Non-toxic Bi_2S_3 quantum dot-sensitized TiO_2 electrodes for cost-efficient solar power conversion

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Abstract

Inorganic light harvesting materials are revolutionizing the current research scope of Quantum dot-sensitized solar cells (QDSSCs) day by day. However, it is challenging due to the issues in toxicity and stability of existing light-harvesting materials. Herein, we present highly stable non-toxic bismuth trisulfide (Bi_2S_3) QDSSCs with iodide/triiodide redox couple electrolyte. The solar cell is configured as FTO/TiO_2 P90/TiO_2 P25/Bi_2S_3/(I^-/I^-_3) electrolyte/Pt. Bi_2S_3 Quantum Dots (QDs) were fabricated onto the FTO/TiO_2 P90/TiO_2 P25 electrode at room temperature using the Dip-Successive Ionic Layer Adsorption Reaction (Dip-SILAR) which is an easy and efficient technique. Electron microscopic studies confirmed the homogeneous formation of the quantum dots on the photoanode which have a range of sizes between 50 nm and 80 nm. QDSSCs with an active cell area of 0.16 cm^2 were characterized under an illumination of 100 mW cm^{-2} with 1.5 AM spectral filter and the results depicted that the best cell was able to achieve a power conversion efficiency of 0.26% with an open circuit voltage of 482.9 mV and short circuit current density of 1.05 mA cm^{-2}. In order to enhance the stability of the solar cells, Polyvinylpyrrolidone (PVP) based gel polymer electrolyte has been used. The high cost of conventional light harvesting materials may be considerably reduced by one-step fabrication of Bi_2S_3 using the SILAR technique.

Keywords: Dip Successive Ionic Layer Adsorption Reaction (Dip-SILAR), low-cost, non-toxic, photovoltaic application, quantum dots, iodide/triiodide electrolyte

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