# Materials Science & Engineering Thesis Defense

## Transmission Electron Microscopy of Formamidinium Lead Bromide and Iodide Perovskite Quantum Dots

**School for Engineering of Matter, Transport and Energy**

## Surya Prakash Reddy Mandalreddy

**Advisor:** Sandhya Susarla

## Abstract

Halide perovskites are prototypical systems touted as the next generation materials for solar cell applications due to their high-power conversion efficiencies. Engineering the same materials with different morphologies (nanodots, nanoparticles etc.) can result in confinement which creates scalable emitters with immense potential in quantum information science and engineering. Recently, nanocrystal morphology of halide perovskites in form of colloidal solutions has been designed but with only limited quantum efficiency. Engineering quantum dots in-situ in thin perovskite thin films during the crystallization process has the potential to create high efficiency emitters.

However, atomic scale microstructural characterization of these embedded emitters is equally challenging due to their electron beam sensitivity and similarity in lattice parameter between the quantum dot and matrix phase. This thesis presents a comprehensive understanding of atomic scale imaging of quantum dots embedded in a Formamidinium lead bromide (FAPbBr3) perovskite matrix with details about change in local lattice parameter, size, phase, and composition of the quantum dots using focused ion beam sample preparation technique, low-dose (scanning) transmission electron microscopy ((S)TEM) imaging and energy dispersive X-ray spectroscopy. The (S)TEM images revealed the formation of mixed halide perovskite phases such as FAPbBrxI3-x and FAPbI3 as quantum dots alongside the FAPbBr3 matrix phase. The size of the quantum dots varied from 3-10 nm with clustering of the smaller dots in some areas. The distribution of quantum dots in matrix was analyzed by creating composite phase maps using local diffraction pattern changes between quantum dot and the matrix. The EDX mapping confirmed the presence of all chemical species. The outcomes of this thesis will inspire further studies on how to prepare beam-sensitive cross-sectional TEM samples, cation/anion engineering to create complex quantum dots phases and how these phases react to external stimuli such as light, electric field and heat.

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Zoom Link: https://asu.zoom.us/j/4437514880

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