Multifunctionality of Novel Ruthenium Dye (RuC) as an Interface Modifier for Nanocrystalline Titanium dioxide / Poly (3-hexylthiophene) Hybrid Solar Cells

S. Rasalingam [1], A. Pirashanthan [2], M. Thanihaichelvan [2], K. Mariappan [3], Dhayalan Velauthapillai [4], P. Ravirajan [2]

[1]*Department of Chemistry, University of Jaffna, Jaffna, Sri Lanka*
[2]*Clean Energy Research Laboratory, Department of Physics, University of Jaffna, Jaffna, Sri Lanka*
[3]*Department of Chemistry, University of South Dakota, Vermillion, USA*
[4]*Faculty of Engineering, Western Norway University of Applied Sciences, Bergen, Norway*
Email: srtharsha12@gmail.com

Abstract

This work reports the multifunctionality of a novel Ru based dye (RuC) in enhancing the performance of nanocrystalline Titanium dioxide (TiO_2) / Poly (3-hexylthiophene) (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 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 the RuC dye. The PL measurements were carried out by pumping with laser at wavelength corresponds to maximum absorption of P3HT. The PL of TiO_2 / P3HT nanocomposite films were significantly quenched when the RuC dye was introduced at the TiO_2 / RuC interface. The PL quenching ensure the efficient exciton dissociation in P3HT when RuC is introduced. The corresponding solar cells were then fabricated using successive evaporation of MoO_3 and silver on top of the films and characterised under monochromatic and under Air Mass (AM) 1.5 conditions (100 mW cm^{-2}, 1 sun). The insertion of the RuC dye suppresses the dark current while extends external quantum efficiency spectra. As such, device with dye shows improved open circuit voltage and more than a factor of two times higher short circuit current density in comparison with the corresponding control. Hence, RuC dye improves the power conversion efficiency by a factor of two. This study concludes that, RuC dye has dual role; extending the spectral response and suppressing the dark current.

Keywords: Solar Cells, Ruthenium Dye, Titanium dioxide, Poly(3-hexylthiophene), co-sensitizers, photovoltaic, absorption, photoluminescence, polymers, efficiency