Investigation of Passivation at the n-Type Interface in Tin–Lead Perovskite Solar Cells for All-Perovskite Tandem Photovoltaics

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Introduction

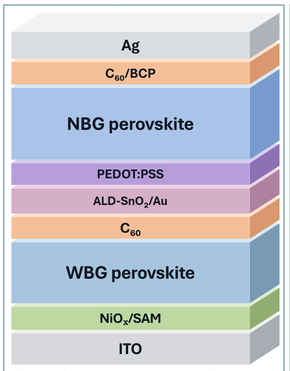


Fig.1. Schematic picture of an all-perovskite tandem solar cell [1].

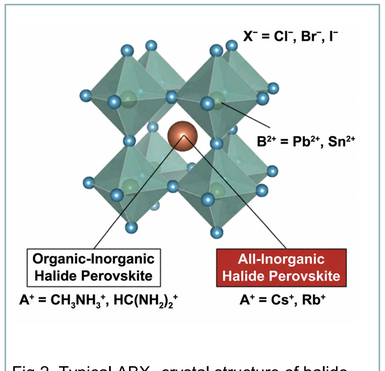


Fig.2. Typical ABX_3 crystal structure of halide perovskites [2].

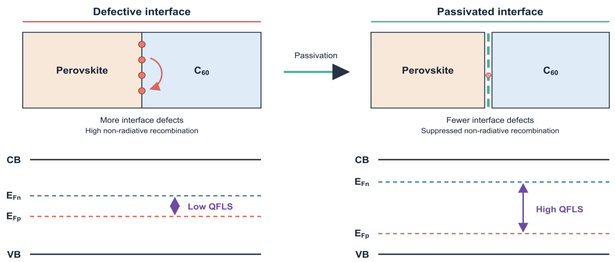


Fig.3. Influence of Interfacial Defects and Passivation on Quasi-Fermi Level Splitting (QFLS) at the Perovskite/C_{60} Interface

Methods

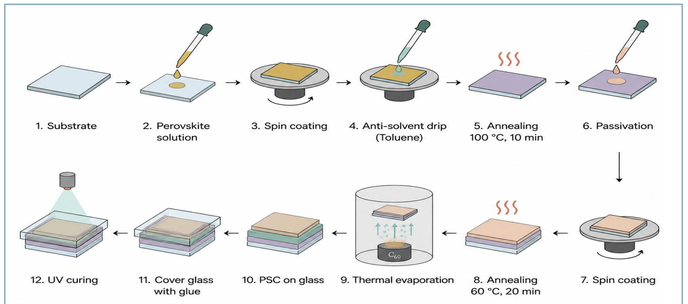


Fig. 4. Schematics of the fabrication procedure and architecture used in this work.

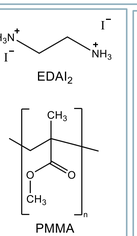


Fig.5. Structure of PMMA and EDAI$_2$

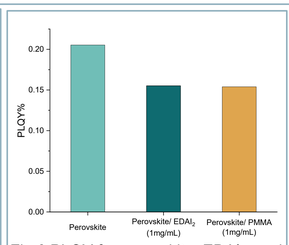


Fig.6.PLQY for perovskite, EDAI$_2$, and PMMA (1 mg/mL) without C_{60}.

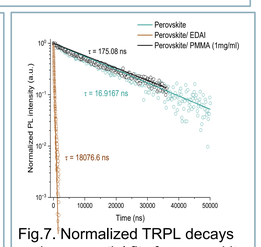


Fig.7. Normalized TRPL decays and exponential fits for perovskite, EDAI$_2$, and PMMA (1 mg/mL).

Results

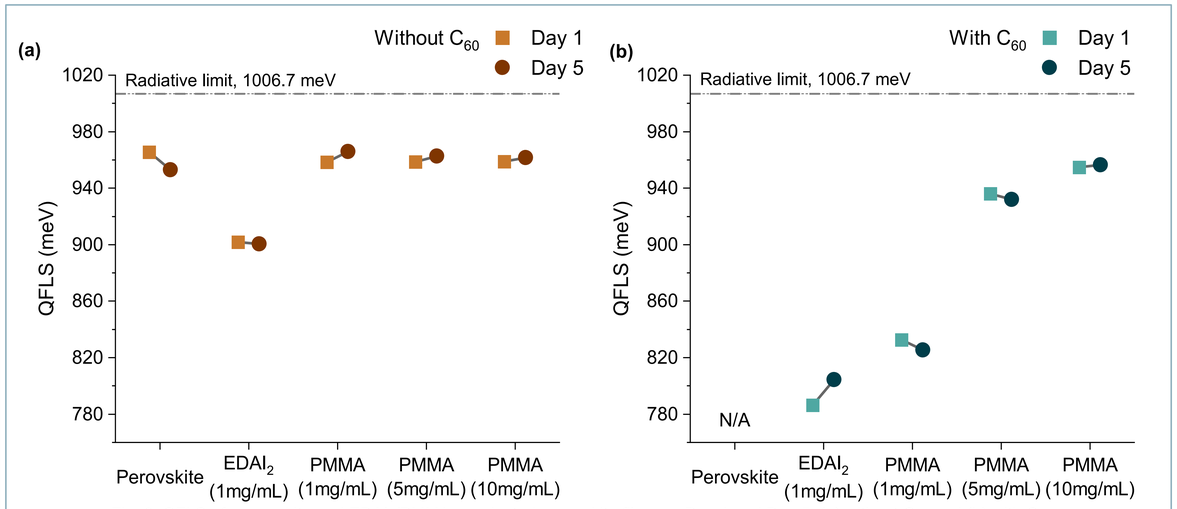


Fig. 8. QFLS of perovskite and EDAI$_2$/PMMA-passivated perovskite films on Day 1 and Day 5: (a) without C_{60} and (b) with C_{60} . The dashed line marks the estimated radiative limit (1006.7 meV; Ref. [3])

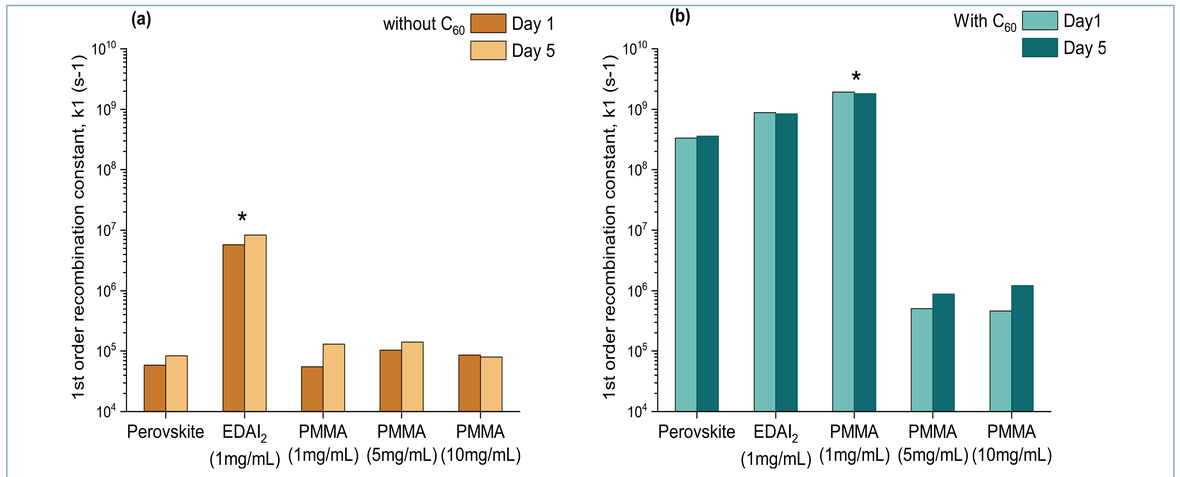


Fig.9. TRPL-derived first-order PL decay rates (k = 1/τ_1) on Days 1 and 5: (a) without C_{60} and (b) with C_{60}.

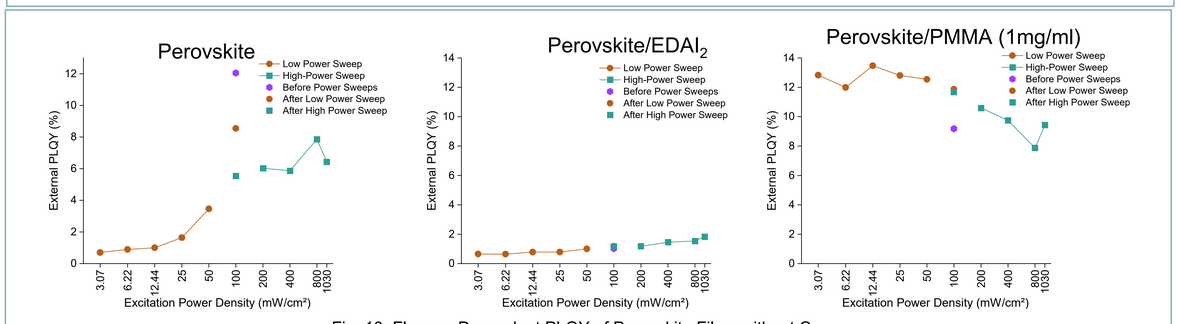


Fig. 10. Fluence-Dependent PLQY of Perovskite Films without C_{60}

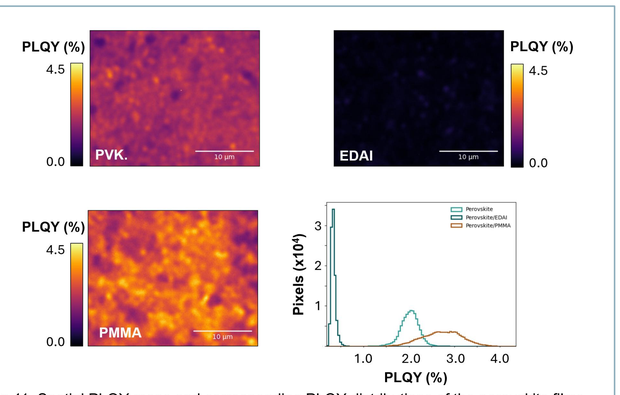


Fig.11. Spatial PLQY maps and corresponding PLQY distributions of the perovskite films

Conclusions

1. EDAI$_2$ passivation reduces the QFLS in perovskite-only films, which means it is degrading the surface.
2. However, EDAI$_2$ does increase the QFLS of films with C_{60}.
3. For PMMA, the surprising result is that the original QFLS in perovskite-only films is maintained, while in C_{60} films it is strongly improved (beyond EDAI$_2$ values).
4. This means that PMMA may impart additional efficiency and stability to solar cells.

Future Work

We are interested to see if the microscale effect of EDAI$_2$ and PMMA is different – we will do further experiments to investigate the photophysical heterogeneity in the different film types with C_{60}.

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References