GLOBAL SUMMIT ON RENEWABLE AND SUSTAINABLE ENERGY

Rania Saleh Alqurashi

Al-Baha University, Saudi Arabia

Comprehensive investigation of material properties and operational parameters for enhancing performance and stability of FASnI3-based perovskite solar cells

Abstract: Recent advancements in the efficiency of lead-based halide perovskite solar cells (PSCs), exceeding 25%, have raised concerns about their toxicity and suitability for mass commercialization. As a result, tin-based PSCs have emerged as attractive alternatives. Among diverse types of tin-based PSCs, organic–inorganic metal halide materials, particularly FASnI3 stands out for high efficiency, remarkable stability, low-cost, and straightforward solution-based fabrication process. In this work, we modelled the performance of FASnI3 PSCs with four different hole transporting materials (Spiro OMeTAD, Cu2O, CuI, and CuSCN) using SCAPS-1D program. Compared to the initial structure of Ag/ Spiro-OMeTAD/FASnI3/TiO2/FTO, analysis on current–voltage and quantum efficiency characteristics identified Cu2O as an ideal hole transport material. Optimizing device output involved exploring the thickness of the FASnI3 layer, defect density states, light reflection/transmission at the back and front metal contacts, effects of metal work function, and operational temperature. Maximum performance and high stability have been achieved, where an open-circuit voltage of 1.16 V, and a high short-circuit current density of 31.70 mA/cm2 were obtained. Further study on charge carriers capture cross-section demonstrated a PCE of 32.47% and FF of 88.53% at a selected capture cross-section of electrons and holes of 1022 cm2. This work aims to guide researchers for building and manufacturing perovskite solar cells that are more stable with moderate thickness, more effective, and economically feasible.

Keywords: Lead free perovskite, Performance, FASnI3, Optical properties, SCAPS-1D

Biography: Rania Alqurashi received her Ph.D in Physics from the University of Sheffield, UK in 2018, a MSc in Nanoscale Science and Technology with a distinction from the University of Sheffield, UK in 2013, and a bachelor's degree in Physics with a second honor from the Umm Al Qura University, Saudi Arabia. She has been a faculty member at Al-Baha University, Saudi Arabia since 2005. Her research interests include the fabrication and development of various solar cell devices, solar energy applications, green synthesis of nanomaterials, and nanotechnology characterization tools including AFM, SEM, TEM, and others like XPS, UPS, XRD, and optical spectroscopies.

ISBN: 978-1-0685851-9-7