M.Phil. in Physics

Fabrication and characterization of Titanium Dioxide (TiO_2) based Organic Solar cells.

Selvaratnam Sarathchandran

Abstract

Organic solar cells have been a focus of considerable research over the last decade. There are four major classes of molecular solar cells in the literature namely, dye sensitized nanocrystalline metal oxide solar cells, polymer blend solar cells, molecular film solar cells and hybrid polymer / nanocrystalline metal oxide solar cells. This study is focused focus on application of Titanium dioxide (TiO_2) in all types of organic solar cells except molecular film solar cells. In hybrid poly (3-hexylthiophene) (P3HT) polymer / TiO_2 solar cells, the best solvent with the optimized conditions to dip the TiO_2 electrode into the polymer and the role of poly (styrenesulfanate)-doped poly(3,4-ethylenedioxythiophene) (PEDOT : PSS) layer were studied in view of improving the performance. Dichlorobenzene was found to be the best dipping solvent with the optimized dipping parameters of concentration, temperature and the time as 1 mg/ml, 120 ^{0}C and 2 hr, respectively. In the study, the optimum power conversion efficiency (PCE) of the solar cells was observed with the 50 nm thick PEDOT:PSS layer. In dye sensitized solar cells (DSSC), a modified Visible Light Responsive (VLR) TiO_2 has instead of regular TiO_2 has been introduced and found to be a promising n-type semiconductor for the DSSC due to the improved optical absorption, dye absorption and charge transport probably attributed to the high anatase content. In addition to this, both regular and VLR TiO_2 solar cells incorporated with the grape fruit cote dye and a Ru based dye (synthesized at the University of Oxford, UK by Meena Senthilnanthan) exhibited promising performance which is comparable to solar cells employing commercial dye. In P3HT: PCBM ((6,6)-phenyl-C61-butyric acid methylester) solar cells, the PCE of both conventional and inverted solar cells having PEDOT: PSS slightly influenced by the temperature. However the PCE of the inverted cells without PEDOT: PSS showed significant increase with temperature and maximized around 60 ^{o}C. This is attributed due to the positive temperature dependence of open-circuit voltage resulted from “kink” in the current-voltage characteristics near open-circuit voltage.