HL 16: Invited Talk Norris

Time: Tuesday 9:15–10:00 Location: H15

Invited Talk HL 16.1 Tue 9:15 H15

Why has doping been difficult in colloidal semiconductor quantum dots? — •David J. Norris — Department of Chemical Engineering & Materials Science, University of Minnesota, Minneapolis, MN 55455 USA

Doping - the intentional introduction of impurities into a material - is fundamental to controlling the properties of bulk semiconductors. The prospect of new technologies has motivated efforts to dope semiconductor nanocrystals since their discovery two decades ago. Despite some successes, many of these efforts have failed, for reasons that remain mysterious. For example, Mn impurities can be incorporated into nanocrystals of CdS and ZnSe, but not into CdSe - despite comparable bulk solubilities near 50 percent. These difficulties, which have hindered development of new nanocrystalline materials, are often attributed to "self-purification", an allegedly intrinsic mechanism whereby impurities are expelled to the nearby surface. We propose instead that doping is controlled by the initial adsorption of impurities on the nanocrystal surface during growth. We find that adsorption - and therefore doping efficiency - is determined by three main factors: surface morphology, nanocrystal shape, and surfactants in the growth solution. Calculated Mn adsorption energies and equilibrium shapes for several nanocrystals lead to specific doping predictions. These are confirmed by measuring how the Mn concentration in ZnSe varies with nanocrystal size and shape. Finally, we use our predictions to incorporate Mn into previously undopable CdSe nanocrystals. This success establishes that earlier difficulties with doping are not intrinsic, and suggests that a variety of doped nanocrystals - for applications from solar cells to bioimaging - can be anticipated.