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Unveiling the Importance of Precursor Preparation for Highly Efficient and Stable PEA-based Perovskite Solar Cells

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For the fabrication of low-dimensional perovskite solar cells using hydrophobic bulky organic cation, understanding the effect of precursor preparation on film formation [1] is critical to achieve high quality perovskite film and therefore high energy conversion efficiency in the associated solar device. Herein, we build on our prevous work on PEA-based mixed organic-inorganic hybrid perovskite [2] and report the use of two methods to prepare precursor solution with the same chemical composition. We called them i) different phase (DP) and ii) same phase (SP) methods as the former involves the mixing of 3D perovskite precursor with 2D perovskite precursor while the latter involves the mixing of quasi-2D perovskite precursors. The films prepared by these methods were characterized by X-ray diffraction (XRD), Kelvin probe force microscope (KPFM), scanning electron microscopy (SEM) and transmission electron microscopy (TEM) revealing different perovskite structure due to different formation mechanisms which also produce different optical properties revealed by ultraviolet-visible (UV-vis) spectroscopy and photoluminescence measurement. The energy conversion efficiency of the champion Au/Spiro-OMeTAD/$PEA_2(FA_{0.85}MA_{0.15})_{n-1}Pb_n(I_{0.85}Br_{0.15})_{3n+1}$/mp-$TiO_2$/c-$TiO_2$/FTO glass solar cells by DP and SP methods reached 19.1 % and 18.9 %, respectively. Results of the aging test show that dramatic improvement in the stability of SP perovskite devices with the most stable device maintaining 86% of its initial performance after exposure to RH 80±5% for 1000 hours and over 80 % of its initial PCE after continuous 1 sun illumination (including UV) at RH 70%. This is the best stability results for highly efficient PEA un-encapsulated cells. The new insights provided by this work are important to design perovskite solution precursor preparation methods for best device performance and stability

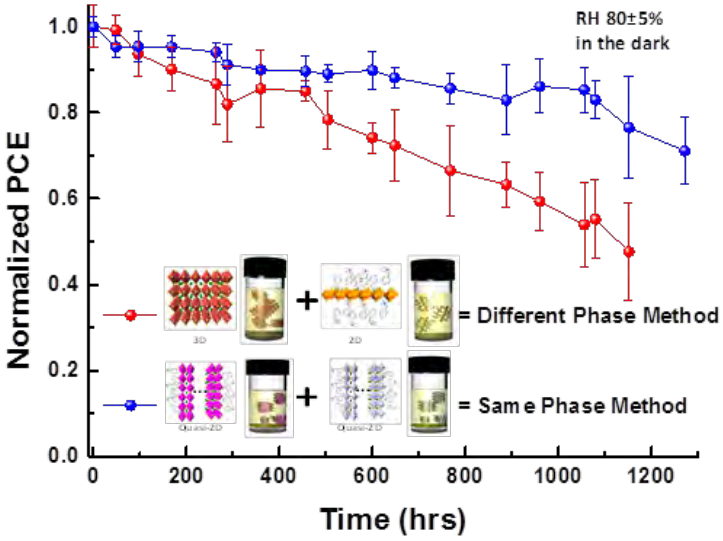

Figure 1 Normalized PCE of DP and SP un-encapsulated solar cells during exposure to RH 80±5% in the dark. Cells using different perovskite precursor preparations show different stabilities

References

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