Abstract

A new type organic-inorganic hybrid perovskite has appeared to be a wonder material for its excellent optical absorption, long range charge-carrier diffusion and apparent tolerance to defects. In the last few years, it has been emerged as a primary candidate material for various photovoltaic, optoelectronic and photoelectronic applications. In just a few years, its solar cell efficiency has been improved from 3.8% to >23%. Moreover, the solar cell fabrication processes based on the planar architecture have been particularly enthusiastic thanks to their low temperature fabrication and compatibility with a range of substrates. Comparing solution deposition with vacuum deposition, the vacuum processes for thermal co-deposition and sequential deposition of PbCl2 and CH3NH3I materials are recognized as efficient means to prepare perovskite film with good uniformity and high surface coverage. A vacuum deposition process has been developed to fabricate high efficiency perovskite solar cells with high stability using alternating layer-by-layer vacuum deposition. The new deposition process allows us to relax the strict deposition monitoring and control measures, while realizing superior uniformity in film morphology, surface coverage and smoothness, together with crystalline phase purity.

For the high efficiency perovskite solar cells, the power conversion efficiencies for the planar device is as high as 22.4%. More importantly, we have developed a superior low temperature modified SnO2 material for ETL and transferred the cell fabrication process onto lightweight flexible polymeric substrate. The highest cell efficiency achieved was over 20%, it is also the highest efficiency among the flexible perovskite cells reported. Meanwhile, the devices show very good stability over long term exposure in ambient with very low degradation. After a representative cell was exposed in ambient lab condition for a year, its final cell efficiency is as high as over 95% of its initial efficiency with its degradation accounts for only smaller than 5%. Further analysis on the stability of the perovskite solar cells will be discussed. We have also developed a series of single-crystalline perovskites with superior stability and optoelectronic performance.

References

1. D. Yang, R. Yang, X. Ren, X. Zhu, Z. Yang, C. Li, S. Liu*, Advanced Materials, http://dx.doi.org/10.1002/adma.201600446.

2. D. Yang, R. Yang, J. Zhang, Z. Yang, S. Liu, C. Li, Energy Environ. Sci. 2015, 8, 3208.

3. D. Yang, Z. Yang, W. Qin, Y. Zhang, S. Liu, C. Li, J. Mater. Chem. A 2015, 3, 9401.