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Passivating Inorganic Interlayers at the Perovskite/C_{60} Interface in Monolithic Perovskite Silicon Tandem Solar Cells

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Abstract

Metal halide perovskites have emerged in recent years as promising absorber materials for solar cells with the potential to combine high power conversion efficiency with low production costs. However, significant non-radiative charge carrier recombination occurs at the perovskite interface with the electron contact, the fullerene C_{60}, which prevents the full exploitation of the solar cell's potential. Thermal evaporation of the C_{60} contact layer induces states within the bandgap, which act as recombination centers, lowers the quasi-Fermi level splitting, and thus, limits the open circuit voltage (V_{OC}) in solar cell devices. Ultra-thin passivation layers at the perovskite/C_{60} interface are used to reduce non-radiative recombination losses. To enable industrial upscaling, our focus is on inorganic passivation layers deposited via atomic layer deposition (ALD, *e.g.*, AlO_x). By adjusting the ALD parameters, an AlO_x interlayer has been developed that increases the iV_{OC} up to 50 mV and improves the V_{OC} for single-junction and tandem devices. To better understand the effects that play a role in this passivation, photoluminescence quantum yield (PLQY), angle-resolved X-ray photoelectron spectroscopy (ARXPS), and surface photovoltage (SPV) measurements were carried out. Since state-of-the-art perovskite solar cells using a LiF_x passivation layer suffer from severe device degradation over time, initial stability testing was carried out providing indications that a thin AlO_x passivation layer can slightly improve device stability and thus, can serve as a robust alternative to LiF_x.

Keywords

Tandem Solar Cells, Perovskite/C_{60} Interface, Passivation Layers, Atomic Layer Deposition