All-Inorganic $CsPbBr_3$ Perovskite Solar Cells Via Sequential Thermal Evaporation

Sahana Suresh[1], Chittaranjan Das[2], Michael Saliba[2, *]

[1]Institute for Photovoltaics (ipv), University of Stuttgart, Stuttgart, Germany

[2]IEK-5 Photovoltaics, Forschungszentrum Jülich, Jülich, Germany

Email address:

sahana.sahana@ipv.uni-stuttgart.de (Sahana Suresh), chittaranjan.das@ipv.uni-stuttgart.de (Chittaranjan Das), michael.saliba@ipv.uni-stuttgart.de (Michael Saliba)

[*]Corresponding author

Abstract

Perovskite solar cells (PSCs), advancing solar technology with remarkable photoconversion efficiency (PCE) and stability, typically use hybrid organic-inorganic lead halide perovskites. However, concerns remain about the organic component's impact on degradation. Transitioning to all-inorganic cesium perovskites is an alternative route to tackle the long-term stability challenges in PSCs. Within inorganic perovskites, $CsPbI_3$ suffers from polymorphism ranging from the photoactive α-phase to the inactive δ-phase. In contrast, $CsPbBr_3$ perovskites offer robust thermal, humidity, light stability and do not suffer from polymorphism. With a Shockley-Queisser single-junction limit of ~ 16% and a wide bandgap of 2.3eV, it is attractive for semi-transparent, building-integrated photovoltaics, and multi-junction applications. Many $CsPbBr_3$ works are based on solution-processing using conventional spin coating technique, limiting uniformity over large areas. Also, dissolving the precursors in solution, which frequently comes with toxicity concerns, can be challenging. Alternatively, thermal evaporation offers a solvent-free, industry-compatible fabrication method, enabling precise thickness control, conformal and uniform coverage over large substrates. Here, we fabricate a solvent-free $CsPbBr_3$ PSC via dual-source sequential evaporation. $CsPbBr_3$ films, deposited on compact SnO_2 electron transport layer, are pinhole-free and exhibit phase purity with reduced defects. Thin film annealing studies using X-ray diffraction, conducted alongside device investigations, revealed a decrease in phase transition temperature from 300 ℃ to 250 ℃. Finally, the fabricated device results in a PCE of 5.6% with an open-circuit voltage of 1.4V. An all-inorganic PSC with a vacuum-processed absorber layer is demonstrated to achieve a phase-pure, compact film of the desired thickness, paving the way for exploring $CsPbBr_3$ active layer.

Keywords

Evaporated Perovskite Solar Cells, All-inorganic Perovskite Solar Cells, Wide Bandgap Photovoltaics, Semi-transparent and Building-integrated PV

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