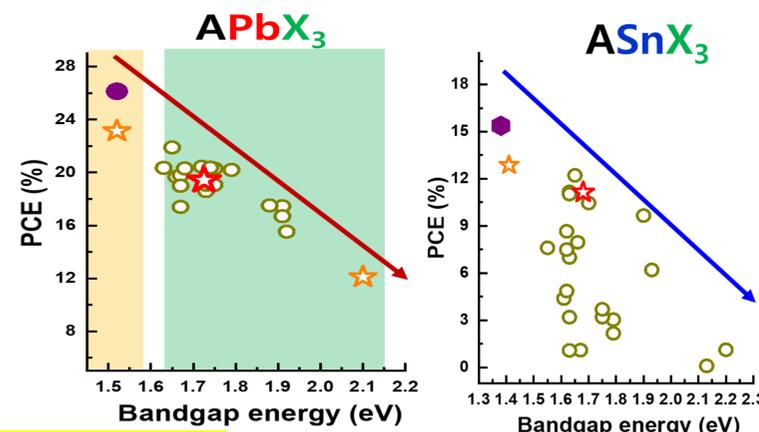


Introduction/Theme under discussion

Tandem solar cells (Silicon/perovskite) have progressed by combining narrow bandgap halide perovskites ($E_g \sim 1-1.3$ eV) as bottom cells with wide bandgap Pb-halide perovskites ($E_g > 1.6$ eV) as top cells. However, the toxicity of the lead in the halide perovskite (HP) has been an impeding factor for broader acceptance. Therefore, wide band gap tin perovskites (WB-Sn-HPs) could be one of the best choices for Pb-free Si/perovskite tandem applications

- Fabrication of WB-Sn-PSCs (FA, MA, PEA)SnI₂Br of $E_g \sim 1.68$ eV- ITO/PEDOT:PSS/WB-Sn-HP/ICBA/BCP/Ag.
- Surface passivation using 4-Fluoro-benzohydrazide (F-BHZ) multifunctional molecule.
- Achieved the best PCE of 11.14 % with inverted device configuration.



Experimental: Material Growth and Device Analysis

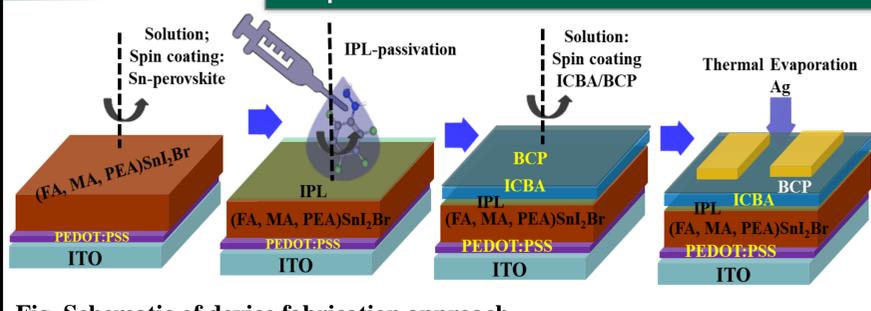
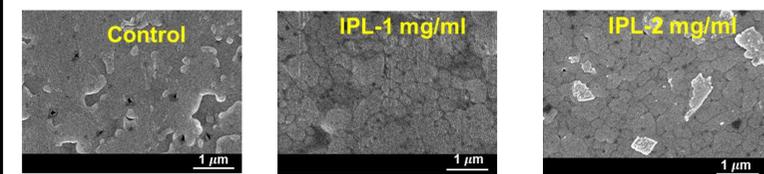


Fig. Schematic of device fabrication approach

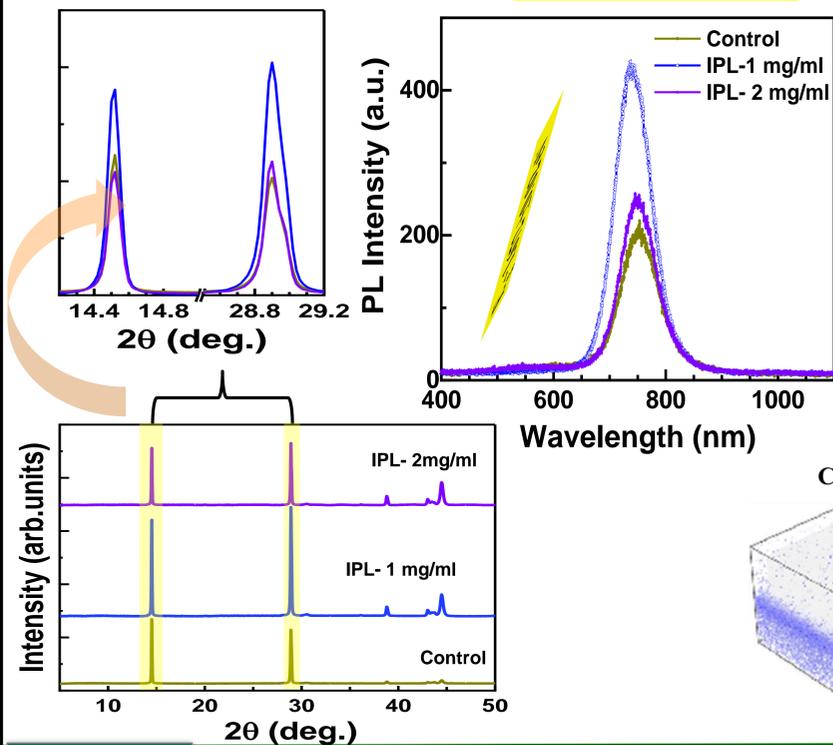
- For IPL with F-BHZ molecules- SEM image: improve film coverage + suppress the pinhole densities.



Materials properties: Sn-perovskite with surface treatment- F-BHZ:

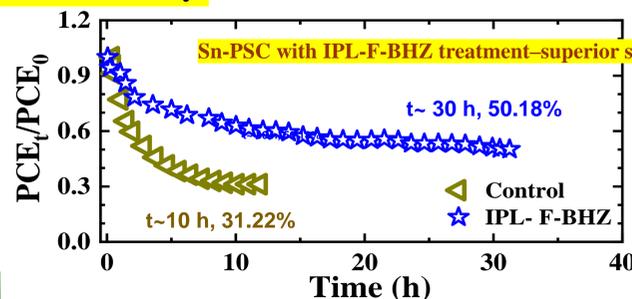
XRD patterns:

- Sn-HP film with IPL treatment:
- Intensified XRD characteristics peak.



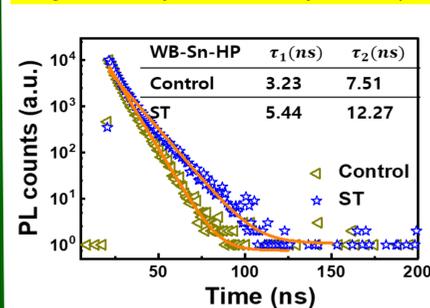
- PL spectra with F-BHZ -IPL
- $E_g \sim$ blueshift
- Intensified

Device stability

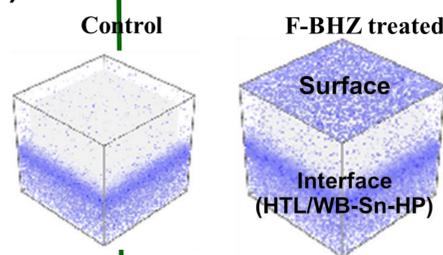


Time-resolved PL (TRPL) characteristics

Longer carrier lifetime- lower defect density

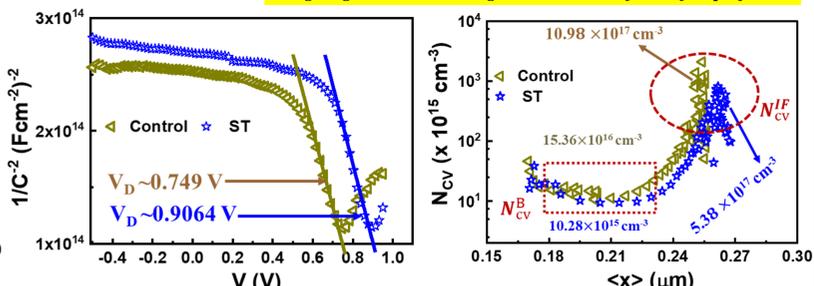


ToF-SIMS distribution: F-BHZ - molecular distribution



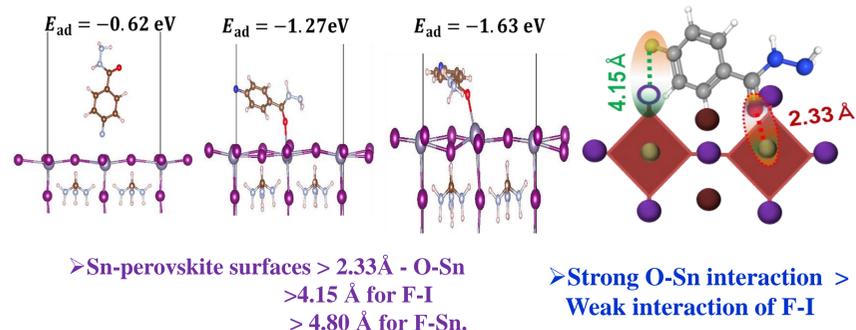
Capacitance spectra

N_{CV} - F-BHZ treatment mitigates the bulk defect at the space charge region or intrinsic regime and the interface defect profile.



DFT calculations

Molecular Interaction: F-BHZ and Sn-perovskite film



- Sn-perovskite surfaces > 2.33 Å - O-Sn
- > 4.15 Å for F-I
- > 4.80 Å for F-Sn.

- Strong O-Sn interaction
- Weak interaction of F-I

Summary

- F-BHZ-IPL improved the device efficiency from 7.96 % (for control WB-Sn-PSC) to 11.14% (F-BHZ surface treatment).
- Form of a compact and larger-grain film with a higher degree of crystallinity.
- Higher diffusion potential and suppression of defect densities in the bulk and at the interface.
- F-BHZ -surface treatment is propitious for better film formation and passivation of detrimental surface chemistry.



Ref:

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