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Enhancing the performance of Hybrid Nanocrystalline Metal oxides / Polymer Solar cells using dye as interface modifier

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Hybrid Polymer / Metal oxide nanocomposite is a good and simple model system to study the effects of interfacial properties and film morphology on the performance of bulk heterojunction solar cells[1-3]. Considerable interest has been paid on these hybrid solar cells for more than two decades because of the expertise knowledge generated with this system which has proved[4] to be valuable in improving the performance of other organic based solar cells[5,6] such as dye sensitized and perovskite solar cells[6].

This talk reviews a range of dyes, including a novel thiophene derivative dye with a cyanoacrylic acid group ((E)-2-cyano-3-(3',3'',3'''-trihexyl-[2,2':5',2'':5'',2'''-quaterthiophene]-5-yl) acrylicacid)(4T) and Ru dyes, that have been applied to improve the performance of hybrid metal oxide / polymer solar cells. The insertion of dye at the interface improves the efficiency regardless of the dye used. However, 4T dye significantly improves the efficiency by a factor of three when compared to the corresponding control[7]. This improvement is mainly due to increase in short circuit current density (J_{SC}), which is consistent with higher hole-mobility reported in TiO_2 / P3HT nanocomposite with 4T dye[8]. Optical absorption data further reveals that 4T extends the spectral response of the TiO_2 / P3HT nanocomposite which could also enhance the J_{SC}. The reduced dark current upon dye insertion ensures that the carrier recombination is controlled at the interface and this in turn increased the open circuit voltage. Optimized hybrid TiO_2 / P3HT device with 4T dye as an interface modifier showed average efficiency over 2 % under simulated irradiation of 100 $mWcm^{-2}$ (1 sun) with Air Mass 1.5 filter.

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