Request for Technical Assistance from Swift Solar

Swift Solar requests technical assistance for the characterization, long-term reliability testing, and packaging of all-perovskite tandem solar cell devices. These tandem devices contain multiple layers of thin films that require careful characterization through various macroscopic and high-resolution nanoscale techniques. Furthermore, the long-term reliability of photovoltaic (PV) products is of utmost importance for commercial deployment, and specialized long-term testing equipment is needed to simulate real-world operating conditions. Cell interconnection and packaging technologies are required for the manufacturing of efficient solar modules and to support longer-term stability of perovskite PV modules by slowing the transport of degradation-accelerating moisture to the sensitive semiconductor layers.

Swift Solar particularly requests technical assistance from the National Renewable Energy Laboratory (NREL) and Lawrence Berkeley National Laboratory (LBNL). The Solar Energy Research Facility at NREL offers many relevant thin-film characterization tools, such as X-ray diffraction spectroscopy (XRD), energy-dispersive X-ray spectroscopy (EDX), scanning electron microscopy (SEM), atomic force microscopy (AFM), time-of-flight secondary ion mass spectrometry (TOF-SIMS), UV-Vis spectroscopy, and several other techniques that are useful for the analysis of individual layers and full tandem devices. For the isolation and interconnection of cells into modules with the highest possible power conversion efficiencies, NREL offers the know-how and equipment for mechanical and laser scribing. Assistance with these activities will play an important role in the scaling of Swift Solar's production. The Imaging and Manipulation Facility within the Molecular Foundry of LBNL offers further nanoscale characterization capabilities for Raman microstrain maps, photoluminescence lifetime and energy maps, cathodoluminescence, and elemental mapping (through EDX or X-ray fluorescence nano-Auger mapping). Additionally, thermal gravimetric analysis, gas chromatography, mass spectrometry, and FTIR spectroscopy would help Swift's scientists understand the quality of their manufactured thin-film devices.

Swift wants to establish outdoor testing procedures for perovskites, and specifically perovskite tandems with the outdoor test facility at NREL. The capability to monitor power output, irradiance, temperature, and weather conditions will be invaluable. Beginning outdoor tests as soon as possible is critical to begin to solve unforeseen challenges in perovskite stability.

The partnership with the National Laboratories and industrial entities is key to an efficient and rapid scaling of a solar start-up company like Swift, due to the tremendous costs that can be saved by not having to purchase highly expensive characterization and

manufacturing equipment while still being able to carry out world-class research and product development on perovskite PV. Swift Solar can then use its limited resources to focus on manufacturing tools specialized for all-perovskite tandem products to gain a competitive edge and at the same time use industry-standard characterization and testing procedures that are carried out by highly skilled professionals. In addition, the tools that are used for characterization and manufacturing can be tested for the specific process, and thus a future purchase of such equipment can be de-risked.

Furthermore, Swift Solar's credibility and the reputation for reliability of its products benefits enormously from trusted institutions such as NREL and LBNL. Many industry-accepted standard testing procedures for solar cells have been developed at NREL, so a close partnership with NREL would undoubtedly assist in the successful introduction of Swift Solar's products into the global PV market.