

# Crystallization regulation helps to realize efficient and stable perovskite minimodules

March 22 2022, by Zhang Nannan

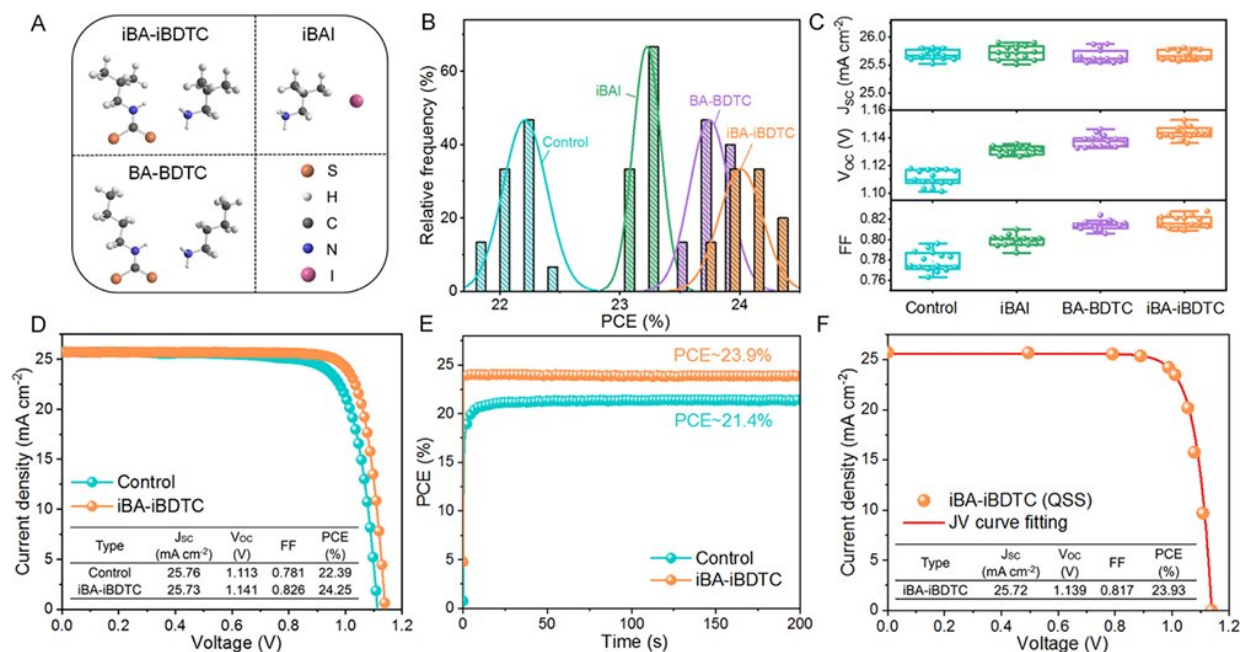


Fig. 1. Device efficiency characterization. Credit: Institute of Physics

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.

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  $\text{FA}^+$  and  $\text{Cs}^+$  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 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.

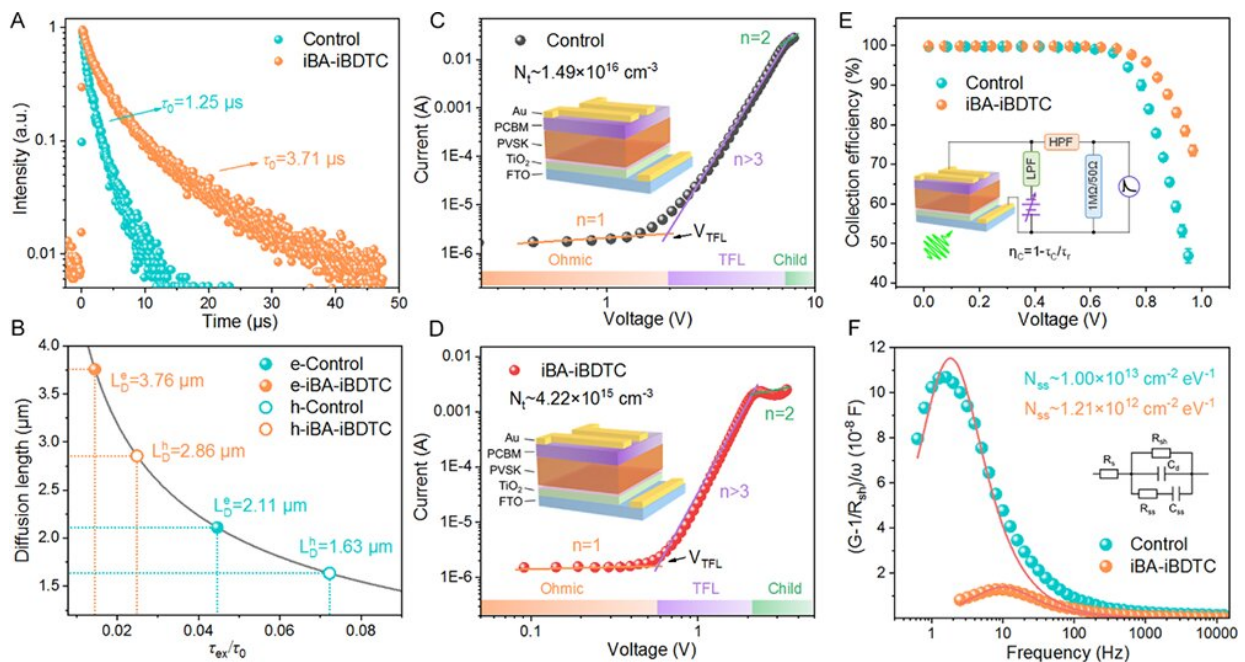


Fig. 2. Defect characterization of perovskite films and devices. Credit: Institute of Physics

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

On the other hand, the long-chain  $\text{iBA}^+$  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 cell has been improved to 24.25% with excellent operational stability. Over 20.5% PCE has been achieved from a  $10.4 \text{ cm}^2$  minimodule, which is among the highest results of the perovskite minimodule.

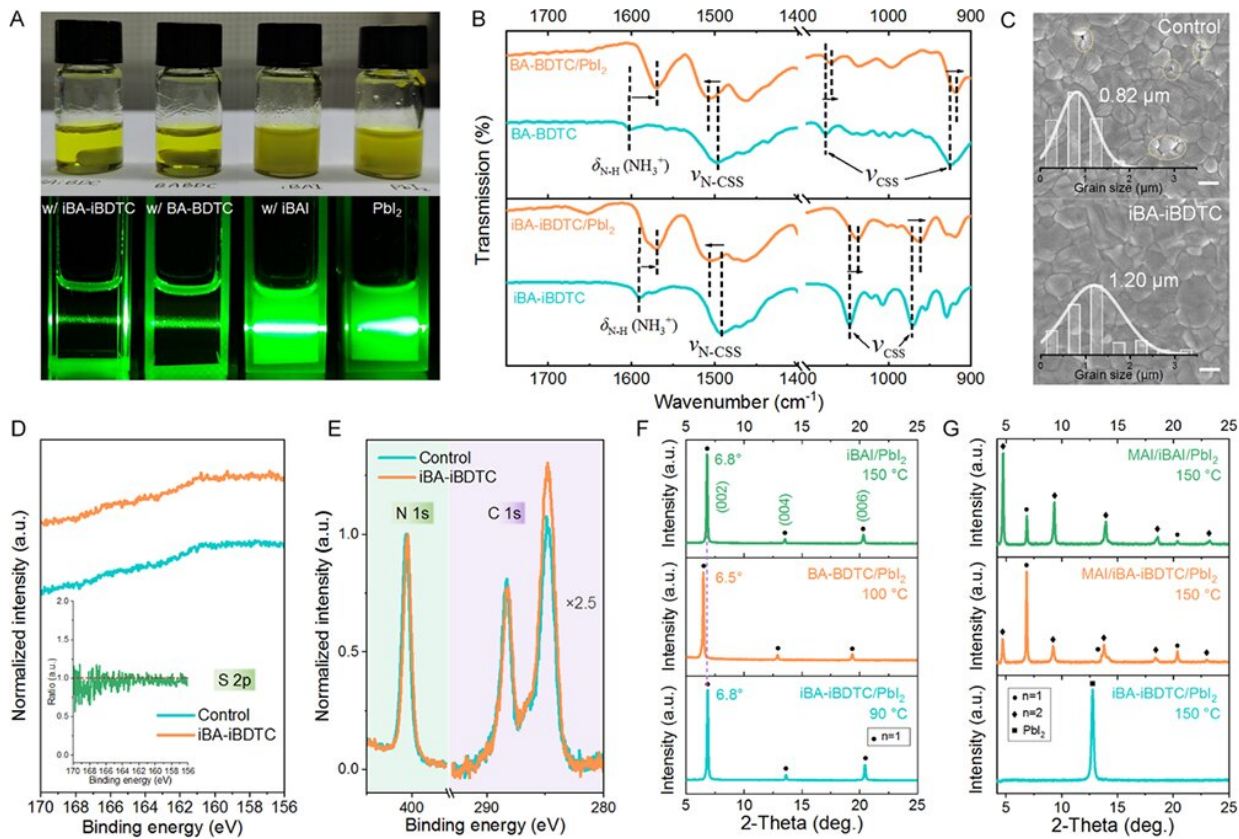


Fig. 3. Interaction between -CSS- anionic group and Pb-I framework. Credit: Institute of Physics

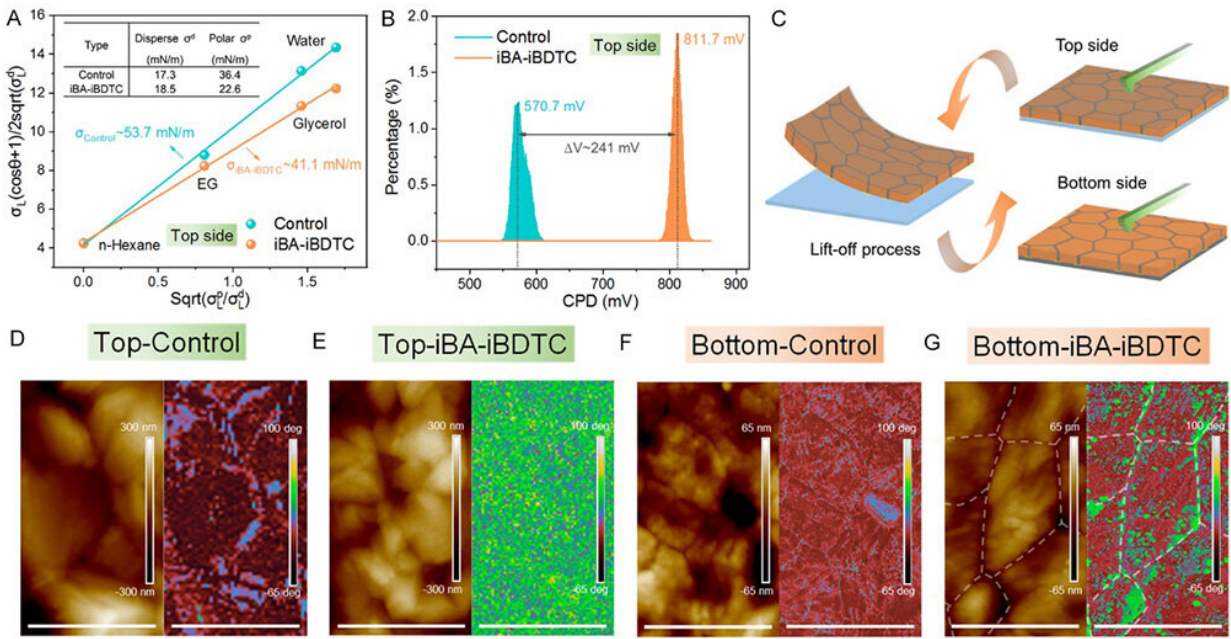


Fig. 4. Spatial distribution of the iBA+ cationic passivation layer in the perovskite film. Credit: Institute of Physics

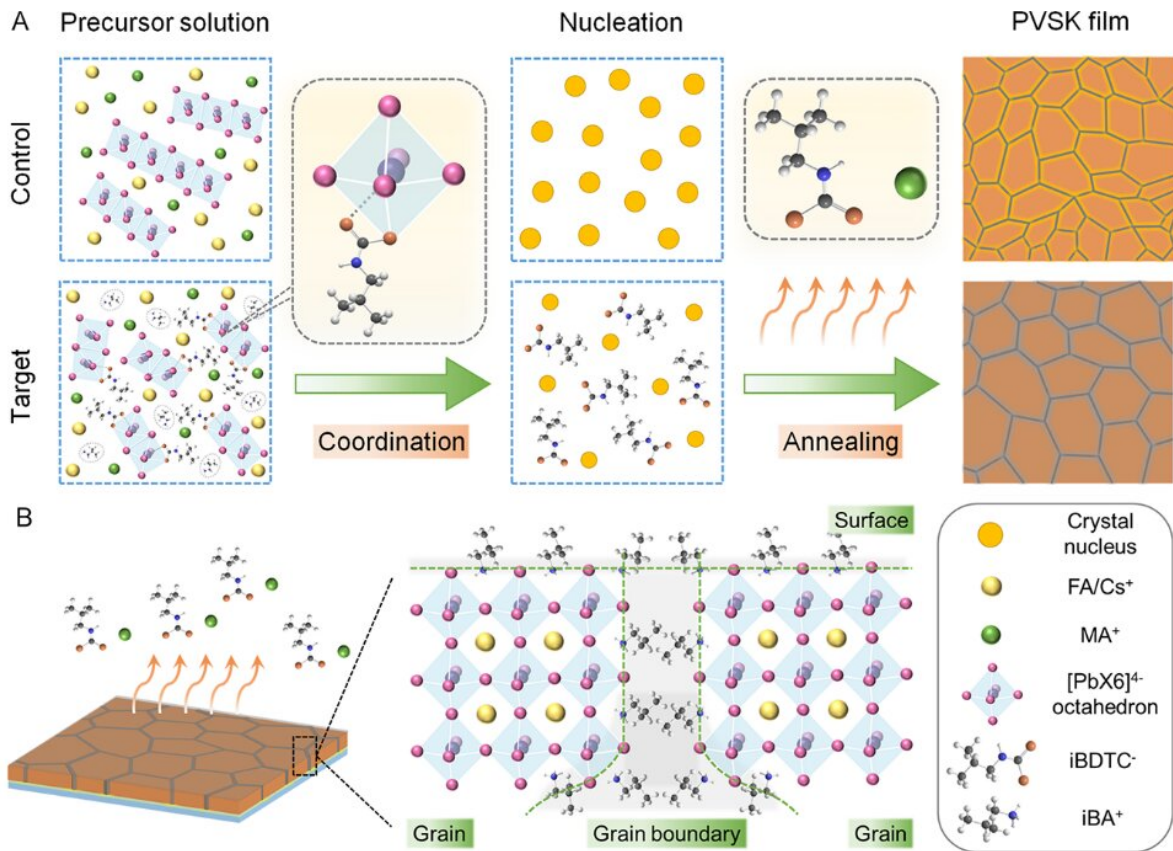


Fig. 5. Schematic illustration of the material and chemistry mechanism for regulating the crystallization and defect of the perovskite film by using iBA-iBDTC. Credit: Institute of Physics

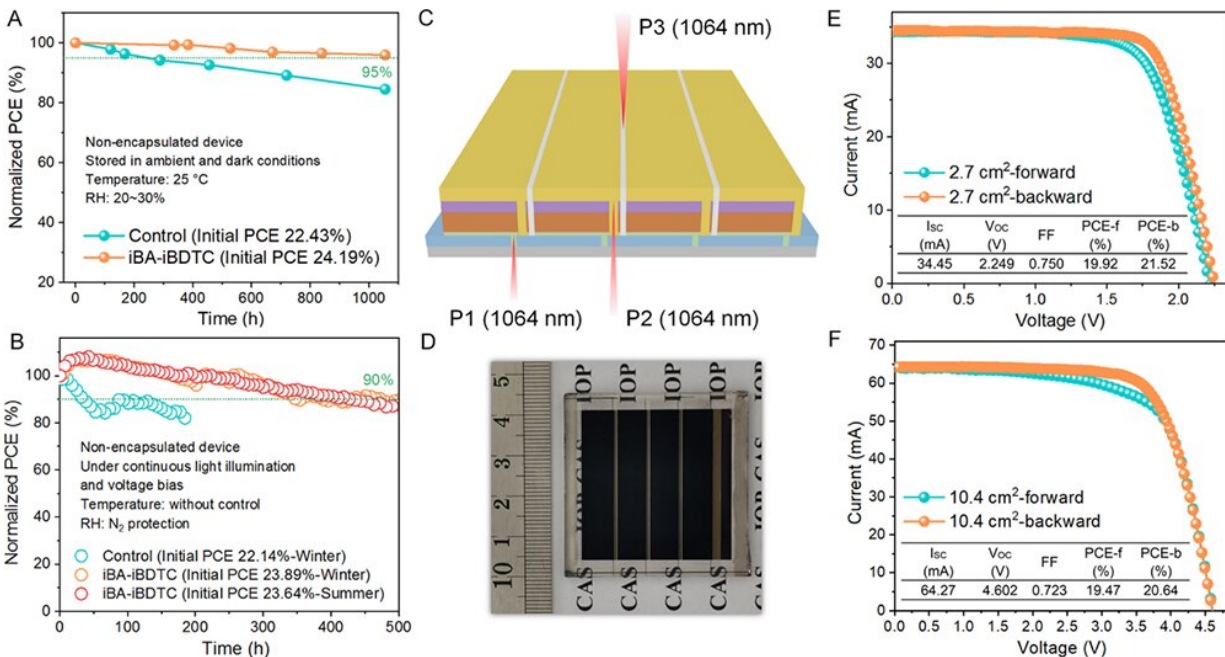


Fig. 6. Stability and large-area device performance. Credit: Institute of Physics

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 and minimodules enabled by crystallization regulation, *Joule* (2022). [DOI: 10.1016/j.joule.2022.02.003](https://doi.org/10.1016/j.joule.2022.02.003)

Provided by Chinese Academy of Sciences

Citation: Crystallization regulation helps to realize efficient and stable perovskite minimodules (2022, March 22) retrieved 27 April 2024 from <https://techxplore.com/news/2022-03-crystallization-efficient-stable-perovskite-minimodules.html>

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.