Technical Assistance Request for Intrinsically Stable and Scalable Perovskite Solar Cells

In this project, we propose a new paradigm to develop intrinsically robust perovskite active layers through the incorporation of multi-functional semiconducting conjugated ligands. 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 mm^2) using a slot-die coating under this American-Made Solar Prize project.

High-level budget:

- Stage I (Ready!): $20,000 will be used to pay for the tuition and stipend for one graduate student who work on this project under the supervision of the PI and co-PIs. $30,000 will be used to purchase chemicals and supplies to carry out the materials synthesis and characterization and computer simulation.
- Stage II (Set!): $40,000 will be used to pay for the tuition and stipend for two graduate students who work on this project under the supervision of the PI and co-PIs. $60,000 will be used to purchase chemicals and supplies to carry out the materials characterization and solar cell device fabrications.
- Stage III (Go!): $100,000 will be used to pay for the tuition and stipend for two graduate students and two postdoctoral fellows. $100,000 will be used to purchase chemicals and supplies to carry out the materials characterization and computer simulation. $300,000 will be used to purchase materials and equipment to carry out the large-scale synthesis and large area solar module fabrication and testing.

Goals by Spring 2020 (Set! contest):

- Molecular simulation and screening
- Synthesis of the organic conjugated ligands
- Fabrication of stable perovskite-ligand hybrid thin films

Goals by Summer 2020 (Go! contest):

- Optical and electronic properties characterization
- Lab scale solar cell device with efficiency over 25%
- Lab scale solar cell device with stability over 5 years (accelerated tests)

Goals for Demo Day 2020:

- Demonstrate a >150×150 mm^2 solar module with efficiency over 15%

Technical Assistance Requested to Meet These Goals:

National Labs:

The Lawrence Berkeley National Laboratory has the state-of-the-art synchrotron X-ray sources to characterize the structure and morphology of the perovskite semiconductor thin films to identify the best condition for improving film quality. The National Renewable Energy Laboratory has extensive experience in fully characterizing solar cells and solar modules under standard test conditions as well as normal operating conditions (including harsh environments such as heat and humidity). Sandia National Lab has extensive experience characterizing the performance of solar panels with real time field testing as well as single module characterization. All of these labs would help characterize our technology as well as lending world class credibility. Therefore, we would like to:

- Access to synchrotron X-ray sources to characterize the structure and morphology of the perovskite semiconductor thin films
- Access to calibration standards for a unique set of solar cells and modules
- Access to measurement equipment such as solar simulators, reverse bias testing, resistance probing, and extended real-world shading testing.
- Access to characterization equipment such as electroluminescence, photoluminescence, electron lifetime photoconductance decay, and dark current-voltage. This is essential for us to fully characterize the devices we fabricate.
- Access to environmental chambers for damp heat testing at 85 ^{o}C and 85% humidity.

Private Industry:

The need for higher volume testing and assembly will require additional solar industry partners to aid in accelerating the development of our technology. In addition, having strategic relationships/partnerships with private industry partners and/or national labs with the ability to help procure the needed high purity raw materials would be helpful. Industry's opinion and advice on the scale-up manufacturing and business model development will be valuable for us to further develop out technology. Therefore, we would like to:

- Access to high-throughput coaters for scaling up production
- Access to raw materials such as high purity lead iodide, transparent conducting substrates.
- Access to consumables such silver paste, aluminum paste, screen printing materials
- Access to installation partners for real world data on performance benefits for shading, hotspot generation, and power production.
- Connection with high volume perovskite solar module manufacturers such as SwiftSolar and HuntPerovskite. In addition, collaboration and partnerships of fellow American Made companies would be a valuable asset to help accelerate the development.
- Connection with ADL Ventures on future commercialization model development.