Optimizing the Performance of Perovskite Solar Cells by Varying Active Layer Thickness

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Abstract

Perovskite solar cells (PSCs) have been emerged as a strong contender for the next generation of photovoltaic technologies due to their promising power conversion efficiency (PCE) along with high absorbance, low-cost of production and facile fabrication process of absorber and Nanocrystalline TiO_2 layers. This study focuses on optimizing the performance of PSCs by modifying the active layers by varying the thickness of the active layers and the reaction time for the perovskite precursor solution. The corresponding ITO /compact TiO_2 / mesoporous TiO_2 / $CH_3NH_3PbI_xCl_{3-x}$ / P3HT / Au devices were fabricated. Mesoporous TiO_2 (mp-TiO_2) layer was deposited by solution processed spin coating method. Various spin rates and different concentrations of transparent Titania (18NR-T) nanocolloidal paste dissolved in Tetrahydrofuran (THF) were investigated for optimizing mp-TiO_2 layer with five different thickness of 400 nm, 500 nm, 600 nm, 750 nm and 950 nm. The best efficiency of 8.6 % was achieved with mp-TiO_2 thickness of 400 nm. Two different reaction times were investigated to identify the optimum reaction time for the perovskite precursor solution, and the device with reaction a time of 8 hours exhibited efficiency of over 3%, whereas the best efficiency of 6.4 % was achieved for the one fabricated with the reaction time of 2 hours. Furthermore, thin layers of perovskite with 400 nm thickness of TiO_2 exhibited better performance than the devices fabricated with the TiO_2 layer thickness of 550 nm. All the measurements were carried out under Air Mass (AM) 1.5 conditions (100 mW cm^{-2}, 1 sun) in air.

Keywords: Perovskite solar cells, thickness of active layers, Mesoporous TiO_2 layer, Titania (18NR-T) nanocolloidal paste