Abstract

Quantum Dot Sensitized Solar Cell with possibility of multiple exciton generation may be exciting prospect for third generation solar cell. In principle, they can surpass theoretical detailed balance limit of a single junction solar cell. This work primarily focuses on in-situ sensitization of CdTe quantum dots in TiO_2 mesoporous electrode. A suitable combination of pH of precursors and heating duration in autoclave is investigated and the process is optimized for the sensitization of mesoporous electrodes. The sensitized mesoporous electrodes are investigated to characterize their structural, optical and photovoltaic characteristics with Cu_2S counter electrode and polysulfide electrolyte. It is observed that a passivation layer results during the sensitization which eliminates the requirement for additional passivation, a necessary step in conventional sensitization processes to avoid CdTe quantum dots degradation. This work also explores the design and development of zinc titanate as an alternative photoelectrode for quantum dot sensitized solar cells. X-Ray diffraction confirms the existence of multiphase zinc titanate and phase evolution is studied against calcination temperature. The prepared zinc titanate is utilized as photoelectrode material for CdS quantum dot sensitized solar cell and respective photovoltaic measurements confirm that low temperature calcinated zinc titanate is a relatively better photoelectrode material. Further, transition metal doping is investigated in cadmium sulfide sensitized TiO_2 keeping work function of transition metal in consideration. Manganese, iron and nickel are investigated as transition metal dopant in this work. Photovoltaic studies confirm that transition metal with work function close to electron transport material will be a suitable dopant for realising efficient quantum dot sensitized solar cells.

Further, detailed balance calculations are done by considering TiO_2 as electron transport material and polysulfide as hole transport material due to their wider applications in quantum dot sensitized solar cells. These calculations show that ultimate efficiency is much lower as compared to ideal electron and hole transport materials case. Detailed balance efficiency is also lower as compared to ideal case and differences are more significant for higher bandgap quantum dot absorbers. Detailed balance efficiency computed in this case is much closer to practically observed efficiencies.

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