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Dye – TiO2 Interfacial Structure in Dye-Sensitized Solar Cells

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Solar cells are a widespread, clean and renewable source of energy for humanity's growing power needs. An emerging type of solar cell based on natural dyes to harvest sunlight has been the subject of growing interest. Dye-sensitized solar cells (DSCs) are transparent, flexible, and made from low cost, readily available materials. Compared to traditional silicon-based solar cells, DSCs have higher efficiencies in ambient or dim light. DSCs can be harnessed in areas such as solar windows to generate electricity and offset power costs in buildings.
The dye molecules used in this study are organic, and are structured as donor – linker – acceptor molecules. A range of different donor, linker and acceptor functional groups have been synthesized, including the addition of bulky hydrophobic alkyl chains.
At the interface between dye molecules and titanium dioxide (TiO2) semiconductor, the adsorbed dye molecules harvest energy from light and enters an excited state. The photoelectron is injected into the TiO2 conduction band, where the electrical circuit begins. The dye – TiO2 interface is vital to the efficiency and performance of DSCs, but is poorly understood. This study investigates dye adsorption and packing arrangements at the TiO2 interface using X-ray reflectometry (XRR) and atomic force microscopy (AFM) instruments at ANSTO, Australia for organic dye structures with different donor and linker groups. Neutron reflectometry (NR) will examine the dye – TiO2 interfacial structure in the presence of solvent and electrolyte to probe the extent of dye – solvent and dye – electrolyte interactions *in situ*.
By changing the dye chemical structure, linker groups and donor groups, a range of structures are observed at the surface. While XRR measurements reveal an adsorbed monolayer at the local scale (area ~ 1 cm2), AFM measurements detect small dye aggregates at the surface (area ~ 225 μm2) for all dyes except for the largest and sterically bulky dye studied. This study demonstrates the importance of dye structure on interfacial properties in DSCs, and may be used to design dyes to optimise properties and solar cell efficiencies, in turn developing DSCs towards full-scale commercialisation.

Speakers Gender

Female

Travel Funding

No

Level of Expertise

Early Career <5 Years since PdD

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No

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