Crystallization regulation helps to realize efficient and stable perovskite minimodules
22 March 2022, by Zhang Nannan

Hybrid organic-inorganic perovskite materials have emerged as promising candidates for photovoltaic applications due to their outstanding optoelectronic properties and low-cost solution processing technique. Power conversion efficiency (PCE) of the perovskite solar cell (PSC) has rapidly risen over the last decade, from 3.8% to 25.7%, comparable to Si-based photovoltaic technology. At present, the low stability and the efficiency loss while the cell area is enlarged, are two key issues that need to be overcome in the commercialization of PSCs.

Coordination-induced crystallization regulation to improve perovskite film quality and introduction of organic long-chain ammonium halides to passivate interface and grain boundary defects have been demonstrated as effective approaches to improve cell performance. Recently, Prof. Meng Qingbo's group from the Institute of Physics of the Chinese Academy of Sciences has developed a dual-functional material to simultaneously realize the above-mentioned two modification effects for highly efficient and stable PSCs.

Fig. 1. Device efficiency characterization. Credit: Institute of Physics

The researchers report efficient, stable perovskite solar cells and minimodules realized by using an isobutylammonium isobutylidithiocarbamate (iBA-iBDTC) as an additive. On one hand, CSS' group of the iBA-iBDTC will effectively coordinate with the Pb\(^{2+}\) to improve the Pb-I nucleation and FA-Cs perovskite crystal growth.

On the other hand, the long-chain iBA\(^+\) cation group is distributed on the film surface and grain boundaries to passivate defects, reduce surface energy and stabilize surface structure.

With the synergistic contribution of the cationic and anionic groups, the PCE of the small-area single

Fig. 2. Defect characterization of perovskite films and devices. Credit: Institute of Physics

Formamidinium-cesium (FA-Cs) lead halide perovskite has attracted wide interest because of its high thermal and operational stabilities. However, its crystallization suffers from complicated intermediate phase transition processes because the two ion sizes of the FA\(^+\) and Cs\(^+\) mismatch, leading to smaller dipole moment and weaker interaction with the Pb-I framework. Therefore, it has usually brought about unsatisfied perovskite films with large lattice distortion, element segregation and defect centers.

Coordination-induced crystallization regulation to
cell has been improved to 24.25% with excellent operational stability. Over 20.5% PCE has been achieved from a 10.4 cm$^2$ minimodule, which is among the highest results of the perovskite minimodule.

This cation-anion synergistic effect of the dual-functional additive provides a more feasible technique route to promoting the PSC development and commercialization.

This study entitled "Efficient, Stable Formamidinium-Cesium Perovskite Solar Cells and Minimodules Enabled by Crystallization Regulation," was published in Joule.

More information: Yiming Li et al, Efficient, stable formamidinium-cesium perovskite solar cells

Provided by Chinese Academy of Sciences


*This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.*