# Materials Science & Engineering Doctoral Defense

## Novel Approaches for Improving Efficiency and Stability of Next Generation Perovskite Solar Cells

School for Engineering of Matter, Transport and Energy

Aditya Yerramilli

**Advisor:** Dr. Terry Alford

## Abstract

Perovskite solar cells are the next generation organic-inorganic hybrid technology that achieved remarkable efficiencies that are comparable to Si-based conventional solar cells. Since their inception in 2009 with an efficiency of 3.9%, they have improved tremendously over the past decade and recently demonstrated 25.2% for single-junction devices. There are a few hurdles, however, that prevent this technology from realizing their full potential, such as stability and toxicity of the perovskites. Apart from the solution processing in the fabrication of perovskites, precursor composition plays a major role in determining the quality of the thin film and its general properties. This work studies novel approaches for improving the efficiency and stability of the perovskite solar cells with minimized toxicity. The effect of excess Pb on photo-degradation in MAPbI3 perovskites in an inverted device architecture was studied with a focus on improving stability and efficiency. Precursor concentration with 5% excess Pb was found to optimal for better efficiency and stability against photo-degradation. Further improvements to efficiency were made possible through the addition of Zirconium Acetylacetonate as a secondary electron buffer layer. Partial substitution of Pb with non-toxic Sn was studied for improving the stability of inverted devices. In another study, triple cation perovskites with FAMACs cations were studied with doping different amounts of Phenyl Ethyl Ammonium (PEA) to induce a quasi 2D-3D structure for improved moisture stability. We found that doping the perovskite with 1.67% PEA was best for improved morphology with fewer pinholes, which also resulted in better open-circuit voltage and stability. A passivation effect for triple cation perovskites was further proposed with the addition of Guanidinium Iodide layer on the perovskite for reducing defects and trap states and increasing the overall stability of the device.

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Zoom Link: https://asu.zoom.us/j/91488110725