Inorganic Chemistry Seminar

219 Brown Laboratory

March 22, 2017, 4:00 pm

Inexpensive, Efficient Approaches for Energy Production and Storage

We are interested in developing new synthetic methods for nanoscale materials with applications in energy conversion and storage. We work in three general areas: photovoltaics, hydrogen storage, and Li-ion rechargeable batteries. For this talk, I will focus first on using photovoltaic devices to produce energy, and second on developing new architectures for rechargeable Li-ion batteries for storing that energy.

Colloidal inorganic nanocrystals offer many advantages for use in photovoltaic devices: controllable synthesis, processability, and tunable band gap energies. Ideal materials for photovoltaics would contain earth abundant, nontoxic elements and would possess ideal band gaps. Copper and iron chalcogenides exhibit these properties. I'll discuss the synthesis and characterization of Cu_2ZnSnS_4 nanoparticles, as well as structure-property relationships for these particles as the metal and chalcogen stoichiometries are tuned. Finally, preliminary results on the effects of ligand exchanges on the surface of the particles on overall device efficiency will be presented.

The second part of the talk will focus on batteries. There are two main limitations to the rate of charging Li-ion batteries: slow diffusion of Li^+ into the electrodes and slow diffusion between them. The synthesis of high surface area electrodes has been shown to dramatically enhance performance because reducing the particle size of the electrode material reduces the distance the Li^+ ions have to diffuse. *The problem of decreasing the Li^+ diffusion length between electrodes has not yet been solved.* We are working to incorporate high surface area structures of a novel anode material into a new battery architecture wherein the current collector is conformally coated with an electrolyte made by electrochemical deposition, then surrounded by the cathode electrode. The significant advantage is that the diffusion length for Li+ between the cathode and anode will be dramatically reduced, which should lead to much faster charging rates.

Amy Prieto Ph.D.
Colorado State University
Department of Chemistry

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