Seeded Growth of Shape-Controlled Wurtzite CdSe Nanocrystals: Cubes, Platelets, and Bullets
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Previous investigations into the synthesis of wurtzite CdSe nanocrystals have given rise to well-developed methods for producing particles with inorganic shapes such as rods, tetrapods and wires; however, the synthesis of other inorganic shapes has proved challenging. Here, we demonstrate the use of a seeded-growth approach to produce colloidal, shape-controlled wurtzite CdSe nanoparticles with previously unobserved morphologies. The synthesis, which makes use of small CdSe nanocrystals as nucleation sites for subsequent growth, can be tuned to selectively yield colloidal CdSe cube- and hexagonal platelet- and bulb-shaped nanocrystals, in addition to previously observed rod- and bullet-shaped particles. We characterize the structure and discuss possible growth mechanisms for these new shapes, and demonstrate a quantitative analysis technique for shape classification based on Fourier descriptors obtained from transmission electron micrographs.

Postfocused Nanocrystal Diameter Tuning through Control of the Reaction Rate and the Solubility: Experiment vs. Realistic Modelling
Maurice D. Bomardin1,2,3; Sohinsu Abe1,2,3; and Zeger Hens1,3; Department of Inorganic and Physical Chemistry, Ghent University, Ghent, Belgium.

We show that adjusting the reaction rate and solubility through ligand engineering in a hot-injection synthesis is a viable strategy to tune the diameter of colloidal nanocrystals at the end of the size distribution focusing, i.e., the post-focused diameter. The approach is introduced by synthesis simulations, which describe nucleation and growth of colloidal nanocrystals from a soluble or insoluble that is formed in situ out of the injected precursors. We present a coupled set of continuous rate equations, including monomer generation, nucleation and growth in one model. Instead of dimensionless parameters, we use common dimensions of diameter, time and concentration to keep comparison with experiments straightforward. We explore a three-dimensional parameter space by adjusting the reaction rate for monomer generation, the solubility and the temperature. These simulations indicate that the post-focused diameter is reached at almost full yield, and that it can be adjusted by the rate of monomer formation or the appropriate choice of ligand. We implement this site tuning strategy using a particular CdSe quantum dot synthesis that shows excellent agreement with the model synthesis. After demonstrating that the reaction rate depends in first order on the Cd-Se precursor concentration, the proposed strategy of site control is explored by varying the precursor concentration. This enables the synthesis of colloidal nanocrystals with a predetermined site at almost full yield and sharp size distributions, which is highly relevant especially in the context of reaction upscaling and automation. Moreover, the results obtained challenge the traditional interpretation of the hot injection synthesis, in particular the link between hot injection, burst nucleation and sharp size distributions.

Localised Defects of SiGe/Si Superlattice Structures for Sensor Application Using Ion Beam Bombardment
Craig J. Robertson1,2,3; Claudia Muscelli1,2,3; and Oyoil Saikhu1,2,3; Department of Physics, Auburn A&M Universit
8:30 AM CCL1
Silicon and Copper Selenide Nanocrystals for Biological Applications. Colin M. Hasel, Michael Rasch and Brian A. Koelle. Department of Chemical Engineering, University of Texas at Austin, Austin, Texas.

Nanocrystal and metal nanocrystals have been extensively studied for use in biological applications, for both disease detection and therapy. This research, however, has focused on a relatively narrow range of materials, primarily on gold and silver nanocrystals in the case of metals and Cd-based nanocrystals in the case of semiconductors. In recent years, the nanocrystal "tool box" has been expanded, including light-emitting silicon nanocrystals and more recently, transition metal chalcogenides like copper selenide for photonic heating. Here, we present recent research on the synthesis and surface functionalization of silicon nanocrystals for biological applications, including their inclusion in liposomes. We will also present our efforts on the synthesis and use of copper-deficient copper selenide nanocrystals for photothermal heating. Ligand-stabilized CuSe nanocrystals were synthesized by a colloidal hot injection method and coated with amphiphilic polymer. The nanocrystals readily disperse in water and exhibit strong near infrared (NIR) optical absorption with a high molar extinction coefficient. The NIR absorption is due to a photonic resonance related to the high free carrier density in the nanocrystals due to copper vacancies. When excited with 800 nm light, the CuSe nanocrystals produce significant photothermal heating with a photothermal transduction efficiency of 22%, comparable to nanorods and nanoshells of gold (Au). In vitro photothermal heating of CuSe nanocrystals in the presence of human colorectal cancer cell (HCT-116) led to cell destruction, demonstrating the viability of CuSe nanocrystals for photothermal therapy applications.

9:00 AM CCL2
An All-Quartz-Phase Approach for the Fabrication of Silicon Quantum Dots Light Emitting Devices. Rebeca Anthony, Kai-Yuan Chong, Zachary C. Holman, Russel J. Holmes and Vivek R. Kulkarni. 1Mechanical Engineering, University of Minnesota, Minneapolis, Minnesota; 2Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, Minnesota.

Quantum dots offer unique advantages for the manufacture of light emitting devices including their tunable optical luminescence, and compatibility with device fabrication on low-cost, flexible substrates that may open up routes to roll-to-roll manufacturing. To date, the fabrication of light emitting devices using quantum dot luminescence exclusively has relied on either the carbonate chemistry for the quantum dot synthesis, surface treatment, and deposition. In this presentation we demonstrate, to our knowledge for the first time, an all-quartz-phase approach for the formation of light-emitting devices from silicon quantum dots. In a single gas phase reactor, silicon quantum dots are synthesized, their surfaces functionalized with organic ligands, and deposited onto glass substrates carrying a transparent conductive oxide bottom contact. Production of silicon nanocrystals is achieved through plasma decomposition of the mono-silane precursor, leading to the formation of monodisperse silicon nanocrystals. Quantum dot surfaces are functionalized with organic monolayers by reacting the various alkoxides into the afterglow of the synthesis plasma. Inertial impaction of the functionalized silicon nanocrystals is used to form dense nanocrystal films. Devices are completed by metal evaporation of a top contact. The approach presented here completely avoids the use of solvents and allows the formation of field-emissive quantum dot devices with as little as three deposition steps for the top and bottom contact layers and the silicon quantum dot layer. Primary support for this work was received from the National Science Foundation (NSF) Award Number ECS-0925624. Partial support was also received from the NSF MRSEC Program under Award Number DMR-0820589. R.J.H. would also like to acknowledge support from IBM Company through a Non-Tenured Faculty Grant.

9:15 AM CCL3
Pyrite Nanocrystals: Shape-Controlled Synthesis and Tunable Optical Properties via Reversible Self-Assembly. Wei Li, Markus Doeblinger, Aleksandr Varesko, Andrey L. Rogach, Frank Jendruch and Jochen Peukmann. 1Photronics and Optoelectronics Group, Faculty of Physics and Center for Nanoscience, Ludwig Maximilians Universität München. 2Center for NanoMaterials, University of North Carolina at Chapel Hill.

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