Improved Photovoltaic Performance from High Quality Perovskite Thin Film Grown with the Assistance of $PC_{71}BM$

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Abstract

The strategy of sequentially spin-coating a perovskite film from the perovskite precursor and an electron transporting layer of [6,6]-phenyl-C71-butyric acid methyl ester ($PC_{71}BM$) is developed to simplify the fabrication procedure of perovskite solar cells. X-ray diffraction and scanning electron microscopy indicate that $PC_{71}BM$ film on perovskite layer can retard the evaporation of dimethyl sulfoxide (DMSO) efficiently, thus prolonging the transformation of intermediate phase to perovskite crystals, leading to a high quality perovskite thin film. The solar cells with the structure of ITO/PEDOT:PSS/$CH_3NH_3PbI_3$ /$PC_{71}BM$/BCP/Ag made from this simplified method exhibit a higher efficiency (12.68%) than those from the conventional one-step method (9.49%).

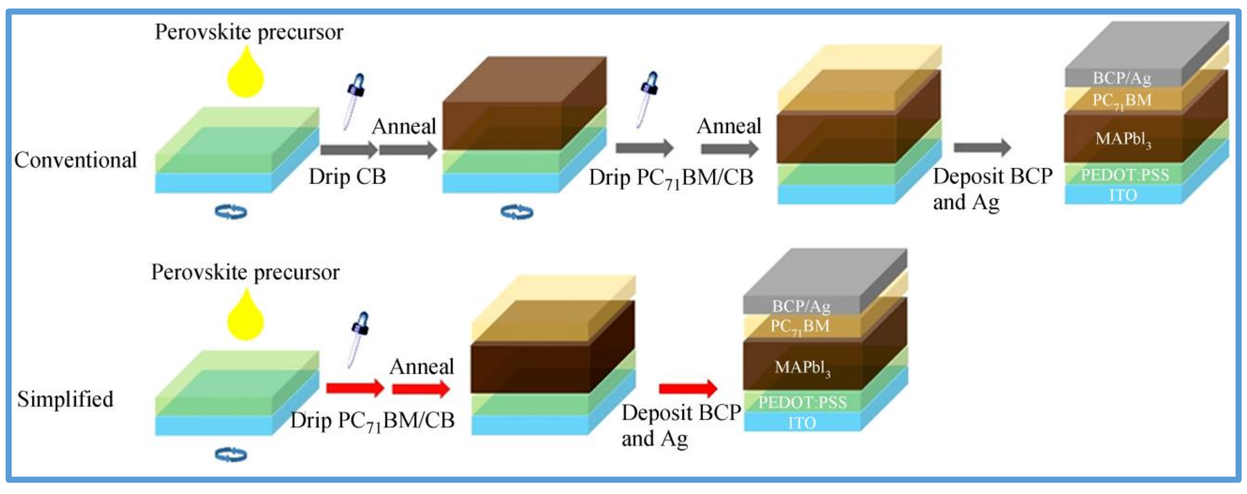

Fig. 1 The device structure and processing routes for PVSCs from conventional one-step (top) and simplified one-step (bottom) methods

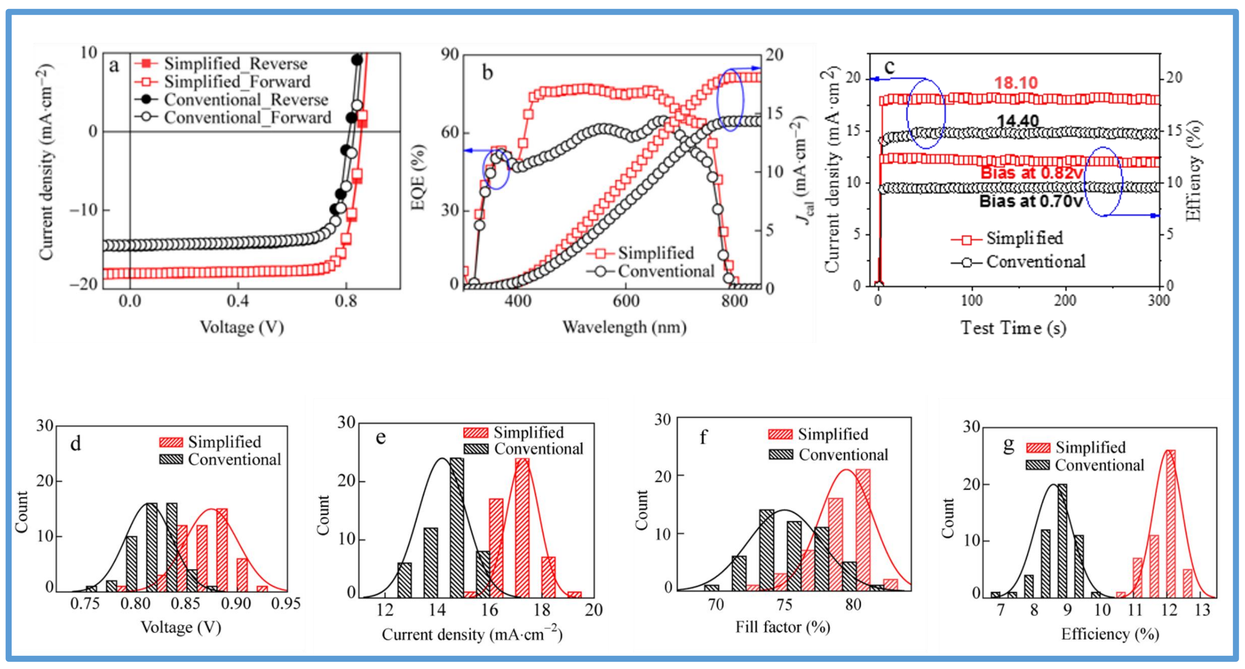

Fig. 2 (a) J-V curves of PVSC devices from the simplified and conventional methods under the standard AM1.5G illumination; (b) External quantum efficiency (EQE) spectra and the integrated current densities of PVSC devices from the simplified and conventional methods; (c) Stabilized photocurrent measurement of the best device and its power output at the maximum power point from simplified and conventional methods; (d-g) The histograms of the photovoltaic parameters of 50 devices from the simplified and conventional methods

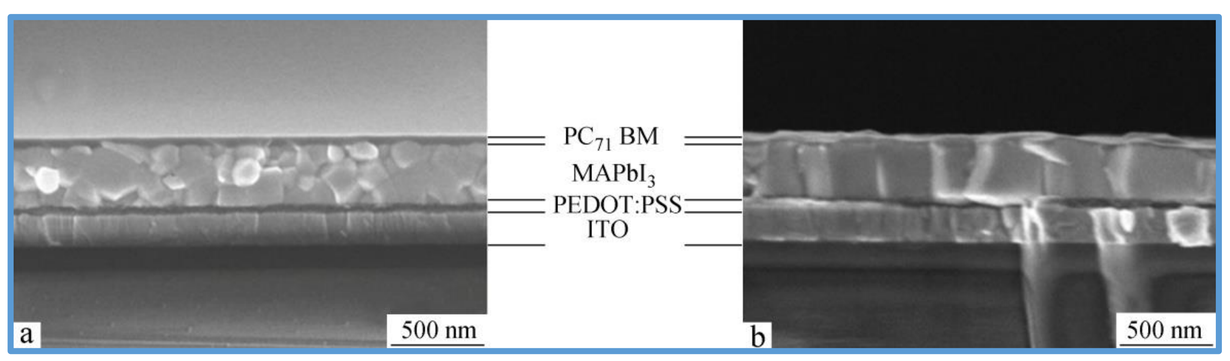

Fig. 3 The cross-sectional SEM images of ITO/PEDOS:PSS/$MAPbI_3$ /$PC_{71}BM$ films made from conventional (a) and simplified (b) methods

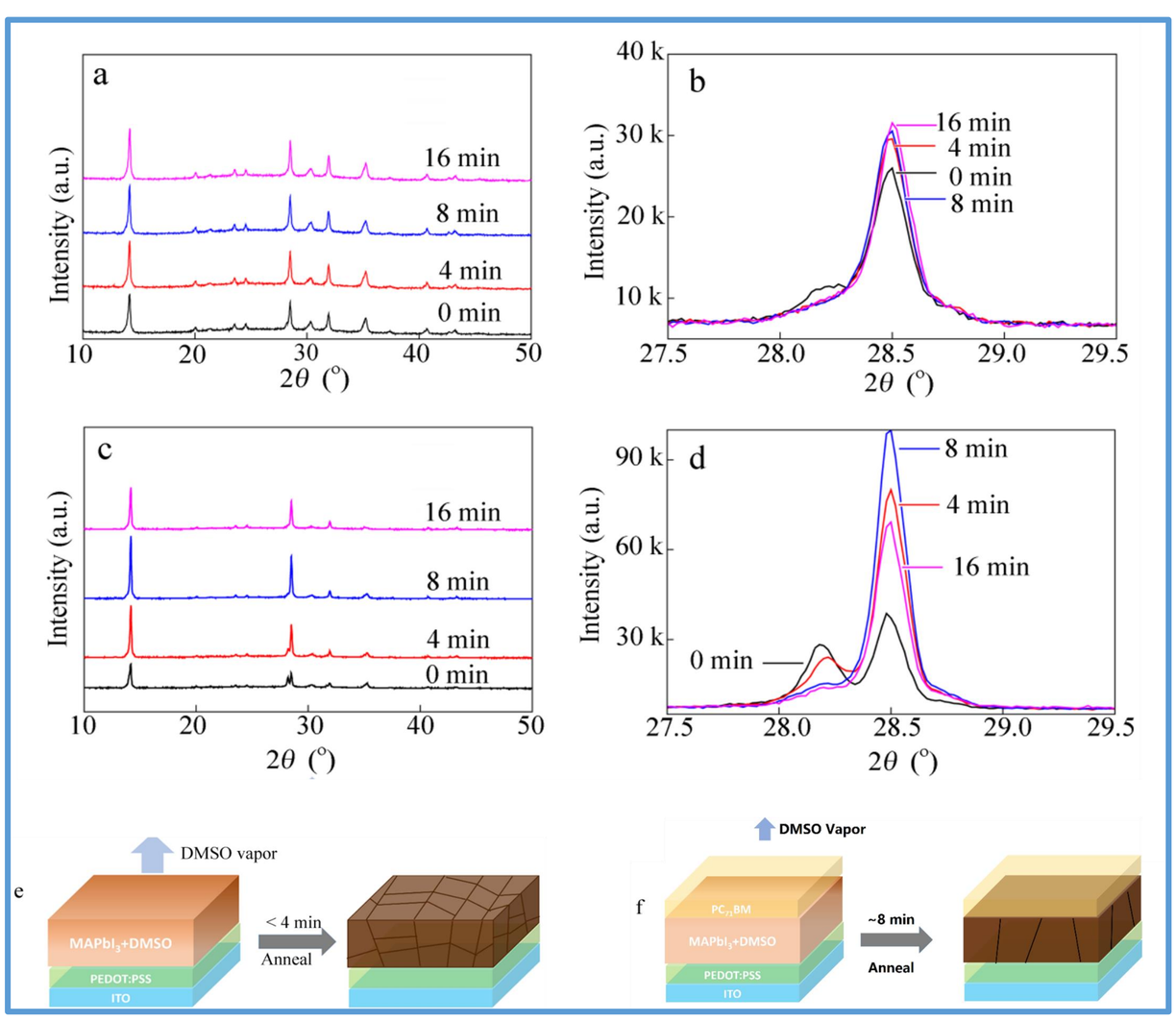

Fig. 4 XRD patterns of perovskite films made from the simplified method (a) and the conventional method (c) with various annealing time and their corresponding enlarged patterns (b and d) during range of 27.5°–29.5°。(The schematic diagrams for the annealing process of conventional (e) and simplified (f) methods.)

Conclusion

We simplify the preparation process of PVSCs by spin coating electron-transporting layer ($PC_{71}BM$) directly on perovskite precursor. The $MAPbI_3$ produced by simplified method shows the vertically oriented grain boundaries and large grain size crystals, which result to the improvement in efficiency.

Reference: Chen J., Yang S., Liu W., Fu W. and Chen H.; Chinese J. Polym. Sci., 2017, 35