Numerical study and optimization of GO/ZnO based perovskite solar cell using SCAPS

ABSTRACT

This paper focuses on the numerical study of hybrid organic-inorganic perovskite solar cells. It investigates the incorporation of a graphene oxide (GO) thin layer to enhance solar cell efficiency. The study demonstrates that the GO layer improves interaction with the absorber layer and enhances hole transportation, resulting in reduced recombination and diffusion losses at the absorber and hole transport layer (HTL) interface. The increased energy level of the Lower Unoccupied Molecular Orbital (LUMO) in GO acts as an excellent electron-blocking layer, thereby improving the VOC. The objective is to explore different structures of perovskite solar cells to enhance their performance. The simulated solar cell comprises a GO/FASnI3/TiO2/ZnO/ITO sandwich structure, with FASnI3 and ZnO thicknesses adjusted to improve conversion efficiency. The impact of thickness on device performance, specifically the absorber and electron transport layers, is investigated. The fill factor (FF) changes as the absorber and electron transport layers (ETL) increase. The FF is an important parameter that determines PSC performance since it measures how effectively power is transferred from the cell to an external circuit. The optimized solar cell achieves a short-circuit current density (JSC) of 27.27 mA/cm2 , an open-circuit voltage (VOC) of 2.76 V, a fill factor (FF) of 27.05% and the highest power conversion efficiency (PCE) of 20.39% with 400 nm of FASnI3 and 300 nm of ZnO. These findings suggest promising directions for the development of more effective GO-based perovskite solar cells.