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Improving the Performance and Stability of Triple Cation Perovskite Solar Cells Using Various 2D Passivation

Fatai Ayodele Adeleye[1], Felix Lang[2, *]

[1]Karlsruhe School of Optics and Photonics KSOP, Karlsruhe Institute of Technology, Karlsruhe, Germany

[2]Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany

Email address:

fatai.adeleye@student.kit.edu (Fatai Ayodele Adeleye), felix.lang@uni-potsdam.de (Felix Lang)

[*]Corresponding author

Abstract

Perovskite Solar Cells (PSCs) offer several advantages such as high carrier mobility, absorption coefficient, carrier lifetime, and low exciton binding energy. Over the past decade, their power conversion efficiency (PCE) has increased from 3.8% to an impressive certified value of 26.1%. However, the commercialization of PSCs faces challenges such as degradation from exposure to oxygen, moisture, and ion migration. To address these challenges, we employed a pin architecture, and various 2D passivation molecules between the interlayer of triple cation perovskite and the C_{60} were introduced. This was followed by sequential treatment of ammonium benzenesulfonate (ABS), Ethane-1, 2-diammonium iodide ($EDAI_2$), and phenethyl ammonium iodide (PEAI) to enhance the performance and stability of triple cation PSCs. The diammonium molecules act as a barrier to minority carriers and reduce contact-induced interface recombination through field-effect passivation. The ABS treatment is believed to have created an additional (PbI_2) on the film surface of triple cation perovskite $Cs_{0.05}(MA_{0.02}FA_{0.98})_{0.95}Pb(I_{0.98}Br_{0.02})_3$, which further reacted with PEAI to generate 2-dimensional perovskite layers. We observed that the sequential treatment of ABS, PEAI, and ($EDAI_2$) resulted in a significantly enhanced PCE of 24.03%, which is attributed to an increased open circuit voltage (V_{OC}) as a result of reduced non-radiative recombination.

Keywords

Perovskite Solar Cells, Power Conversion Efficiency, Triple Cation Perovskite, 2D Passivation, Non-Radiative Recombination