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TS2-ThP-6 Perovskite Solar Cell with Potassium Chloride Treated SnO2 Electron Transport Layer for Increased Efficiency, ***Akhil Prio Chakma [akhilprio.chakma@udc.edu]***, *Biplav Dahal, Tewelde Semere, Hongmei Dang,* University of The District of Columbia, USA

Perovskite solar cells (PSCs) have emerged as a promising candidate for next-generation photovoltaicsdue to their low fabrication cost and high-power conversion efficiency (PCE). However, recombination losses and charge transport issues at the interface between SnO_2 electron transport layer (ETL) and perovskite absorber are hindering the performance improvement. The SnO_2 surface often has oxygen vacancies and other defects that act as trap sites for electrons. These defects can lead to charge recombination, reducing the efficiency of charge extraction. This study demonstrates that potassium chloride (KCl) surface treatment of SnO_2 helps passivate these surface defects. Potassium ions (K^+) can fill oxygen vacancies, reducing trap density, mitigating recombination losses, and decreasing hysteresis in the current-voltage (I-V) characteristics. Characterization using scanning electron microscopy (SEM), atomic force microscopy (AFM), kelvin probe force microscopy (KPFM) confirmed better surface morphology and larger grain sizes onKCl treated SnO_2 and the corresponding perovskite layer. X-ray diffraction (XRD) analysis further revealed enhanced crystallinity, which is evident by intense diffraction peaks and reduced full-width half maximum (FWHM) compared to control samples. Photovoltaic performance measurements demonstrated improvements in device performance after KCl treatment. The best performing KCl based PSCs showed a PCE of 21%, fill factor of 77%,open-circuit voltage (V_{OC}) of 1.08V, and short-circuit current density (J_{SC}) of 25 mA/cm^2. The KCl based PSCs demonstrated that average efficiency is about 25% higher than control samples. These results highlight the effectiveness of KCl surface treatment in enhancing charge extraction, enhancing crystalline, reducing recombination losses, and improving overall device performance, making it a promising strategy for advancing high-efficiency PSCs.

Keywords: Perovskite Solar Cells, Electron Transport Layer, Efficiency, Atomic Force Microscopy, Kelvin Probe Force Microscopy, Scanning Electron Microscopy, Forward Width at Half Maximum.

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