Charge Career Dynamics of PbS in PbS/ CdS Quantum Dot Sensitized Solar Cells: Electrochemical Impedance Spectroscopic Analysis

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Quantum dots (q-dots) having attractive characteristic features, such as tunable band gaps and broad-band absorption properties, persuade scientific research interest on semiconductor sensitized solar cells. PbS/CdS q-dots absorb light in wide range include ultraviolet, visible and infrared region. However, the performance of quantum dot solar cells (QDSCs) is inferior because of higher recombination, less stability and poor catalytic activity of counter electrode. This problem could be overcome by synthesis of q-dots and fabrication of counter electrode by optimizing the methods and conditions. In this research, PbS q-dots were synthesized by SILAR Method by manipulating the cationic and anionic precursor solutions. For PbS quantum dot deposition, TiO_2 photoanode fabricated by Doctor Blade Method, immersed into the Pb^{2+} solution for 90 s and S^{2-} mixed 3-mercaptoproponic acid solution for another 90 s period. After each deposition, loosely bound ions were removed by washing with methanol -water solvent mixture. This process of q-dot deposition is called ‘one cycle of deposition’. After deposition of PbS q-dots, three cycles of CdS and three cycles of ZnS deposited by SILAR Method using 0.05 M cationic and 0.05 M anionic (S^{2-}) precursor solutions. PbS q-dots prepared with 0.03 M Pb^{2+} and 0.03 M S^{2-} ion mixed 3-mercaptoproponic acid show enhanced efficiency up to 5.87%. Deposition of PbS q-dots with lower concentration of precursor solution is hindered by higher recombination and higher transport resistance. Deposition with very low concentration leads to very low quantum dot loading. Enrichment of quantum dot deposition with higher concentration of solution shows higher absorbance of light, although the recombination resistance and charge transport resistance play the main hurdle in the performance of such device.

Keywords:q-dot, solar cell, PbS/ CdS, recombination.