In_2S_3 Co-Sensitized PbS Quantum Dot Solar Cells

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초 록: Quantum-dot sensitized solar cells (QDSCs) are an emerging class of solar cells owing to their easy fabrication, low cost and material diversity. Despite of the fact that the maximum conversion efficiency of QDSCs is still far less than that of Dye-Sensitized Solar Cells (>12 %), their unique characteristics like Multiple Exciton Generation (MEG), energy band tune-ability and tendency to incorporate multiple co-sensitizers concurrently has made QDs a suitable alternative to expensive dyes for solar cell application. Lead Sulfide (PbS) Quantum dot sensitized solar cells are theoretically proficient enough to have a photo-current density (J_{SC}) of 36 mA/cm^2, but practically there are very few reports on photocurrent enhancement in PbS QDSCs. Recently, Hg^{2+} incorporated PbS quantumdots and Cadmium Sulfide (CdS) co-sensitized PbS solarcells are reported to show an improvement in photo-current density (J_{SC}).
In this study, we explored the efficacy of In_2S_3 as an interfacial layer deposited through SILAR process for PbS QDSCs. In_2S_3 was chosen as the interfacial layer in order to avoid the usage of hazardous CdS or Mercury (Hg). Herein, the deposition of In_2S_3 interfacial layer on TiO_2 prior to PbS QDs exhibited a direct enhancement in the photo-current (Isc). Improved photo-absorption as well as interfacial recombination barrier caused by In_2S_3 deposition increased the photo-current density (J_{SC}) from 13 mA/cm^2 to 15.5 mA/cm^2 for single cycle of In_2S_3 deposition. Increase in the number of cycles of In_2S_3 deposition was found to deteriorate the photocurrent, however it increased V_{oc} of the device which reached to an optimum value of 2.25% Photo-conversion Efficiency (PCE) for 2 cycles of In_2S_3 deposition. Effect of Heat Treatment, Normalized Current Stability, Open Circuit Voltage Decay and Dark IV Characteristics were further measured to reveal the characteristics of device.

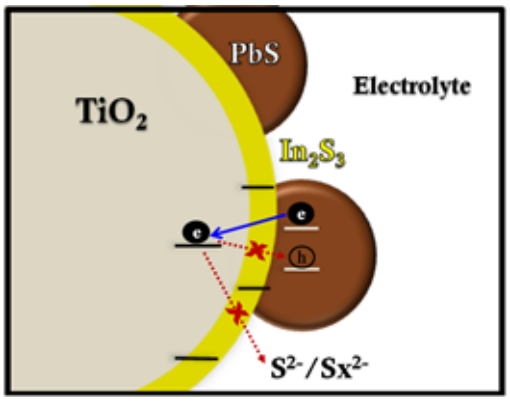

Fig. 1. Schematic Diagram of In_2S_3 Interfacial Layer based PbS QDSCs

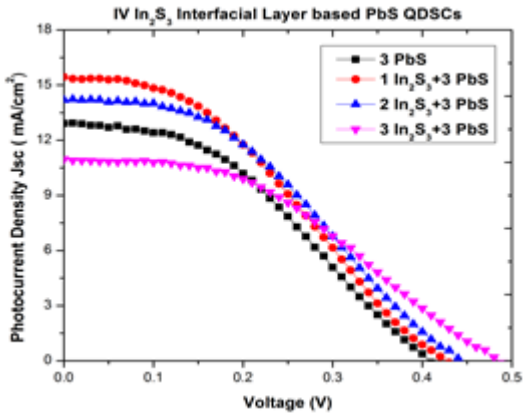

Fig. 2. I-V of In_2S_3 Interfacial Layer based PbS QDSCs