UNIVERSITY OF CENTRAL FLORIDA

Research and Develop PV Devices Science and Laboratories

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Description: The primary challenge facing the PV industry is to dramatically reduce the cost/watt of delivered solar electricity by approximately a factor of 2 to 3, to increase the manufacturing volume by a factor of 10 and to improve the cell efficiencies by a factor of 2 to 3. This task will conduct R&D on basic science of PV cells and develop a world class PV cell laboratory for future cell research. The R&D will focus on developing new and improved PV cells such as organic PV, nano-architectures, multiple excitation generation, plasmonics, and tandem/multi-junction cells.

Budget: $882,507

Universities: UCF/FSEC

Progress Summary

The following are the PV measurement and evaluation systems procured and configured at FSEC during the last year and put into operation the last six months.

1. Customized Oriel Quantum Efficiency System

A quantum efficiency (QE) system is an essential tool for any laboratory working on photovoltaic (PV) materials and devices. With the help of Oriel's product engineers, our research group has configured this system to measure internal quantum efficiency (IQE). The difference between IQE and EQE is that IQE measurements account for any EM radiation reflected from or transmitted through the PV cell under test. By doing this, one can infer more about the internal workings of the active semiconductor layer, without concern regarding the cell's external optical properties (e.g. anti-reflection coatings). This allows one to determine whether bad performance comes from the active semiconductor itself or simply from high reflection losses at the surface of the cell.

The configuration and operation of this system has included many tasks, including installation of the individual components, optical beam alignment, integration of the LabView based software, several rounds of troubleshooting relating to both hardware and software complications, procedure development, adaptation of test procedures to novel materials and device architectures (e.g. organic PV, multi-junction devices), and development of analytical techniques for processing data. A large part of the effort was placed in customizing this system to measure transmission, absorption, and reflection measurements of samples, which is required for IQE. Working with Sphere Optics, a manufacturer of integrating spheres, our research group was successful in achieving this new functionality.

2. Oriel Class AAA Solar Simulator

In the context of PV materials and device research, a solar simulator allows for a dependable measure of device performance under broadband radiation that is spectrally similar to that coming from the sun.

The configuration and operation of this system has included the fabrication of a suitable structure for safely mounting the simulator on the laboratory bench, installing individual components (e.g. light source, power supplies, optical filters, etc.), verifying proper beam alignment and light throughput, and testing the unit with actual PV cells with known current-voltage characteristics.

3. Laurell Technologies Spin Processor

Spin coating systems are a common tool in semiconductor fabrication labs and facilities. They allow for a controlled deposition of liquid phase materials. The Laurell Technologies system features an automated dispense system, which allows for better control of the fluid during deposition, therefore better control of the final thickness, which is very important for PV devices which features individual layers smaller than 100 nm in some cases. The configuration and operation of this system has involved the fabrication of a structure to house the system, installation of individual components (e.g. vacuum pump for the substrate chuck, compressed nitrogen cylinder and regulator for system's pressure inlet), integration of the system software, and final verification of proper operation.

4. Dimatix DMP-2831 Materials Printing System

The largest and most expensive item of fabrication equipment is the Material printing system (Dimatix, Inc.). It is a system used for Inkjet- printed quantum dot and nanostructure hybrid PV and TE materials and devices towards solar energy application. This system provides a high degree of accuracy and reliability of fabrication when operated and maintained correctly. The DMP-2831 is a state of the art printing system which will generate new research capabilities for the FSEC, including experimentation with inkjet deposition of organic semiconductors, inorganic solution based semiconductors, and patterned conductive layers. The configuration and operation of this printing system has included the installation of individual components, installation and operation of the system software, fluid transfer to printer cartridge, and troubleshooting to overcome non-jetting nozzles.

Work will continue on developing advanced PV cells using the above experimental measuring systems.