Intrinsically Stable and Scalable Perovskite Solar Cells

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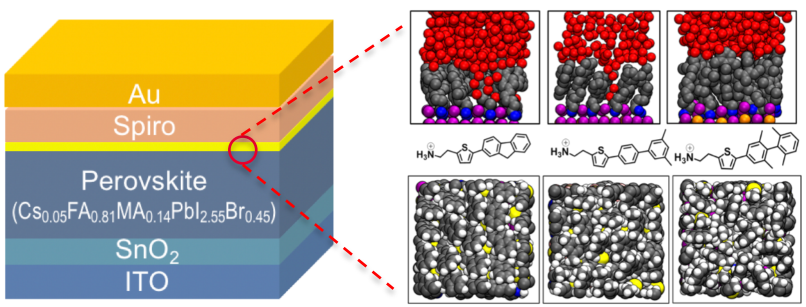
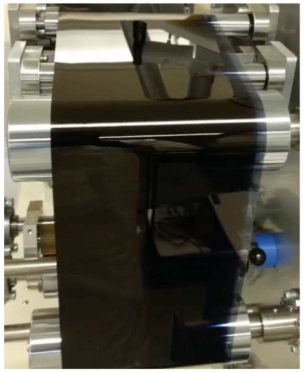
Project Summary

In this project, we propose a new paradigm to develop intrinsically robust perovskite active layers through the incorporation of multi-functional semiconducting conjugated ligands. Combining a team with expertise spanning the gamut of materials synthesis, computational materials design, and device engineering, we propose to develop a suite of multi-functional semiconducting ligands capable of improving the intrinsic stability perovskite materials while preserving and even enhancing their electronic properties. Through this strategy, we aim to achieve over 25% cell efficiency with operational stability over 5 years (under accelerated tests) and 18% mini-module efficiency (150 × 150 mm2) using a slot-die coating under this American-Made Solar Prize project.





Technical Approaches

- Molecular simulations, multi-functional ligand design and synthesis for perovskite active layer stabilization
- High performance lab-scale perovskite solar cell fabrication and characterization
- Scale-up materials synthesis and mini-module fabrication using fully printed slot-die coating
- Stability tests and stabilization mechanism investigation

Expected Outcomes

- Identify the most promising candidates and synthesize stable perovskite materials under moisture, oxygen, heat, and UV.
- Fabricate highly-efficient solution-processed perovskite solar cells with a power conversion efficiency over 25% with a device area of 1 cm^2.
- Demonstrate a >150 × 150 mm^2 solar module with efficiency over 15% using slot-die coating.
- Demonstrate supreme cell and module stability at 85 degree Celsius and 85% humidity.

Project Impact

Increasing intrinsic chemical stability and suppressing the ion migration in halide perovskites are vital for the device's long-term operational reliability. In addition, inhibiting ion migration and phase segregation is key for mixed halide perovskite sub-cell in a tandem device to avoid halide segregation and band gap shift. Success in addressing these issues will greatly accelerate the commercialization of perovskite photovoltaic technology, including both single junction as well as perovskite-silicon tandem junction devices.