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Soluble Thiophene and Furan based functionalized conducting polymers for sensitization of TiO_2 in dye sensitized solar cells

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Dye Sensitized Solar Cells (DSSCs) have been developed as an alternative to solid-state silicon-based cells for the conversion of solar energy into electricity. DSSCs uses a mesoporous nanocrystalline n-type semiconductor layer, such as TiO_2 deposited on a transparent conducting glass plate (FTO), with an attached dye to collect sunlight, and it acts as a photo-anode. The cathode is a liquid electrolyte containing a redox couple Iodide/triiodide and platinum or a gold plate usually acts as the counter electrode to enhance the electrical contacts. One major problem associate with DSSCs is the use of expensive and long-term unavailable ruthenium complexes as sensitizer dyes. As an alternative for these expensive dye complexes, conducting polymers (CPs) have attracted much attention, due to their low cost and easy synthesis using readily available starting materials.

By keeping this in mind, we successfully synthesized Poly(3-hydroxy-3-thiophen-3-yl-propionic acid)-P3H3TPA and Poly(3-furan-3-yl-3-hydroxypropionic acid)-P3F3HPA both containing two functional groups; carboxylic acid and hydroxyl. Both polymers were readily soluble in ethanol and therefore easy to process.

DSSCs were fabricated using those two polymers and TiO_2 and the type was FTO/TiO_2/Polymer/Electrolyte/Pt. Their performances were measured under simulated sunlight of 100 mW cm^{-2} (Air Mass 1.5). The cells sensitized with P3H3TPA generated a short-circuit photocurrent (J_{sc}) of 0.776 mA cm^{-2}, an open-circuit voltage ($\mathbf{V_{oc}}$) of 352 mV with a fill factor (FF) of 61% and an overall efficiency (0) of 0.166%. While the cells sensitized with P3F3HPA generated J_{sc} of 0.428 mA cm^{-2}, V_{oc} of 391 mV, FF of 67% and 0 of 0.112%. A significant enhancement of the cells was observed for both polymers after addition of an ionic liquid (1-methyl–3-n-hexylimidazolium iodide) in to the electrolyte. For P3H3TPA the values obtained for the above polymers were 0.884 mA cm^{-2}, 351 mV, 60%, 0.185% respectively while for P3F3HPA they were 0.528 mA cm^{-2}, 386 mV, 68%, 0.137% respectively.

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