Additive Engineering of SnPb-Based Narrow Band Gap Perovskite Solar Cells Using Functional Molecules

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Introduction

Narrow-bandgap Sn-Pb halide perovskites (E_g~1.2-1.3 eV) are promising absorbers for high-efficiency single-junction and all-perovskite tandem solar cells. However, rapid crystallization, Sn^{2+} oxidation, and high defect density lead to severe non-radiative recombination and limit device performance. Additive engineering is an effective approach to regulate crystallization and passivate defects.

Theme Under Discussion

- ❑ Fabrication of narrow-bandgap SnPb halide perovskite solar cells
- ❑ Defect passivation using guanidinium thiocyanate (GASCN) as an additive.
- ❑ Enhanced power conversion efficiency from 16.18 % to 18.5 %.

Experimental: film formation

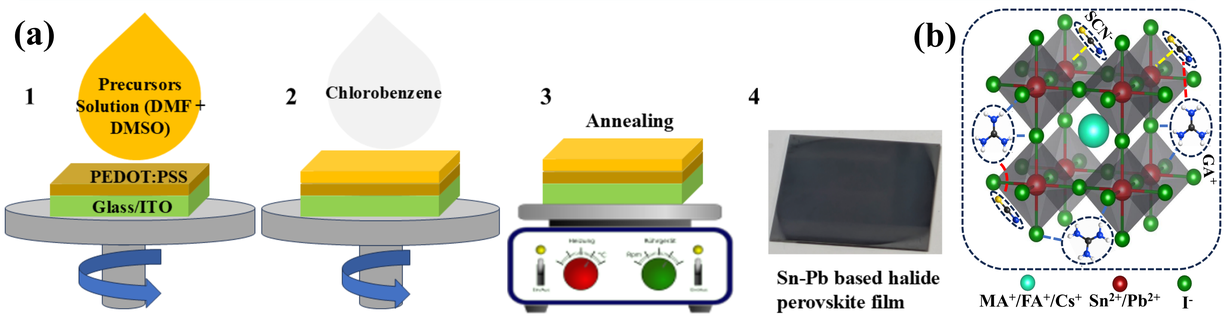


Figure 1. (a) Fabrication process of the narrow-bandgap SnPb perovskite films, (b) Crystal Structure of SnPb perovskite with GASCN additive.

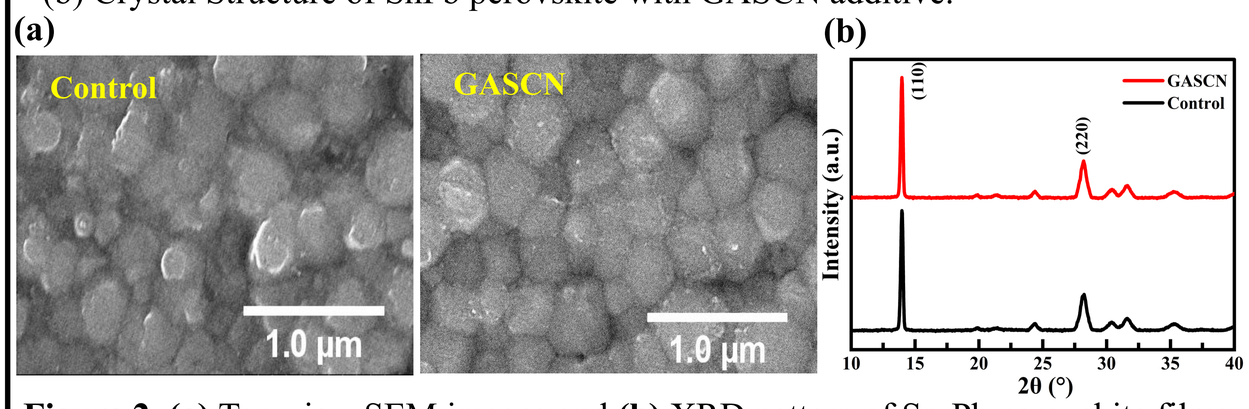


Figure 2. (a) Top-view SEM images and **(b)** XRD pattern of Sn-Pb perovskite films

>>> Less affect of GASCN additive on absorption and HOMO level of Sn-Pb halide perovskite.

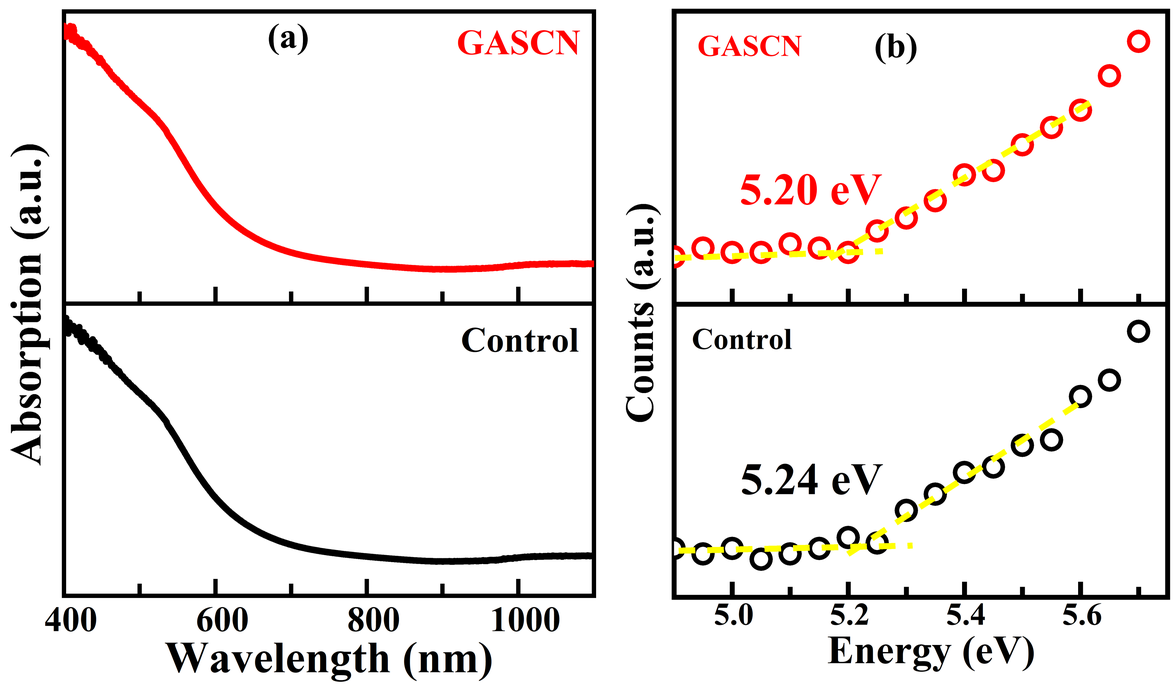


Figure 3. (a) Optical absorption spectra, (b) Photoelectron-yield spectra

>>> The enhanced average life time of carriers and peak intensity of photoluminescence of SnPb halide perovskite film with optimized GASCN additive indicates suppression of non-radiative recombinations.

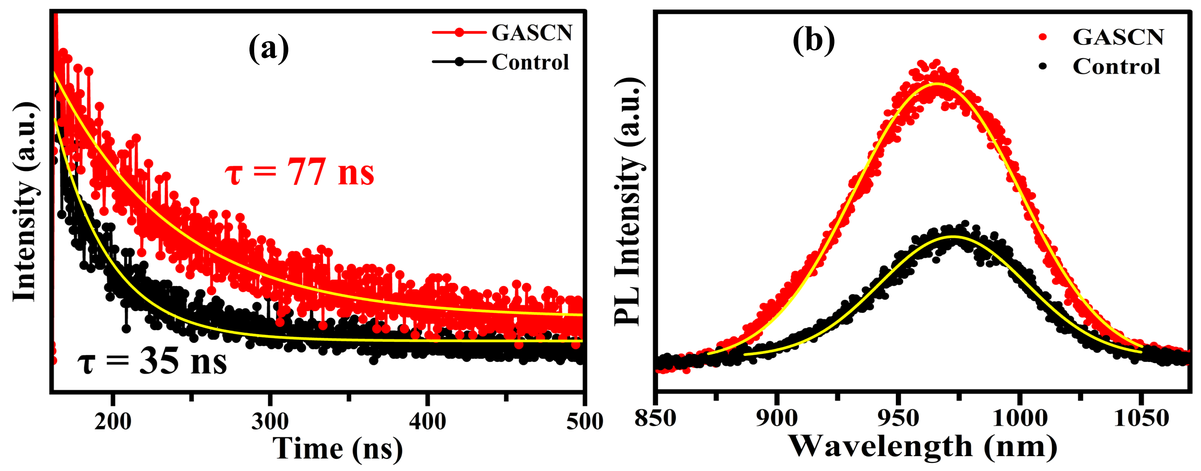
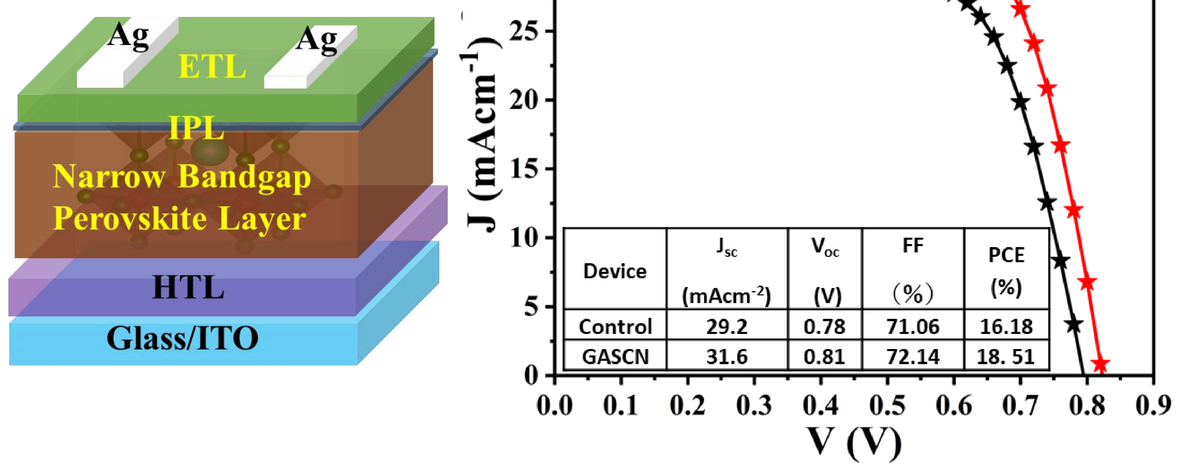


Figure 4. (a) Time-resolved PL decay curves, (b) Steady-state PL spectra

Device Structure and Corresponding J-V Characteristics



Device	J_{sc} ($mAcm^{-2}$)	V_{oc} (V)	FF (%)	PCE (%)
Control	29.2	0.78	71.06	16.18
GASCN	31.6	0.81	72.14	18. 51

Conclusion

- ❑ GASCN effectively suppressed defect-assisted non-radiative recombination, increasing the carrier lifetime from 35 to 77 ns.
- ❑ Improved film quality and charge-carrier dynamics enhanced the power conversion efficiency from 16.18% to 18.5%.

Future Plan

- ❑ To improve the optoelectronic quality of the SnPb perovskite film.
- ❑ To investigate interfacial and charge-transport-layer engineering.
- ❑ To examine Sn^{2+} oxidation, ion migration, and long-term device degradation mechanisms.

References

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