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# Bismuth trisulfide ($Bi_2S_3$) quantum dots for cost-efficient solar energy conversion

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Quantum dots are paving new paths in the field of photovoltaics. Due to their excellent size-dependent properties, they have become dominant light-harvesting materials in photovoltaic applications. In most cases, the incorporation of heavy metal quantum dots (QDs) such as CdS and PbS has given higher efficiencies in Quantum Dot-Sensitized Solar Cells (QDSSCs). The application of QDs in the fabrication of QDSSCs is often challenging due to the high toxicity of such heavy metal halides and the greater expense due to the scarcity of such elements. In this study, non-toxic and cost-effective QDSSCs have been fabricated with $Bi_2S_3$ QDs. The fabrication of $Bi_2S_3$ on the photoanode was accomplished using the Dip Successive Ionic Layer Adsorption and Reaction (Dip-SILAR) technique. The device configuration of the QDSSCs is FTO/$TiO_2$/$Bi_2S_3$/($I^-/I^-_3$) electrolyte/Pt with an active cell area of 0.16 $cm^2$. To fabricate the best QDSSC, the number of SILAR cycles were varied during the quantum dot formation. The highest efficiency recorded was 0.26%, with an open circuit voltage of 482.9 mV and a short circuit current density of 1.05 mA $cm^{-2}$ under solar radiation 100 mW $cm^{-2}$ with an AM 1.5 filter. Electrical and optical measurements related to the performance of electrodes and QDSSCs were conducted using standard techniques. The stability of the best solar cell was further studied with liquid and gel forms of the iodide/triiodide electrolytes separately. A Polyvinylpyrrolidone (PVP)-based gel electrolyte enhances the stability of the $Bi_2S_3$ QDSSC. The power conversion efficiency of the fabricated QDSSC is lower than that of the conventional dye-sensitized solar cells. However, the fabrication cost of $Bi_2S_3$ QDs is 100 times cheaper than that of inorganic dyes.

**Keywords:** *Dip-SILAR, low-cost, non-toxic, photovoltaic applications, quantum dots*

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