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Conclusion

The present thesis work concludes that sensitization is important aspect for quantum dot sensitized solar cells. It governs the photovoltaic efficiency of QDSSCs. In this study, in-situ hydrothermal sensitization for CdTe quantum dots has been investigated and optimized for TiO_2 mesoporous electrodes. The sensitized electrodes have been evaluated for photovoltaic performance with polysulfide efficiency and PbS counter electrode. This optimized hydrothermal in-situ process demonstrated efficient sensitization of CdTe QDs with record efficiency reported in the literature. Further, this process resulted in an amorphous covering over sensitized electrode that protects CdTe quantum dots from polysulfide electrolyte, thus avoiding CdTe QDs degradation. This sensitization strategy can be adopted for other sensitive quantum dots like PbS to realize higher efficiency as it results in additional protective covering and ZnS surface passivation is not required for the developed process.

The transition metal doped CdS QDs may provide some rationale for selection of transition metal doping in CdS or other QDs sensitized TiO_2 mesoporous electrodes. We observed that a transition metal whose doping results in insertion of states close to the conduction band minima of electron transport material can enhance photoconversion efficiency while if induced states energy levels are in between conduction band minima of electron transport material and redox hole conductor then efficiency will be poor due to induced recombination because of mid band states.

Zinc titanate is explored as an alternate photoelectrode material for quantum dot sensitized solar cells. The lower temperature calcinated zinc titanate material is more efficient photoelectrode material as compared to that of a higher temperature calcinated zinc titanate material. Lower efficiency for high temperature calcinated zinc titanate material is attributed to the availability of low surface area for quantum dot sensitization and more recombination due to presence of different phases with different electronic properties.

The detailed balance efficiency calculations are carried out for quantum dot sensitized solar cells considering non-ideal electron transport material and red-ox hole conductor. We observed that carrier multiplication does not affect detailed balance efficiency due to finite threshold in carrier multiplication. The efficiency decrease more rapidly for higher bandgap QD absorbers due to finite open circuit voltage condition. This is due to finite conduction band minima of electron transport material and finite redox potential of hole conductor. These detailed balance studies will assist in realizing the efficient QDSSCs under realistic conditions.

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