

Protection of Organic Solar Cells for Long Lifetime

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Today the majority of installed photovoltaic modules use crystalline silicon (c-Si) as semiconductor material. However the demand for photovoltaic modules using thin film solar cells, such as amorphous silicon (a-Si), microcrystalline silicon ($\mu\text{c-Si}$), Copper-Indium-Gallium-Selenide (CIGS), Copper-Indium-Diselenide (CIS), Cadmium-Telluride (CdTe), and organic solar cells, is rapidly growing with special demands regarding encapsulation material and furthermore lifetime.

Thin film and organic photovoltaic modules are produced on substrates due to the low thickness of the active layers. Window or photovoltaic glass is predominantly used for this purpose. Due to limited flexibility of glass, metal foils and particularly flexible films act as substrates. These flexible films fulfill a second demanded function, namely working as encapsulation material.

Requirements for flexible encapsulation material are very challenging. Beside a transparency of at least 80 %, permeation values as low as 10^{-5} g/cm²*d for water vapor transmission (WVTR) and 10^{-5} cm³/m²*d*atm for oxygen transmission (OTR) respectively are needed. Through the use of oxide layers (e.g. AlO_x, SiO_x) barrier properties of commodity polymer substrates are improved to barrier values around 0.1 for WVTR and OTR respectively. Additional applied oxide layers improve these barrier properties to a certain extent without reaching essentially lower values due to defects of inorganic oxide layers. Defects are being eliminated using elaborated barrier coatings together with oxide layers. These coatings are based on functionalized hybrid polymers equipped with tailor-made adhesion functionalities of the substrate, e.g. the ability to form networks, UV stability or weatherability. Fast production technologies, such as roll to roll (R2R) production, are used for encapsulation of flexible solar cells. Consequently production processes speed up, costs are minimized and an increase of efficiency producing photovoltaic modules is monitored.