

PRELIMINARY STUDY OF $\text{TiO}_2@\text{In}_2\text{O}_3$ OBTAINED FROM SOLVOTHERMAL SYNTHESIS AS POTENTIAL RECOMBINATION BARRIER LAYER IN DYE SENSITIZED SOLAR CELLS

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Abstract

In order to successfully commercialize dye-sensitized solar cells (DSSCs) and achieve high conversion efficiency, the technology must be optimized to reduce charge recombination between the electron transport layer and the contact. For such solar cells, undesirable interfacial charge recombination reactions occurs when an electron injected from the dye into the metal oxide photoanode recombines with a hole from an oxidized dye molecule or from a hole-transport material (HTM). It was previously observed that the reduction of oxidized dye molecules by the HTM is relatively fast, hence the recombination with oxidized dye molecules has a smaller impact on charge collection efficiency than does the photoanode–HTM recombination process [1]. In order to reduce this recombination process (photoanode–HTM), many authors have proposed different approaches for thin, passivating, insulating, barrier layers deposited on top the photoanode in a “core–shell” structure prior to dye adsorption [2; 3; 4; 5; 6; 7; 8]

Optimizing the front blocking layer (BL), a crucial part of the DSSC structure, may improve the efficiency of photoelectron transfer from the dye to the semiconductor by reducing charge recombination at the interfaces between the TiO_2 /electrolyte and FTO/electrolyte. The mechanisms by which a barrier layer can enhance DSSC performance was described by O'Regan et al [9], consists of two competitive processes: it can either introduce a surface dipole that increases the photoanode's conduction band or passivate surface defect sites that act as recombination centers or it can also act as an insulating wall between the photoanode and the oxidized dye molecules as well as the HTM, acting as a tunneling barrier to recombination.

In this paper, we are considering using a blocking layer consisting of core-shell $\text{TiO}_2@\text{In}_2\text{O}_3$ structures. The solvothermal synthesis method used for the fabrication of novel core-shell $\text{TiO}_2@\text{In}_2\text{O}_3$ structures is presented. The core of the nano-structures consists of TiO_2 nanoparticles of around 18 nm, obtained through a different solvothermal synthesis [10]. The as-obtained products were characterized by X-ray diffraction and UV-Vis-NIR spectroscopy. Our results show band gaps (calculated from the diffuse reflectance spectra) between 3.31 eV and 3.5 eV for core-shell $\text{TiO}_2@\text{In}_2\text{O}_3$. Since the blocking layer is not intended to absorb light- its main role is to suppress charge/electron recombination, a higher band gap suggests both a optical transparency across the visible spectrum that absorbs only deep UV and does not reduce the light reaching the dye, and also a conduction band offset at the TiO_2 interface, that could improves open-circuit voltage (V_{oc}) and overall charge separation. This preliminary study demonstrate that core-shell $\text{TiO}_2@\text{In}_2\text{O}_3$ structures could be successfully used for DSSC as a layer designed to **block recombination** and **enhance device performance**, while remaining fully transparent to visible light.

References

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