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Multifunctional Novel Ruthenium Dye (RuC) for Nanocrystalline Titanium dioxide / Poly (3-heylthiophene) hybrid Solar Cells

Pirashanthan. A, Thanihaichelvan. M, Shivatharsiny. R, Dhayalan V, Prof. Ravirajan. P South Eastern University of Sri Lanka, Sri Lanka

Hybrid solar cells with conjugated polymers as donors and metal oxide nanocrystals as acceptors have generated significant interest owing to their light weight, low cost, mechanical flexibility, and simple solution processing methods. However, it's well documented that the poor charge separation and collection efficiencies and limited spectral response of polymer limits their power conversion efficiencies due to the disordered metal oxide-polymer interface. Hence the power conversion efficiencies are heavily depends on the quality of the interface. Engineering the interface is a well-known technique to improve the charge separation, collection and transport in hybrid solar cells. Range of novel organic and inorganic materials were successfully tested as the interface modifiers which results with improved power conversion efficiencies of the hybrid solar cells.

In this work, we report the multifunctionality of a novel Ru based dye (RuC) in enhancing the performance of nanocrystalline Titanium dioxid /Poly (3-heylthiophene) (TiO_2/P3HT) hybrid solar cells. TiO_2/P3HT nanocomposite films were fabricated with and without the RuC dye as the interface modifier and their optical properties were tested using UV-Vis and photoluminescence (PL) spectroscopies. UV-Vis spectra of the TiO_2/RuC and TiO_2/RuC/P3HT films ensure that the absorption spectra is broadened in the UV region due to the addition of dye. The PL measurements were carried out using a 530 nm pumping laser to selectively excite the P3HT. The PL of TiO_2/ P3HT nanocomposite films were strongly reduced when the RuC dye was introduced at the TiO_2/RuC interface. The PL quenching ensure the efficient exiton dissociation in P3HT during illumination. The solar cells were then fabricated using successive evaporation of MoO_3 and silver on top of the films and tested in a simulated irradiation of 100 $mWcm^{-2}$ at AM 1.5 conditions. The insertion of dye improves the power conversion efficiency by a factor of two, which is mainly due to the enhanced short circuit current density attributed to the broaden spectral response as confirmed by broadened external quantum efficiency (EQE) spectra.