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Efficiency enhancement in dye-sensitized solar cells by co-sensitization with CdS quantum dots

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Quantum dots have received a considerable attention over the past decade due to their low fabrication cost and exceptional optoelectronic properties including tunable band gap with size by the quantum confinement effect and the ability of multiple exciton generation. Enormous efforts have been made to enhance the efficiencies of dye-sensitized solar cells (DSSCs) by modifications in both photoanodes and counter electrodes in these devices. Usually, the photoanode of a DSSC consists of a wide band gap semiconductor such as TiO_2 coated with a monolayer of dye molecules (usually Ruthenium based dyes, N719). However, these dye molecules generate electrons when they are excited by the solar energy in a particular wavelength range only. Therefore, in order to capture the whole energy spectrum in the sunlight, co-sensitization techniques can be employed in these DSSCs. In this work, the DSSC photoanode has been modified by co-sensitization with both, the N719 dye and CdS quantum dots. CdS quantum dots were deposited on the TiO_2 nanostructure by successive ionic layer adsorption and reaction (SILAR) method. Co-sensitized solar call shows an efficiency of 6.79% with a higher short-circuit current density of 15.55 mA cm^{-2} under the illumination of 100 mW cm^{-2} with AM 1.5 spectral filter. The corresponding solar cell sensitized only with N719 dye shows an efficiency of 6.10%. An enhancement of 12.11% in current density and 11.31% in efficiency have been achieved due to the co-sensitization of the DSSCs by the CdS quantum dots.

Keywords: co-sensitization, multiple exciton generation, quantum dot and quantum confinement effect

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