the formation of the nanostructures will be discussed as well as how they may be manipulated to control the formation of these nanostructures in this system and other III-V systems. Also presented will be the results from a preliminary analysis of the effects of the nanostructure on the optical properties of the system.

¹Co-authors are J.H. Li, O.Caha, S.L. Ammu, J. Bai, K.E. Bassler, J. Wickett and S.C. Moss. We are grateful to the National Science Foundation for support of this work.