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

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Background

Today’s roll-to-roll (R2R) technologies are well known in the field of packaging manufacture. They offer high productivity, reasonable coating cost and good reliability. R2R technology can be much more environmentally benign and energy-efficient process as compared to wafer-based or vacuum-based manufacturing.

Flexible PV Module

The state-of-the-art flexible PV film technologies have efficiencies at or beyond the level of Si-based rigid PV modules currently in use, are those based on the material aluminium oxide barrier layer is $\text{Al}_2\text{O}_3$. Defects in the barrier coating.

Cataloguing of the Defects

A set of Al$_2$O$_3$ ALD representative samples were assessed for environmental degradation test “MOCON”. Following that surface metrology techniques were employed to detect defects are postulated to be responsible for causing efficiency drop. Different types of features were noted on each sample; these features are different in terms of their type and size. Typical examples of these features are shown in the following figures.

Methodology

Surface segmentation through Wolf pruning method with threshold conditions at area prune 2.5% of the total area, and area combine of 1% of S was found to be optimal prune criteria which could help to predict PV module efficiency degradation and lifespans reduction.

Segmentation Process

Surface segmentation through Wolf pruning method with threshold conditions at area prune 2.5% of the total area, and area combine of 1% of S was found to be optimal prune criteria which could help to predict PV module efficiency degradation and lifespans reduction.

Research Impact

- High efficiency solar cells.
- Low cost.
- Low weight solar modules.
- Flexible solar modules.
- Maximise production yield.
- Reduction in scrap.
- Maximise production speed.
- Less energy.
- Low cost.

Future work

- Implementation of on-line metrology for the roll to roll ALD process at the centre for Process innovation (CPI) using the knowledge gained from the present work.
- Implementation of the areal feature analysis to carry in-line metrology and process control.

References