The Role of the Hole Transport Layer in Hybrid Sn-Pb Perovskite Solar Cells

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Hybrid Sn-Pb perovskite solar cells have captured significant interest in photovoltaic research due to their capacity to fine-tune the bandgap between 1.4eV and 1.25eV. This feature is crucial for achieving near Shockley-Queisser (S-Q) limit efficiencies in single-junction cells and holds potential for high-efficiency sub-cells in all-perovskite tandem configurations. Central to this study is the hole transport layer (HTL), a vital component that significantly influences the efficiency and stability of Sn-Pb perovskite solar cells. The research focuses on exploring various materials and methodologies to tune the HTL's properties, including its conductivity, energy level alignment, doping level and interaction with the perovskite layer. A particular emphasis is placed on reducing surface recombination and minimizing open-circuit voltage (Voc) losses, which are critical for improving the overall cell performance. Photoluminescence Quantum Yield (PLQY) measurements to assess charge carrier recombination at the HTL-perovskite interface, indicating charge transfer efficiency. Time-Correlated Single Photon Counting (TCSPC) is used to determine charge carrier lifetimes, shedding light on recombination processes and HTL's role in reducing non-radiative losses. Additionally, Transient Absorption Spectroscopy (TAS) investigates the ultrafast charge carrier dynamics, from generation to extraction, demonstrating the HTL's impact on improving device performance. By optimizing the HTL, this study aims to address one of the primary challenges in the development of hybrid Sn-Pb perovskite solar cells, contributing to the advancement of solar cell technology and its application in high-efficiency solar energy systems