Post-processing treatments in hybrid polymer/titanium dioxide multilayer solar cells

Ravirajan, P., Atienzar, P., Nelson, J.

Abstract

We report on a study of post-processing treatments in hybrid solar cells based on poly(3-hexylthiophene) (P3HT) being in contact with nanocrystalline TiO 2 films. The power conversion efficiency of the hybrid polymer/TiO 2 solar cells is increased over three-fold through the simultaneous application of external bias voltage and UV illumination. These treatments enhance short-circuit current density, J SC, from 1 mA/cm 2 to over 3 mA/cm2 under simulated air mass (AM) 1.5 conditions (100 mW cm -2) and lead to a peak external quantum efficiency of over 16%. The AM 1.5 open circuit voltage reaches 0.47 V and the fill factor reaches 0.53, resulting in an overall power conversion efficiency of 0.74%. The improved performance following UV exposure is correlated to a slowing of over one order of magnitude in the dynamics of charge recombination as monitored by transient optical spectroscopy. We further demonstrate that while the UV radiation present in a simulated AM 1.5 solar spectrum is sufficient to cause the increase in the J SC and efficiency after two hours of exposure, no change results from exposure to the same spectrum when a UV blocking filter is used. We propose that UV exposure modifies the nature or density of surface trapping species in the nanocrystalline TiO 2, resulting in reduced recombination rates and a higher efficiency of collection of photogenerated charges.