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Enhanced Photovoltaic Performance of Dye-Sensitized Solar Cells via Sensitization of Nanocrystalline TiO_2 Films with Metal-Free Indoline Dye

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Abstract. Abstract: D149, a metal-free indoline dye, is one of the most promising sensitizers for dye-sensitized solar cells (DSSCs). The D149 sensitizer with the solvent acetonitrile gives two distinct absorption bands: first band is in the region of 350-430 nm due to (π–π*) electron transitions of the conjugated molecules, and the next in the region of 430-614 nm can be allocated to an intermolecular charge transfer (ICT) between the electron-donor and electron-acceptor anchoring moieties. Upon optimization, the device given a Jsc of 13.2 mA/cm2, Voc of 752 mV, and FF of 0.749 % and the conversion efficiency of 7.4%.

Keywords: Dye sensitized solar cells, TiO_2 Films, Indoline.

Introduction

One of the most promising solar cells is the Dye-sensitized solar cells (DSSCs). DSSC offer a relatively inexpensive as well as eco-friendly alternative to silicon solar cells (Hagfeldt *et al.*; O'regan *et al.,*). A DSSC is made up of photoanode in which the nanocrystalline TiO2 is deposited on the surface and attached with a single layer of dye molecules, a redox-couple electrolyte and for counter electrode, the platinized coated FTO glass substrate used. The sensitizer is then regenerated through an electrolyte including a redox-couple. The photosensitizer is one of the main components of DSSCs for attaining high efficiency. Photosensitizer employ as a solar light harvester of the photovoltaic cell as well as their electronic properties is renowned to manipulate the light harvesting efficiency and power conversion efficiency (PCE). Last many years, the Ruthenium complex based sensitizers have set for the highly efficient DSSCs, but sensitizer like pure-organic, metal free dyes, or compounds containing common transition metals are increasingly replaced the replace the Ruthenium complex based sensitizers. The DSSC co-sensitized with zinc porphyrin based sensitized reached efficiency of 12.3% (Yella *et al.,2009*). Sensitizers such as Porphyrins and metal-free organic dyes like indoline derivatives give many leads to Ru-complex based sensitizers. The metal free organic sensitizer are relative and produced at a large scale (Yoshida *et al.,*; Keis *et al.,*.) and have prominently higher molar absorption coefficients.

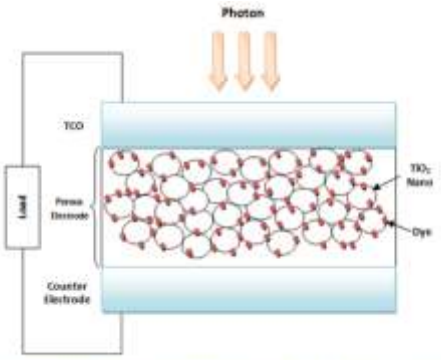
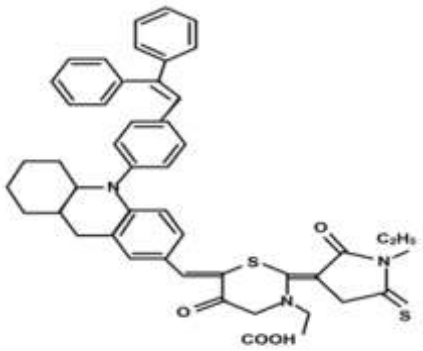


Figure 1. Diagram of Dye-Sensitized Solar Cell (DSSC) structure.



D149 Dye

For DSSC applications, Indoline dyes are one of the most emerging class of compounds. They are synthetically simple to attain and give high conversion efficiency and high molar absorption coefficients (Horiuchi *et al.,*; Le Bahers *et al.,*.) The central indoline group performs like an electron donating group and is conjugated to an electron accepting group, stabilized via supplementary phenyl rings. Cyanoacrylic acid has accepting properties as well as performs like a binding group that association to the semiconductor film. On the other hand, a carboxylic acid attached to one or more rhodanines has been exposed to provide high injection yield as well as strong charge transfer electronic transitions (Horiuchi *et al.,*; Le Bahers *et al.,*.) According to the time-dependent density functional theory (TDDFT) (Ito *et al.,*), considering three distinct entrants of this group verified the charge-transfer behavior of the $St_0 \rightarrow St_1$ transition, which holds a extremely huge oscillator strength (f = 2.06) as well as assists to a dipole moment of >30 D in the excited state.