Toward High performance and stable perovskite solar cells by the process from regulation of solvent evaporation to the Ge-doping in B site

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Organic-inorganic hybrid perovskites solar cells (OIHPs) has attracted great attention recently due to the extraordinary performances comparable to silicon-based solar cells. The most technologies developed for organic solar cells can be directly applied to OIHPs owing to the structural similarity between them, which has accelerated the development speed of OIHPs, recording more than 30% of power conversion efficiency (PCE). Despite the great improvements, the poor reproducibility and stability are still great concerns regrading OIHPs, which should be overcome for commercialization in the future. Here, we briefly introduce the process to solve those problems when fabrication OIHPs by adequately regulating the evaporation rate of solvent during annealing and doping Ge forming mixture of Pb-Ge forming double B site cations in organic-based perovskites. It was found out that mixed cation/halide perovskites are likely to be more sensitive to the evaporation rate of solvents than single cation/halide perovskites such as MAPbI3 and FAPbI3. The phenomenon indicates that the extra care should be taken into account when fabricating mixed cation/halide perovskites, otherwise, the performances would be incoherent for different batches. The adequate control of solvents for quadrupole cation/halide perovskites consisting of Rb,Cs,MA,FA in A site cations led to high PCE, recording 21.3%. Also, the large area cells (1 cm2) showed high PCE, recording 18.27% of PCE certified from the measurement of maximum power point tracking (MPPT) in National Institute of Advanced Industrial Science and Technology (AIST). Further, we tried to dope Ge in Pb-based mixed cation/halide perovskites to improve electronic stability. The solubility problems by adding Ge in the precursor was solved by adding organic additive, resulting in uniform and pin-hole free films. The OIHPs with Ge showed significantly improved stable output, which keep the same current density values at constant voltage without any encapsulation, UV-filter and temperature controllers.