# Lead-based perovskite solar cells that are highly efficient and environmentally friendly with lead recycled

**Huan Bi, Shuzi Hayase*, Qing Shen***

**Graduate School of Informatics and Engineer, The University of Electro-Communication, Tokyo 182-8585, Japan.**

**E-mail: hayase@uec.ac.jp, shen@pc.uec.ac.jp**

Perovskite solar cells (PSCs) have demonstrated tremendous success in terms of power conversion efficiency (PCE) and stability. However, further improving PSC PCE and stability remains a significant challenge.[1-5] Here, we try to improve the PCE and stability of PSCs by incorporating a functional additive called 3-mercaptopropyltriethoxysilane (SiSH) into the perovskite antisolvent. As shown in Figure 1, it has been discovered that SiSH can relieve stress in the film, reduce defects, and prevent lithium-ion migration and lead leakage. As a result, the target device improves its efficiency from 20.80% to 22.42% when compared to the control device. Meanwhile, SiSH modification improves device stability. This work provides an idea for developing multifunctional antisolvent additives and adsorbents for high PCE, long stability, and environment-friendly Pb-based PSCs.

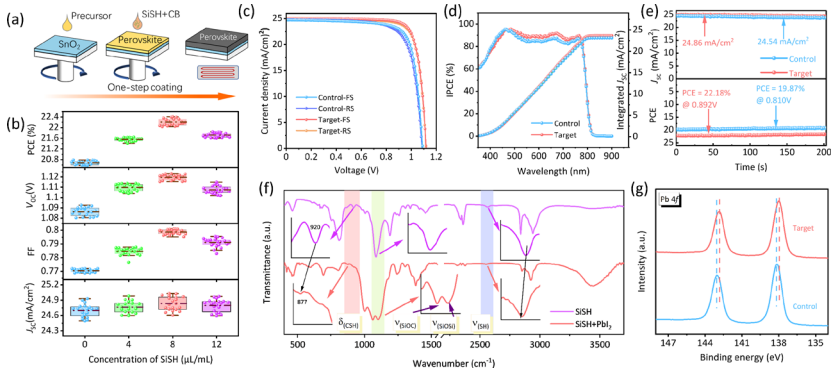


**Figure 1.** a) the preparation process of the PSCs used in this work. b) statistical of the photovoltaic parameters modified by different concentrations of the SiSH. c) *J–V* curves and d) corresponding IPCE spectra of the control and target devices. e) the time dependence of the stabilized current and PCE output of the PSCs with and without SiSH modification. f) FTIR spectra of the $PbI_2$ films without and with SiSH modification. g) Pb 4*f* XPS spectra of the perovskite films without and with SiSH modification.

**Keywords:** lead leakage and recycling, perovskite solar cell, 3-mercaptopropyltriethoxysilane

**References**

[1] https://www.nrel.gov/pv/cell-efficiency.html NREL.

[2] H. Bi et al., Chem. Eng. J. 15, 129375 (2021).

[3] H. Bi et al., Chem. Eng. J. 1, 135671 (2022).

[4] H. Bi et al., J. Mater. Chem. A 9, 3940 (2021).

[5] H. Bi et al., Sol. RRL 2200352. https://doi.org/10.1002/solr.202200352.