Efficient and Stable Solution-Processed Planar Perovskite Solar Cells

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Organic-inorganic hybrid halide perovskites are an interesting class of materials that have excellent semiconductor properties, and demonstrated promising applications on many fields, such as solar cells, water photolysis, light emitting diodes, and amplified simutannous emission. The power conversion efficiency of perovskite solar cells (PSCs) have rapidly increased to more than 20% since first publication by Miyasaka and co-workers in 2009.[1] So far, the device lifetime is still short, this is key issue faced for all researchers in this field.[2] The deep understanding of their durability and degradation mechanism are important and necessary toward future applications.

Herein, we systematically studied the relationship between crystallization, morphology, device structure, efficiency and durability of PSCs. As the results, we obtained the well crystalized and fully covered perovskite layer (Figure 1), which improves not only power conversion efficiency but also long-time durability. Compared to a widely used lithium fluoride/aluminum counter electrode, gold electrode-based PSCs demonstrated better durability owing to less chemical degradation and interface changing, which were proved by absorption and X-ray diffraction spectroscopy, external quantum efficiency spectra, as well as electrical impedance spectroscopy. Finally, we realized a planar PSC with excellent durability by improving device encapsulation and optimizing device structures. The conversion efficiency of this PSC could keep more than 90% of the original value after 1000 h exposure under solar light (AM 1.5G, 100 mW cm^{-2}) in the ambient atmosphere (45 ± 5 ℃, 40 ± 5 % relative humidity).

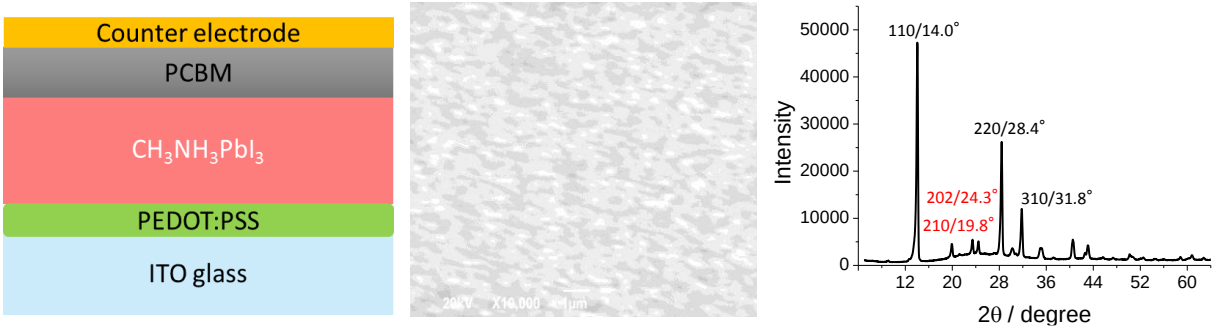

Figure 1. Device structure (left), SEM image (middle) and X-ray diffraction profile (right) of optimized $CH_3NH_3PbI_3$ film for high efficiency and stable PSCs.

Reference:

1. A. Kojima, K. Teshima, Y. Shirai, T. Miyasaka, *J. Am. Chem. Soc.* 2009, 17, 6050-6051.

2. M. Grätzel, *Nature Materials* 2014, 13, 838-842.