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The concentration effect of PbS, CdS quantum dots on efficiency of co-sensitized TiO_2 photoanode based solar cells

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Semiconductor quantum dots (QDs) such as lead sulphide (PbS) and cadmium sulphide (CdS) are widely employed as sensitizers of solar cells due to their specific advantages such as easily tunable energy gap, broadband optical absorption, potentially higher stability and resistivity against oxygen and water. Co-sensitization of a dye/QDs hybrid is a more trivial and crucial one compared with co-sensitization by dyes and QDs alone. It helps the improvement of energy transfer efficiency and the photo stability of solar cells. In this study, a double layer structured titanium dioxide based photoanode was prepared by co-sensitization with PbS, and CdS QDs with Ru N719 dye. The Successive Ionic Layer Adsorption and Reaction (SILAR) technique was applied to the TiO_2 photoanode to deposit QDs. In this study, we have focused on the concentration effect of precursor solutions of QDs on the device performance. First, PbS QDs were deposited on a TiO_2 photoanode and then CdS QDs were deposited. Finally, Ru N719 dye was adsorbed to a photoanode with an active cell area of 0.16 cm^2. The PbS and CdS concentrations were varied to find the best device performance and the best efficiency obtained was 9.96 % with the iodide/triiodide based liquid electrolyte and Pt counter electrode. This is a 17 % efficiency improvement compared to the 8.5 % efficiency of the DSSCs without QDs. Material characterization of the photoanode was done using scanning electron microscopy. From the electrochemical impedance spectroscopy (EIS) results, it is confirmed that the reduction of the charge transfer resistances improved the current density of the solar cell.

Keywords: *Co-sensitization, Concentration effect, Dye sensitized solar cells, Quantum dots.*