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Innovative hybrid encapsulation solutions for industrial flexible Cu(In,Ga)Se_2 photovoltaic technology

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Cu(In,Ga)Se_2 (CIGS) based photovoltaics (PV) technologies, being the thin film technology with one of the highest conversion efficiency, are well positioned among the different flexible PV technologies already at industrial scale. In order to achieve a stringent cost reduction for a cost-competitive market entry, innovative encapsulation solutions are required. The European Solar-era.net project "Advanced Global Encapsulation Solutions for Long Term Stability in Industrial Flexible CIGS Photovoltaic Technology (DURACIS)" [1] addresses this challenge.

In this work, we report an innovative hybrid encapsulation approach which combines a thin film of oxide materials of large band gap (Al_2O_3) grown by atomic layer deposition (ALD) and a transparent front sheet, the two of which are laminated for optimal adhesion. Studies on CIGS solar cells after damp heat test have suggested that Al:ZnO window layer is the primary degradation component[2-3]. Therefore, we first grow oxide barrier layers of different thicknesses by ALD on Al:ZnO/glass. Characterization of electro-optical and structural properties of such test samples are carried out before and after damp heat test (i.e. 1000h at 85°C/85%R.H.) in order to determine the optimal barrier layer thickness which suffices to protect Al:ZnO (and thus suffices for device encapsulation). Then CIGS mini-modules developed on both glass and flexible polyimide substrates are encapsulated with oxide barrier layer by ALD, followed by detailed investigation on device performance under damp heat test.

Reference:

[1]. http://www.duracis-solareranet.com/

[2]. *Proc. of the 39th IEEE PVSC*, **2013**, 2047

[3]. M.J. Theelen, *Degradation of CIGS solar cells*, PhD thesis, **2015**