Optimization of Inverted Planar Methylammonium Lead Halide Perovskite Solar Cells

Alkhonaizi, Noor

Solar energy can be utilized through photovoltaic cells to simultaneously meet the global demand for energy and decrease the production of greenhouse gases. However, their low efficiency rates and the presence of the current density-voltage (J-V) hysteresis impede their use as a main energy source. This research aims to optimize inverted planar methylammonium lead iodide (CH3NH3PbI3) perovskite solar cells through morphological changes. The perovskite layer was fabricated by a two-step inter-diffusion method with poly(3,4-ethylenedioxythiophene): poly(styrenesulfonic acid) (PEDOT: PSS) and phenyl-C61-butyric acid methyl ester (PCBM) as the hole transport layer (HTL) and electron transport layer (ETL), respectively. The perovskite layer deposition parameters remained constant while the ETL and HTL parameters were adjusted in a series of optimization processes, with PCBM concentrations ranging from 20 to 40mg/mL and PEDOT: PSS spin coating times from 15-60s. Two groups of devices were used with the first group not containing a ZnO layer while the second did. The resulted solar cells were characterized according to device performance (J-V), optical (UV-Vis), electrical (4-point probe), and structural (AFM, XRD, SEM) properties. It was found that a higher concentration of PCBM (40 mg/mL) and longer PEDOT: PSS spinning time (60s) resulted in the highest efficiency of 7.92%. In addition, the ZnO layer helped decrease the J-V hysteresis due to its band alignment between the PCBM and Ag contacts. These optimized parameters aid the production of efficient and reliable solar cells, and in turn, the production of a viable energy source.