Reducing Environmental Contamination for Perovskite-based Photovoltaic Panels

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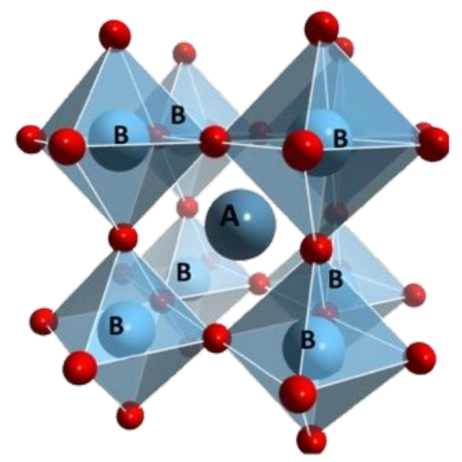
Introduction



Perovskites (ABX_3) are a new class of semiconductors with outstanding light absorption and low-cost processing compared to silicon. They can be produced from solution inks, making solar manufacturing cheaper and more flexible. Yet, these materials still face key barriers that limit large-scale production—instability under moisture and light, and the risk of lead contamination if panels crack.

After successfully producing uniform, high-performance $FAPbI_3$ films, the project now shifts focus to safety: preventing lead (Pb^{2+}) release if a solar panel fractures. Lead remains one of the main barriers to perovskite commercialization due to environmental and regulatory concerns. By demonstrating that ethylenediaminetetraacetic acid (EDTA) can effectively capture and mitigate lead exposure, this research aims to make lead-based perovskites a safer and more sustainable option for large-scale solar applications.

Materials & Methods

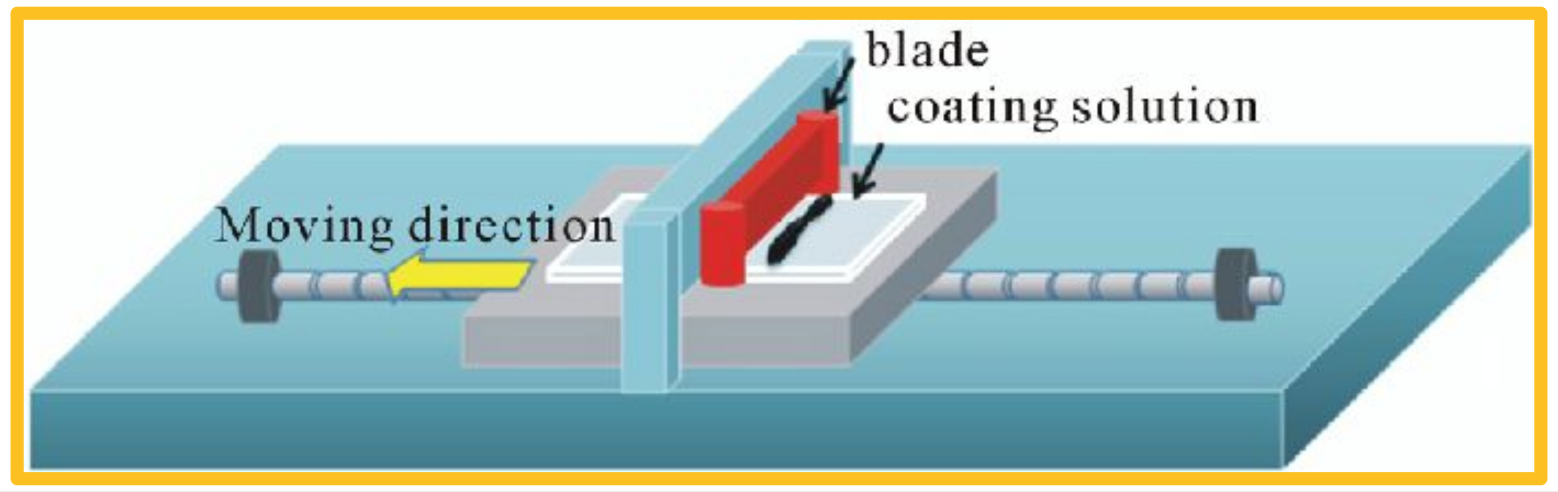


Fig. 1:
Blade coater used to spread the perovskite ink across the glass substrate.The chosen method for processing the films due to its scalability, uniform thickness control, and compatibility with large-area manufacturing.

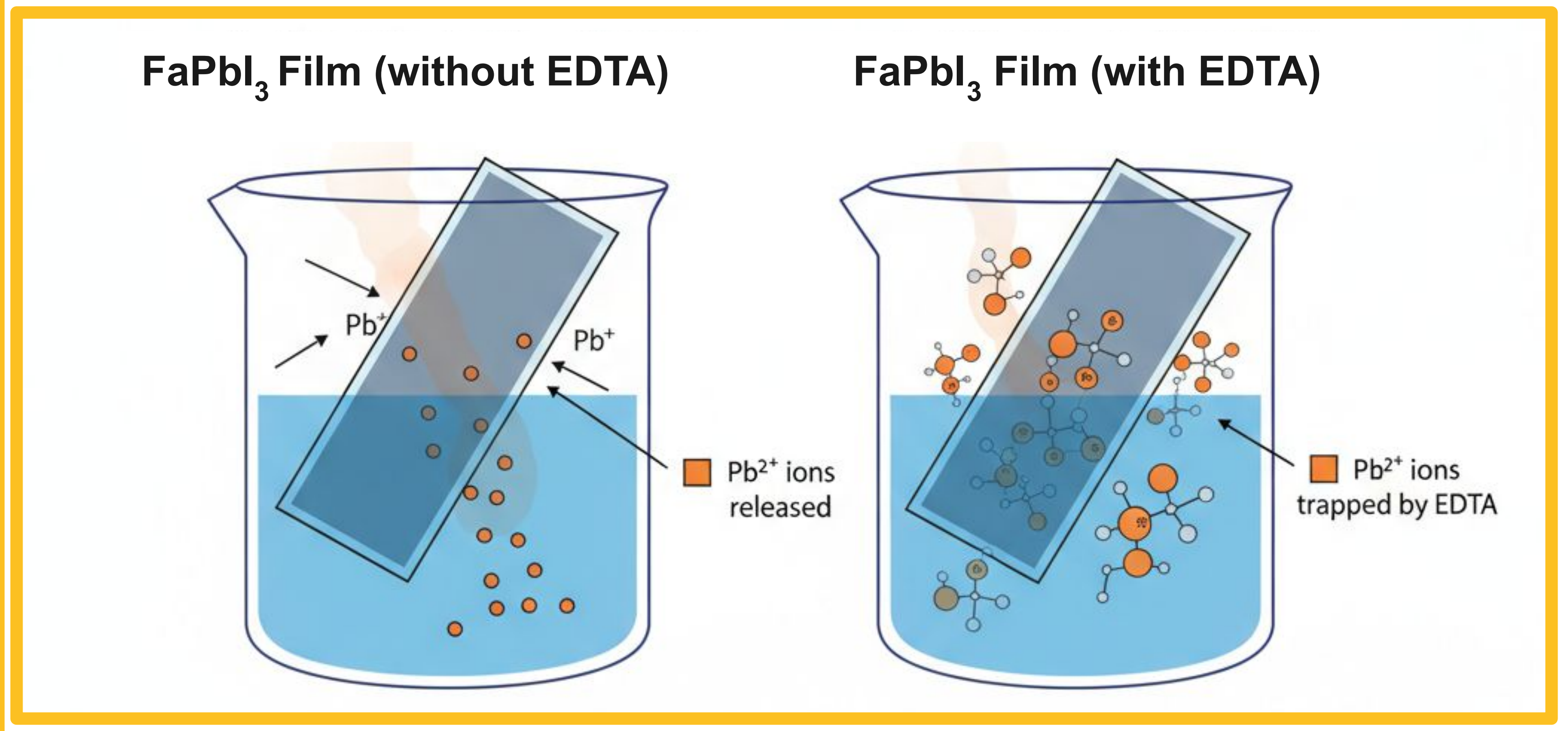
The perovskite precursor ink was composed of formamidinium lead iodide ($FAPbI_3$) with starch added to improve film stability. Because EDTA was not soluble in the perovskite ink, several incorporation methods were tested. Mixing EDTA directly with the precursor ink, with dried powder, and under vacuum all proved unsuccessful. Ultimately, dissolving EDTA in deionized (DI) water allowed proper integration into the perovskite solution for uniform film formation.

Conclusions

Despite the challenges of incorporating ethylenediaminetetraacetic acid (EDTA) into the perovskite ink, we successfully produced uniform, photoactive films, showing that lead mitigation is achievable without compromising performance. These promising results build on our previous success and point toward a safer, scalable pathway for perovskite technologies to move closer to real-world industry adoption.

Future Work

- Optimize deposition parameters to improve film quality affected by EDTA incorporation.
- Test different EDTA and ink concentrations to evaluate their impact on film thickness and uniformity.
- Conduct lead leaching studies at ASU's METAL lab to assess EDTA's effectiveness in mitigating lead release.
- Use the results to guide further formulation adjustments and scale-up for safer perovskite solar devices.



Results

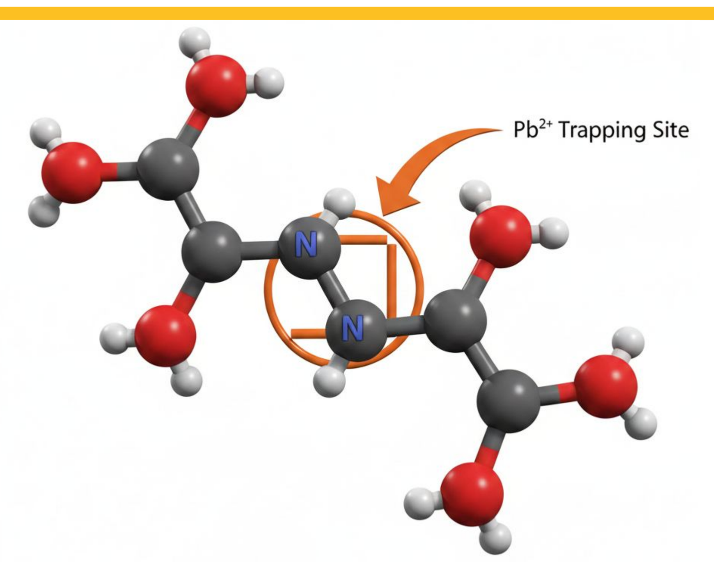
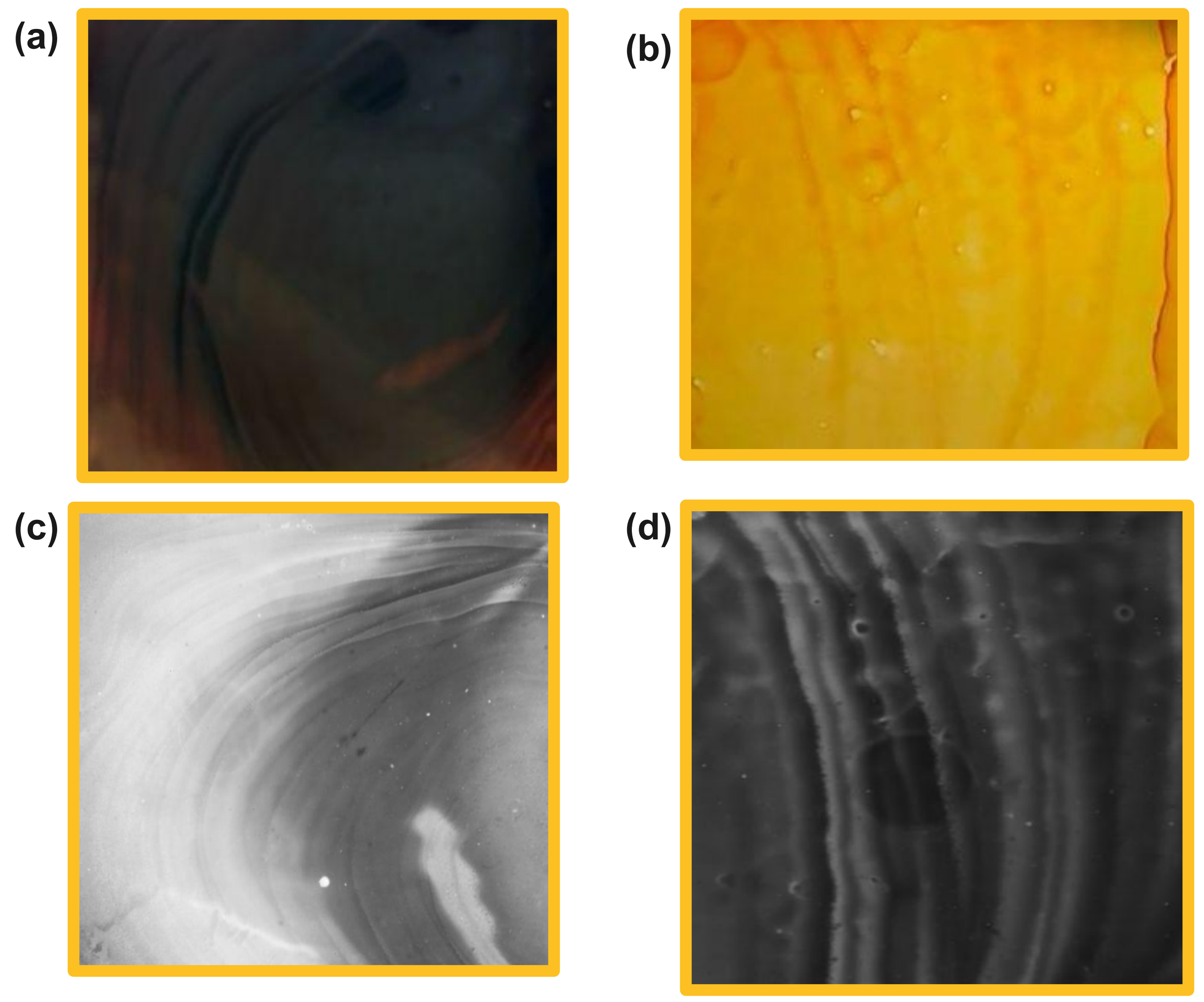


Fig. 3 ethylenediaminetetraacetic acid
EDTA traps lead ions (Pb^{2+}) through chelation, a process where its multiple negatively charged sites bind tightly to the positively charged lead ion. The molecule forms a stable ring-like complex around Pb^{2+}, preventing it from reacting with the environment or dissolving into water. This makes lead far less mobile and significantly reduces its toxicity and potential for contamination.



Challenges:
Identifying the right conditions for a more diluted perovskite ink to form a stable photoactive film and successfully integrate ethylenediaminetetraacetic acid (EDTA) without affecting film quality significantly.

Fig. 2:

(a-b) Images (a) and (b) show $FAPbI_3$ + starch and $FAPbI_3$ + starch + EDTA films, respectively. A clear change in film thickness can be observed after the addition of EDTA; however, the films still exhibit good uniformity and maintain their photoactive properties.

(b-d) Images (c) and (d) show photoluminescence (PL) measurements for the $FAPbI_3$ + starch and $FAPbI_3$ + starch + EDTA films, respectively. It can be observed that both samples exhibit a PL signal, confirming that photoactivity is preserved even after the incorporation of EDTA.

References

1. *Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Blade-coating-operation_fig1_276491510 [accessed 1 Nov 2025]*

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