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Efficient dye-sensitized solar cells with dye-semiconductor multilayer

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The conventional dye-sensitized solar cells response in a narrow band consistent with the absorption spectrum of the dyes resulting lower conversion efficiencies. This could be enhanced by utilizing several dyes that absorb light at different wavelengths over the visible spectrum. But merely coating several dyes one on another without any chemical bonding does not permit transfer of electron or holes to the semiconductor, as they undergo mutual deactivation process called concentration quenching. The dye monolayer must always be coupled to a semiconductor for fast electron injection of excited dye molecules to the semiconductor. This could be circumvented by interposing thin semiconductor layer in-between dyes that act as a platform for dye chelation.

In this study we constructed a multiple dye-semiconductor heterostructure of the configuration, TiO2-D1/CuSCN-D2/CuSCN-D3 /CuSCN, where D1, D2, D3 are three dyes, Fast Green, Rodamin 6G and Acridine Yellow respectively and CuSCN in italics denotes the thin CuSCN layer used for dye attachment. The action spectra showed that all three dyes contribute for the photocurrent generation, broadening the spectral response of the cells. The I-V curves also showed high Voc and Isc than single-dye heterostructures of these dyes. The thickness of CuSCN thin film is critical when large number of dyes are used because of increasing barrier width for electrons and holes to tunnel, limit the photocurrent of the cell. Implementation of this structure for number of dyes needs fine tailoring of the CuSCN thin layer.