## Multifunctional additive strategy to stabilize precursor solution and passivate film defects for MA-free perovskite solar cells with an efficiency of 22.75%

Huan Bi, Qing Shen<sup>\*</sup>, Shuzi Hayase<sup>\*</sup>

1The University of Electro-Communications, Tokyo 182-8585, Japan.

\* E-mail: <u>shen@pc.uec.ac.jp</u>; hayase@uec.ac.jp.

Though great progress has been realized in perovskite solar cells (PSCs), there are still some thorny challenges that exist such as 1) low power conversion efficiency (PCE) and loss of stability due to the defects in the film; 2) the reproducibility of solution-processed PSCs is poor due to the unstable perovskite precursor solution. Here, an effective multifunctional additive benzoyl hydrazine (BH) was developed to modify the perovskite film. The result shows that the defect of the film decreased after BH modification due to the interaction between BH and perovskite. Meanwhile, the I ions (I<sup>°</sup>) migration is also suppressed due to the weak interaction between BH and perovskite. In addition, the -NH-NH<sub>2</sub> in BH can reduce the undesired I<sub>2</sub> by reducing it to I-. Finally, the PCE of PSCs modified by BH achieved a PCE of 22.75%, which is one of the highest PCE of the reported MA-free PSCs. The modified device still exhibited excellent stability in different conditions.



Figure 1. J-V curves of the champion device; Photographs of the  $I_2$  solutions without (Control) and with BH (Target) additive with different aging times; TR-UV-vis spectroscopy of the film (e) without and (f) with BH modification.

**Key words:** MA-free perovskite solar cell; multifactional additive; reduce I<sub>2</sub>; ion migration suppression; defect passivation

## **References:**

[1] H. Bi, B. Liu, D. He, L. Bai, W. Wang, Z. Zang, J. Chen Chem. Eng. J. 2021, 418, 129375.

[2] H. Bi, X. Zuo, B. Liu, D. He, L. Bai, W. Wang, X. Li, et al. J. Mater. Chem. A 2021, 9, 3940-3951.

[3] H. Bi, Y. Guo, M. Guo, C. Ding, S. Hayase, T. Mou, Q. Shen, G. Han, W. Hou Chem. Eng. J. 2022, **439**, 135671.