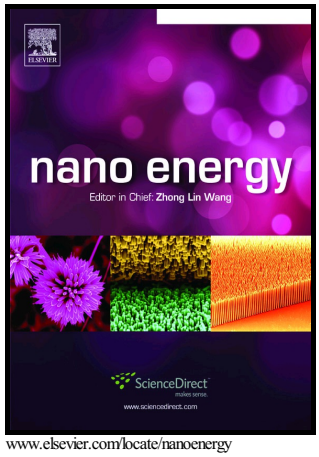

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ABSTRACT:

Mixed cation halide perovskite solar cells (PSCs), in a formula of ABX_3 where A is a mixture of formamidinium (FA) or cesium (Cs) cations, represent a promising new architecture to achieve largely improved stability and higher power conversion efficiency (PCE). While all these mixed-cation PSCs were synthesized via a solution method, we here propose and demonstrate a precisely tunable stack sequence physical-chemical vapor deposition (SS-PCVD) approach to prepare a mixed-cation absorber in CsBr-doped hybrid organic perovskite, which features a beneficial gradient bandgap profile to enable an improvement of PCE from 11.69% in pure $FAPbI_3$ to 18.22% in mixed-cation PSCs. Remarkably, an excellent stability in ambient exposure for 60 days has been achieved by a proper control of the CsBr cation incorporation and interface passivation. This new approach indicates a simple, precisely tunable and low cost fabrication strategy to implement high performance and scalable mixed-cation halide perovskite solar cells.