High efficiency Pb-In binary metal perovskite solar cells

With the support by the National Natural Science Foundation of China, the research team led by Prof. Liao Liangsheng (廖良生) at the Institute of Functional Nano & Soft Materials (FUNSOM) of Soochow University collaborated with the research team led by Prof. Gao Xingyu (高兴宇) at Shanghai Institute of Applied Physics (SINAP) of Chinese Academy of Sciences, reported high efficiency Pb-In binary metal perovskite solar cells with a champion power conversion efficiency (PCE) up to 17.55% and improved stability due to the good crystal quality of the prepared perovskite films with multiple ordered crystal orientations, which was published in *Advanced Materials* (2016, 28(31): 6695—6703) as an inside back cover paper.

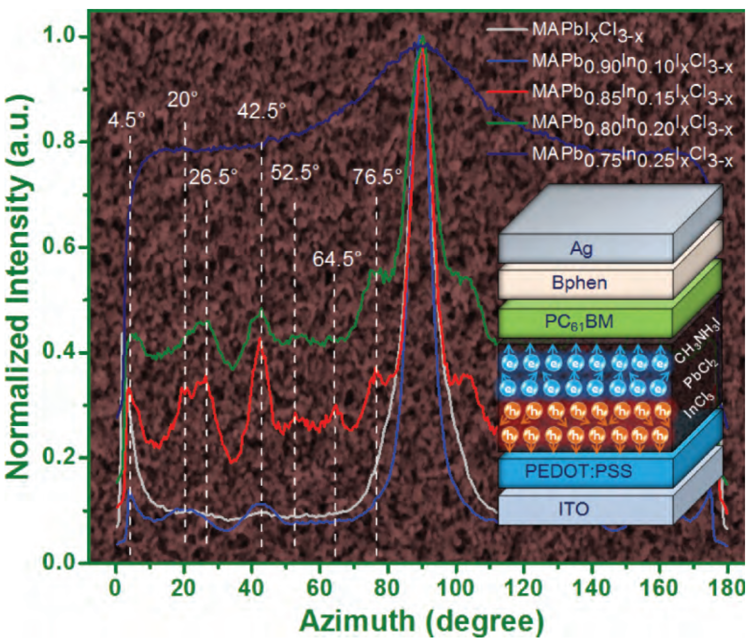

Figure High efficiency Pb-In perovskite and their multiple ordered crystal orientations.

Perovskite solar cells have recently achieved a certified PCE of 22.1% since the initial report of 3.8% in 2009. However, lead halides have to be utilized in most state-of-the-art perovskite-based devices and the presence of lead could create toxicological issues to the environment in the future. Therefore, researchers currently are searching hard for new materials to replace or substitute toxic lead.

In this study, researchers used sizable and oxidation-stable Indium cation (In^{3+}) embedded into a "cation cascade" to create binary Pb-In perovskite materials with excellent material properties. By optimizing the $InCl_3$ molar ratio, a substantially improved PCE of 17.55% in a planar heterojunction device based on this system has been achieved, which is even much higher than that of 12.61% in a pure lead-based control device. In addition, the Pb-In perovskite-based device demonstrated more stable PCE performance than the control device. By grazing incidence X-ray diffraction (GIXRD) experiments performed at beamline BL14B1 at Shanghai Synchrotron Radiation Facility (SSRF) and Carrier Mobility Evaluation (CME) measurements, Pb-In perovskites were found to exhibit a good crystal quality with multiple ordered crystal orientations, resulting in efficient charge transport along multiple directions, which was believed to be the main factor for substantially improved cell performance.

Thus, the successful substitution of Pb^{2+} with In^{3+} in perovskite without sacrificing the device performance opens a promising route to fabricate alloy perovskite solar cells with mitigated ecological impact.