The Hebrew University Center for Nanoscience & Nanotechnology

האוניברסיטה העברית בירושלים

Nano Seminar

Challenges and Solutions to Functional Nanoparticle Devices

Prof. Richard Robinson

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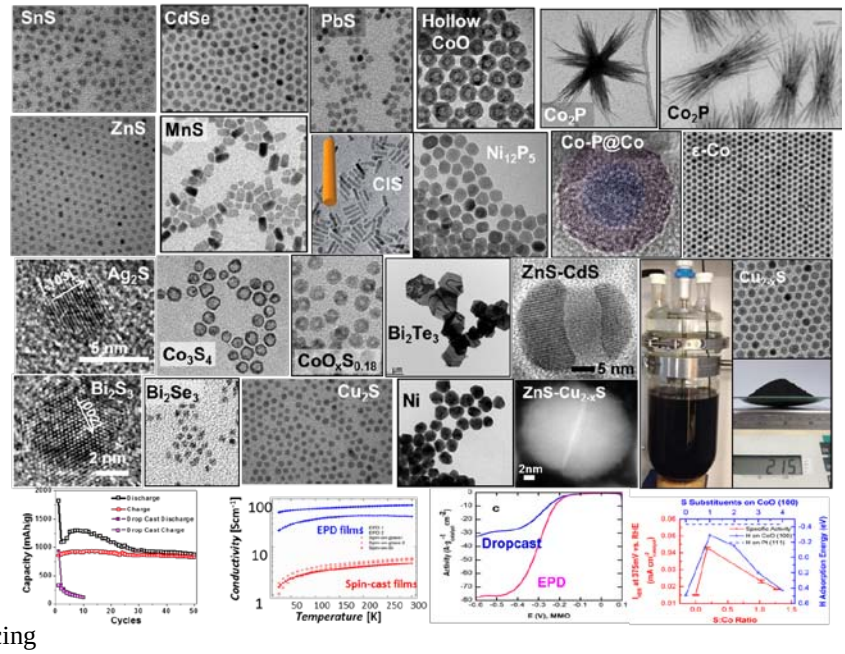
Abstract: Our research group works to gain a fundamental understanding of how to program and process nanoscale building blocks into functional structures, and the structure-property relationships of the resulting nanostructured materials. We seek to develop new nano-materials and methods for energy storage, fuel cells, and printable electronics. In this talk I will discuss our recent results overcoming critical challenges to the goal of creating functional nanostructured materials. I will discuss our work on scaling the synthesis, and our work chemically transforming nanoparticles to post-synthetically tailor their composition and properties.

I'll discuss our work on a rational method for the synthesis of monodisperse metal sulfide nanocrystals in organic solutions by using (NH4)2S as a sulfide precursor. The method enables low temperature (< 100 oC) syntheses, open-air reactions, high conversion yields (>90%), and large-scale production of monodisperse nanocrystals can be synthesized in a single reaction. I will also discuss our scalable results using ultra-high concentrations in a heat-up synthesis. These new highly-concentrated regimes alter the kinetics of the reaction and diverge from the classical LaMer model on solution-phase synthesis. Specifically, we synthesize high-quality metal sulfide nanoparticles (< 7% relative standard deviation for Cu2-xS, CdS, and PbS), and demonstrate a 1000-fold increase in production (>200 g) relative to the current field. Surprisingly, the nanoparticles in the matrix are resistant to Ostwald ripening over 4 hours under high heat (185 oC). To understand the mechanism we probed the interplay between chemical, thermal, and rheological properties on growth and dissolution. We find that ultra-high concentrations have an order of magnitude increase in viscosity, reducing mass diffusion, and a ~67% increase in heat capacity, stabilizing the reaction to perturbations. We find that nanoparticle growth at ultra-high concentration more closely align with a step coalescence growth model, while conventional synthesis conditions fall within a living coalescence model.



Finally, I'll discuss our work using chemical transformations to tailor particles for devices. Chemical transformations in nanoparticles are performed on as-synthesized nanoparticles to alter their composition, morphology, and/or phase. Focusing on electrocatalysis, I'll discuss our recent work showing how to optimize the hydrogen evolution reaction (HER kinetics) in cobalt oxysulfide nanoparticles by tuning the anion stoichiometry. We find that when sulfur is dilutely substituted for oxygen the enhancement can be as large as 5x for HER.

Gathering & Refreshments at 10:50

Please contact Liron Dover at 6584919 if you are interested in meeting the lecturer.

Sunday, Dec 6th 2015, 11:00 at the Seminar Hall

Los Angeles Building, entrance floor.