Understanding Perovskite Crystallization Process from Precursor to Crystals

Minchao Qin, Xinhui Lu*

Department of Physics, The Chinese University of Hong Kong, 999077, Hong Kong

*Email : xhlu@phy.cuhk.edu.hk

Solution-processed perovskite solar cells (PSCs) have attracted tremendous attention due to their rapidly rising efficiency over 24% in several years. However, some issues such as the degradation of aged precursor solutions and the time sensitivity in fabricating PSCs remain to be resolved. In our first work, we employ a small molecule (ITIC-Th) to stabilize the perovskite precursor solution by effectively suppressing the formation of yellow δ-phase in the films made from aged precursor solutions. Consequently, the PSCs fabricated from the aged precursor solution with ITIC-Th experience much less efficiency drop with the increase of the precursor aging time - from 19.20% (fresh) to 16.55% (39 days), compared with the devices made from conventional precursor solutions dropping from 18.07% (fresh) to 1.76% (39 days). Besides, understanding the crystallization process from precursor to perovskite crystals is essential as well. In the second work, the crystallization pathways of mixed perovskites under spin-coating have been investigated via *in situ* grazing-incidence wide-angle X-ray scattering (GIWAXS), revealing the existence of "annealing window" for the first time. The as-cast film should be timely annealed within the annealing window to achieve a high-quality perovskite film. Remarkably, the incorporating of Cs^+ could extend the annealing window, thereby improving the device performance and reproducibility. These studies unveil underlying reasons of the degradation of precursor solution and time sensitivity in fabricating mixed-perovskite devices, providing insightful guidelines for manipulating the perovskite crystallization pathways towards higher performance.

Reference:

1) M. Qin, J. Cao, T. Zhang, J. Mai, TK. Lau, S. Zhou, Y. Zhou, J. Wang, Y-J. Hsu, N. Zhao, J. Xu, X. Zhan, X. Lu*, Fused-ring electron acceptor ITIC-Th: a novel stabilizer for halide perovskite precursor solution, *Adv. Energy Mater.* **2018**, 1703399.

2) M. Qin, K. Tse, T.-K Lau, Y. Li, C.-J. Su, G. Yang, J. Chen, J. Zhu, U-S. Jeng, G. Li, H. Chen, and X. Lu*, Manipulating the Mixed-Perovskite Crystallization Pathway Unveiled by In Situ GIWAXS, *Adv. Mater.* **2019**, 1901284.