The effect of organo-chalcogen donor molecule BEDT-TTF on the efficiency enhancement of the polymer sensitised solar cell

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Over the past decade, there has been a considerable progress achieved in the dye sensitised mesoporous TiO_2 solar cells employing liquid electrolytes. These devices show excellent power conversion efficiencies (up to 11%) due to the broad absorption spectrum of dyes based on ruthenium bipyridyl complexes. However, due to the long term unavailability of noble metals such as ruthenium and their high production cost , the use of conjugated polymers in such cells has generated a tremendous interest as these materials can be used simultaneously as sensitiser and a possible replacement for the liquid electrolytes. Among these conjugated polymers, poly [2-methoxy-5-(2V-ethyl) hexoxy-1,4-phenylenevinylene] (MEH-PPV) has attracted much attention due to its solubility in common organic solvents. However in the photo-voltaic cells using pure conjugated polymers, the energy conversion efficiencies are too low (typically of 10^{-3} to 10^{-1} %) for practical applications, because these materials suffer from low charge mobility and short exciton diffusion lengths. Further, the transport of charge carriers from the organic film to the inorganic electrode is one of the most commonly observed problems associated with organic materials. In many cases improvement in carrier transport is obtained by introducing a buffer layer which adjusts the electronic behaviour of the adjacent materials. Keeping these in mind, we investigated the effect of organo-chalcogen donor molecule, bisethylenedithio-tetrathiafulvalene (BEDT-TTF or ET), which became the building block of organic superconductors, in the performances of polymer sensitised (MEH-PPV) solar cells. Photresponses of the cells were compared under air mass 1.5 (100 mW 100 cm^{-2}) before and after the addition of ET. Significant enhancement in photocurrent was observed for the TiO_2/MEH-PPV cells when MEH-PPV was blended with 2% (wt) ET. The FTO/TiO_2/MEH-PPV cell gives the open circuit voltage (V_{oc}) of 0.60 V, , the short circuit current density (J_{sc}) of 0.95 mA cm^{-2}, and the fill factor (FF) of 0.62. In comparison, the FTO/TiO_2/MEH-PPV-2% ET cell shows a V_{oc} of 0.56 mV, a J_{sc} of 1.66 mA cm^{-2}, a FF of 0.64 and white light conversion efficiency (η) of 0.6 % that is ten fold to that of the cells without ET. It is observed that the photo current for cell with ET tends to decrease with the increase of the amount of ET.

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