Low dimensionality cesium lead halide nano-perovskites a model system for the study of quantum confinement and luminescence

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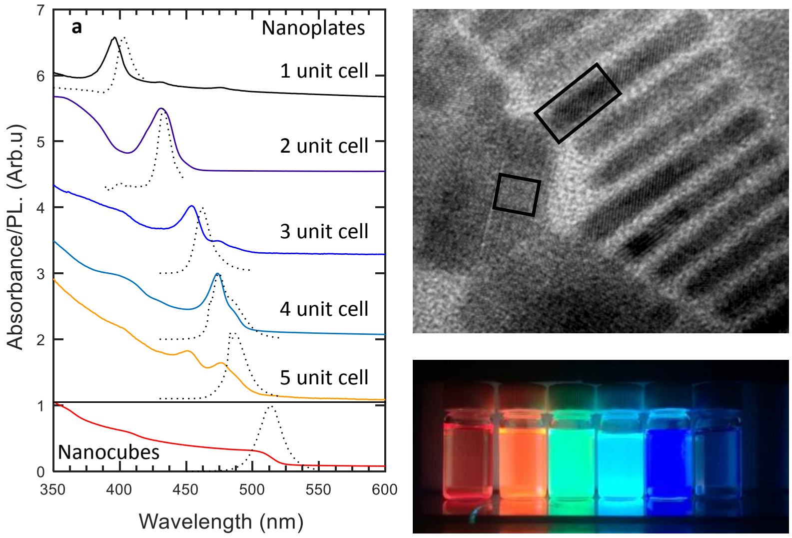
Thermodynamic considerations suggest correlation between efficient photo conversion and luminescent. Lead-halide perovskites have emerged as important optoelectronic materials with excellent efficiencies in photovoltaic and light-emitting applications We study low-dimensional colloidal nano-crystals of cesium lead halide which demonstrate exceptionally high photo luminescent quantum yields. We demonstrate how quantum confinement and dimensionality dictate the photophysical properties of these crystals. Recent synthetic development enable us to grow quantum confined cesium lead halide nanocrystals with cube, plate[1] and wire[2] geometry and with atomic precision[3]. This unique colloidal system enables the study of excitons in perovskites within a controlled quantum confined shape. In the case of 2D plates we observe increased excitonic interaction and increased absorption coefficient. In the case of nanowires we show that the broken symmetry manifests in polarized emission[4]. Through time resolved photoluminescence we demonstrate the importance of lower dimensionality in achieving longer exciton dynamics in perovskites. In addition by changing the anion composition facile band gap tunability throughout the visible spectrum is achieved.

Colloidal perovskites have surprisingly high luminescent (PLQY > 80%) an exceptional property for colloidal systems with untreated far from perfect surfaces. The high defect tolerance of perovskite is strongly related to the electronic structure in which atomic defect present themselves as shallow or in-band non-trapping states. The resulting high QY, combined with the synthetic versatility, position colloidal perovskites as a unique model system for the study of charge dynamics at the nanoscale, which is important in the greater context of understanding next generation materials for energy conversion applications. Future developments in perovskites, leading to more stable and lead free materials will also be discussed.



1. "Highly luminescent colloidal nanoplates of perovskite cesium lead halide and their oriented assemblies." *JACS* 137.51 (2015): 16008-16011
2. "Synthesis of composition tunable and highly luminescent cesium lead halide nanowires through anion-exchange reactions." *JACS* 138.23 (2016): 7236-7239.
3. "Ultrathin Colloidal Cesium Lead Halide Perovskite Nanowires." *JACS* 138.40 (2016): 13155-13158.
4. "Encapsulation of Perovskite Nanocrystals into Macroscale Polymer Matrices: Enhanced Stability and Polarization." *ACS Applied Materials & Interfaces* (2016).