SENSITIZATION OF TITANIA WITH NATURAL AND MODERATED FLAVYLIUM PIGMENTS AND MEH-PPV POLYMER FOR PHOTOVOLTAIC DEVICES

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SENSITIZATION OF TITANIA WITH NATURAL AND MODERATED FLAVYLIUM PIGMENTS AND MEH-PPV POLYMER FOR PHOTOVOLTAIC DEVICES

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In this investigation titania was sensitized with natural and moderated flavylium dyes and MEH-PPV polymer in the fabrication process of efficient photovoltaic devices. Flavylium dye which is one of the pigments in the juice extracted from pomegranate fruit (rich with cyanin and exists as flavylium at natural PH) was utilized as a sensitizer dye. Further, flavylium dye was moderated coupling with mercurochom dye and was used to sensitize titania. In addition, MEH-PPV polymer was used as a sensitizer as well as a hole collector of titania based photovoltaic devices.

The juice extracted from pomegranate fruit, which contains cyanin (flavylium) was utilized as the light-harvesting analog in TiO_2/dye/CuI type dye sensitized solid-state photovoltaic cells. A higher incident photon to current conversion efficiency (IPCE) is observed in this TiO_2|pomegranate pigment|CuI solar cell than the previously reported cells that were sensitized with natural pigments such as cyanidin, tannin and santalin. We have observed a maximum photocurrent of 5±0.5 mA cm^{-2} and a photovoltage of 300±40 mV with a higher reproducibility (over 80%) for TiO_2|pomegranate pigment|CuI cells. Only a very few synthetic dyes (or dye cocktails) are found to produce higher photocurrents than that of pomegranate pigments.

The electronic coupling of a natural pigment extracted from pomegranate fruits with the organic dye mercurochrome enhanced the performance of solid-state TiO_2|dye|CuI-type photovoltaic cells. The photocurrent and photovoltages of this cell are higher than those of the cells fabricated with pomegranate pigments or mercurochrome dye alone.

Incident photon to current conversion efficiencies (IPCE) of 60% and 28% were observed for solid-state TiO_2|dye|CuI type cells fabricated with mercurochrome and natural pomegranate pigment alone. Maximum IPCE of 58% was observed at 510 nm for the TiO_2|mercurochrome|pomegranate pigment|CuI cell. In addition, IPCE was enhanced at longer wavelengths compared to that of the TiO_2|pomegranate pigment|CuI cell.

A conjugated polymer poly[2-methoxy-5(2-ethyl-hexyloxy)-p-phenylene vinylene] (MEH-PPV) was utilized as the light-harvesting agent of a photovoltaic cell. Sensitized anodic and cathodic photocurrents were measured for CuSCN|MEH-PPV|TiO_2 cells and heterojunctions of MEH-PPV respectively. The maximum IPCE of 30% was observed for electrolyte|MEH-PPV|TiO_2 cells in the region of the maximum absorbance of MEH-PPV. The polymer MEH-PPV absorbs visible light of wavelength shorter than 550 nm and emits green luminescence.

A solid-state cell with the configuration of semiconductor |dye|poymer (SDP) was also prepared using poly[2-methoxy-5(2-ethyl-hexyloxy)-p-phenylene vinylene] (MEH-PPV) as a hole conducting material and mercurochrome dye as the sensitizer. TiO_2|mercurochrome|MEH-PPV|I_2|Graphite cell produced an open circuit voltage of 700 mV and short circuit photocurrent of 2.35 mA cm^{-2} with an efficiency of 0.8 % at a light intensity of 1000 W/m^2 under AM 1.5 conditions.