Elrawemi, Mohamed, Blunt, Liam and Fleming, Leigh

Metrology and Characterisation of Micro and Nano-scale Defects for Aluminium Oxide Barrier Film Employed in Flexible Photovoltaic Modules

Original Citation


This version is available at http://eprints.hud.ac.uk/id/eprint/18237/

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

- The authors, title and full bibliographic details is credited in any copy;
- A hyperlink and/or URL is included for the original metadata page; and
- The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: E.mailbox@hud.ac.uk.

http://eprints.hud.ac.uk/
Metrology and characterisation of Micro and Nano-scale defects for aluminum oxide barrier film employed in flexible Photovoltaic modules

Mohamed Elrawemi*, Liam Blunt*, and Leigh Fleming*

*EPSRC Center for Innovative Manufacturing in Advanced Metrology, University of Huddersfield, HD1 3DH, UK. Tel: [01484] 473536 E-mail: U0950234@hud.ac.uk

Abstract
This paper reports on the recent work carried out as part of the EU funded NanoMend project. The project seeks to develop integrated process inspection, cleaning, repair and control systems for nano-scale thin films on large area substrates. As the PV – photovoltaic industry turns its attention on increasing efficiency and functional lifespan, the need for improved, high resolution and high speed surface inspection for the quality control of the manufacture of large area of flexible PV modules is essential. Inspection and metrology are the basic elements to guarantee maximum quality, longer lifetime and enhanced power yield. Flexible PV films are the newest development in the renewable energy field and the latest films have efficiencies at or beyond the level of Si-based rigid PV modules. These modules are fabricated on polymer film by the repeated deposition, and patterning, of thin layer materials using roll-to-roll technology. The functional layer groupings of the module are shown in fig [1].

![Figure 1: Schematic of the flexible PV Module (Courtesy of Flisom, Switzerland)](image)

These modules at present are however highly susceptible to long term environmental degradation as a result of water vapor transmission through the barrier layers defects to the active layer. To reduce the WVTR the PV modules are coated with a barrier layer of aluminum oxide (Al$_2$O$_3$) on a planarised polymer substrate. This highly conformal layer is produced by atomic layer deposition (ALD) technique. Nevertheless water vapour transmission is still facilitated by the presence of micro and nano-scale defects in these barriers which results in decreased cell efficiency and degrades longevity. Therefore, in this study surface metrology techniques including: White Light Scanning Interferometry (WLSI), optical microscopy and Scanning Electron Microscopy (SEM), were used to characterise the water vapor barrier defects. Areal surface texture parameter analysis allows the efficient separation of small insignificant features from significant defects. This parametric analysis is then correlated with the water vapour transmission rate as measured on typical sets of films using Isostatic standard test (MOCON). The outcomes would appear to suggest that small numbers of large defects are the dominant factor in determining WVTR. This result provides the basis for developing roll-to-roll in process metrology devices for quality control.

**Significance Statement***: The significance of this work is the first demonstration of water vapour transmission rate (WVTR) properties as a function of defects in the film.