UNIVERSITY OF SOUTH FLORIDA

Solar Photovoltaic Manufacturing Facility to Enable a Significant Manufacturing Enterprise within the State and Provide Clean Renewable Energy

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Description: The primary goal of this project is to enable the establishment and success of local solar photovoltaic manufacturing companies to produce clean energy products for use within the state and beyond and to generate jobs and the skilled workforce needed for them. Thin film technologies have shown record efficiencies of 20%, and present tremendous opportunities for new Florida start-up companies. USF, UCF, and UF are collaborating to develop a pilot line facility for thin film solar technologies, which will serve as a test bed for making ongoing improvements in productivity and performance of solar modules, develop advanced manufacturing protocols, and help train a skilled workforce to ensure the success of new companies.
Budget: $1.6M
Universities: USF, UCF, UF
External Collaborators: Mustang Solar, a Division of Mustang Vacuum Systems

Progress Summary

During the reporting period we continued progress in both thrust areas of the project. Development of the thin Film Pilot line is awaiting completion and delivery of the deposition system. The components are being assembled at Mustang Solar, and delivery is expected by June 1. Meanwhile we have been conducting extensive laboratory experiments as part of our preparations for the pilot line. These experiments address both near-term and long term issues. Since the line will be processing CIGS technology, main emphasis is in that direction.

We are using our 25 year processing experience with CIGS to develop new pathways for processing. These pathways are a compromise between those that produce the best laboratory cells and those that are necessary for commercial success. The process that we are developing is termed 2SSS, "2 Step Solid State" processing. The advantages are that the process uses solid Se as the Se source instead of the highly poisonous gas H_2Se, and simultaneous control of multiple deposition sources is relaxed. Our primary focus initially is in controlling the material composition with the new process. A particular concern from a manufacturing perspective is the effective utilization of source materials. We discovered an interrelationship between the selenization of the metal layers and the loss of Ga. This issue was observed in applying the 2SSS process to the first step of the two step process that we are developing. In this step we form a Cu-rich CuGaSe layer which provides a larger grain platform for growth of the second step layer containing all four elements. For the simplified 2SSS process we found that in order to achieve full selenization Ga was being lost from the precursor layer. This lead to development of a modified 2SSS process that overcame this difficulty. Through further development of the process we demonstrated that the film composition using this process is the same as that produced by the highly controlled co-deposition process that produces 20% cells. This new approach is now being utilized in both steps of the 2 step process and initial results are indicating that we can produce the same film quality as with co-deposition while keeping the process time the same. We also have reduced Group III loss to the same level as co-deposition.

An important longer term issue for CIGS technology is the potential for scarce and expensive In. Efforts are underway in many labs to find a solution to this problem. A new material, $Cu_2ZnSnSe_4$ holds promise. In is replaced by the Zn/Sn couple and both are earth abundant. The new material structure(kesterite) is similar to CIGS, but adds additional complications. There is ongoing debate as to what the bandgap is, and cell efficiencies are only about 5%. We have developed a new fabrication pathway for the material that may lead to improved performance. By judicious tuning of the kinetics and thermodynamics of film growth we are able to produce films with the same properties as those produced under more tightly controlled deposition conditions. This is again an attempt to find a manufacturable pathway for this material. Our results are also contributing important insights to the structure of the material and its ensuing electronic properties. If these can be understood and controlled, the material could replace CIGS as a more sustainable material for large scale application.