IMEM-CNR, Sala A – 25/09/2019, ore 11.00

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Reliability research on laboratory scale and flexible commercial CuInGaSe2 solar cells and barrier materials

Abstract

Solliance Solar Research is a joint venture between the Dutch TNO, the Belgian imec and ECN (the Energy research Centre of the Netherlands, that became a part of TNO since 2018). It was founded in 2010 to unify research in the next generation of thin film solar cells. Together with the industrial and academic partners Solliance Solar Research plays a leading role in worldwide research and development of thin-film solar technology. Two of the three research programs at Solliance (the Module Programme and Integration Programme) are focused on CuInGaSe2 (CIGS), one of the most mature thin-film solar cell materials at the moment.

In the Module Programme work is being performed on a more fundamental level to improve the inherent stability and reliability of unpackaged CIGS-based devices through processing or material choice. An important aspect in these studies is the identification and classification of material defects, and the identification of the impact of defects on device performance and degradation behaviour. To this end, several laboratory scale cells were exposed to standard damp heat (DH) at 85°C and 85% relative humidity under dark conditions) or moderate DH (40°C and 40% relative humidity under dark conditions) and studied with current-voltage, luminescence and thermography and microscopy measurement techniques. A defect catalogue was created that is continuously being updated to facilitate defect detection and classification in installed modules in the field.

In the Integration Programme research is being performed in the development of flexible PV foils that can be used in mass-production and in any application. The final goal is to have freedom in size, shape, electrical output and lifetime at competitive costs. An important challenge in reaching this goal is to find the suitable materials and processing approach that result in sufficient protection, low cost and flexibility. Currently available protective barriers for CIGS are still relatively rigid, prone to damage during processing and too expensive for large scale application. Various prototypes with alternative protective barriers were produced using commercially available flexible CIGS foils. These prototypes were exposed to several hours (>1000 h) of standard DH and their degradation behaviour was monitored using a combination of current-voltage, luminescence and thermography characterization methods. From these investigations the dominant failure mechanisms still limiting lifetime and reliability of protected flexible CIGS devices with alternative protective barriers were identified.