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Reliability of Photovoltaic Cells, Modules, Components, and Systems

Neelkanth G. Dhere
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Introduction

With photovoltaic (PV) technology being widely launched all over the world, its final success would ultimately rest upon the reliability of the final product. However, it has not been given adequate weight until recently after the PV community realized that without giving a reliable and durable product to the customers it will not be possible to meet the long term goal, set by the U.S. Department of Energy, of reliable PV technology that can last for 30 years.

The SPIE 2008 Optics and Photonics event has made a pioneering step in this direction by tailoring a conference that has addressed vital issues in this regard by setting up a stage to allow intense interaction between the budding PV researchers and the expertise in the PV community.

37 presentations and 28 papers were received for this conference. The conference was divided into seven sessions extending over a three-day period during August 11 to August 13, 2008. Session one titled Metrology and Certification began with a talk on PV reliability determination from I-V measurement and analysis. The measurement and analysis of current vs. voltage (I-V) characteristics of PV cells and modules for reliability determination were discussed along with the error sources in the measurements and the strategies to minimize their influence.

Since III-V cells having >40% efficiency have already been developed, the session topic Reliability of Concentrator Optics and PV Cells is becoming increasingly important. With an attempt to reduce the cost of c-Si solar cell by reducing the wafer thickness, wafer breakage becomes a major reliability concern. The influence of microcracks on wafer strength and the role of reduced wafer strength on the reliability of solar modules were discussed along with a wafer screening technique that can isolate wafers that have a propensity for breakage.

There was an interesting invited plenary paper, "Reliability of PV Systems," during the Plenary Session. Three posters were presented as part of this conference that initiated an interactive session between students and researchers from the PV community.

Regarding Encapsulants, Back Sheet, c-Si and Glass, Thin Film PV—good packaging is synonymous with long term reliability. Good encapsulation and packaging schemes are, therefore, essential for the long term reliability of PV modules. With a greater thrust on minimizing our dependence on petroleum, it is essential to work toward developing backsheets from organic sources instead of producing them from petro-based chemicals as is being done currently. Attempts in this direction are being carried out by choosing PLA film made from corn, a cellulosic paper made from cotton, and nylon 11 made from castor oil.

Two joint sessions on Reliability of Flexible Packaging and Reliability of Organic Photovoltaics were organized in collaboration with conference 7052: Organic Photovoltaics IX.

There was also a short course on Design and Reliability of Photovoltaic Modules that turned out to be a grand success with a record enrollment of 34 students for the class. It was very well received and appreciated by the attendees. The tutorial's main discussion centered on the purpose of module packaging with typical configurations, concepts of physics of failures and their applicability in the PV systems, a brief history of field failures, development of accelerated tests, present status of module reliability, and, finally, the application of this knowledge to new products and technologies.

Neelkanth G. Dhere