**Metal Halide Perovskites at the Nanoscale: high quality optoelectronic materials with unique functionality and distinctions from thin film perovskites.**

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The rediscovered metal halide perovskite semiconductor system has the potential to be extremely transformative for all optoelectronic devices, especially photovoltaics (PVs). Perovskites show a unique tolerance to crystalline defects that cause trouble in most other semiconductors. Therefore, the potential offered is that very high efficiency PVs can be fabricated in extremely fast and inexpensive ways, thus offering a revolution for the solar industry and a direct route toward producing the world’s energy with a simple and clean technology. Long-term durability of the devices is the critical remaining challenge to be solved. Two examples of major instabilities in device performance are the volatility of the organic cation and the specific crystal habit in which the material embodies.

Nanoscale versions (often termed quantum dots (QDs)) of the all-inorganic metal halide perovskite (CsPbI3) tend to retain the desired perovskite phase due to strain effects at the surface of the QDs whereas conventional films of the same material “relax” to an orthorhombic non-perovskite structure at room temperature. Therefore, these QDs potentially solve both of the instability issues. This customizable new nanomaterial system has incredible potential for many applications in optoelectronics, including photovoltaics, LEDs, displays and lasers. This talk will cover several related projects that describe:

1) the phase stability of all-inorganic perovskite QDs

2) surface treatments to manipulate transport in perovskite QD arrays

3) cation exchange-based synthesis of homogeneous alloyed QDs

4) our latest work in QD solar cell device architectures

5) doping of perovskite QD films for manipulating electronic properties (enhanced mobility).