Tin-based perovskites nontoxic alternative for solar energy production

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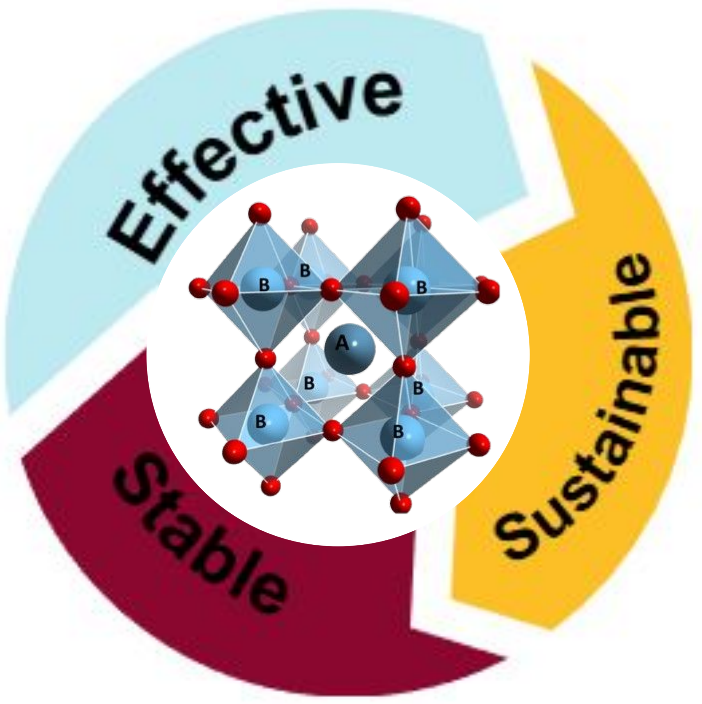
Introduction



A= Cs B=Sn X=Br

The research endeavors to enhance the utilizing tin (Sn) instead of toxic lead (Pb), aiming to reduce environmental impacts while developing transparent photovoltaic window absorber materials. Lead from perovskite that seeps into the soil can be absorbed by plants and enter the food chain at a rate ten times higher than other lead pollutants already present due to human activities.[1] The data indicates that lead from perovskite must be handled with great caution, emphasizing the need to replace it with a safer and more sustainable alternative. This work uses fully inorganic precursor materials to create a more stable crystalline material, notably CsSnBr3 (cesium tin bromide). Although this alternative is not yet perfect, therefore showing the need for improvements.

Materials & Methods

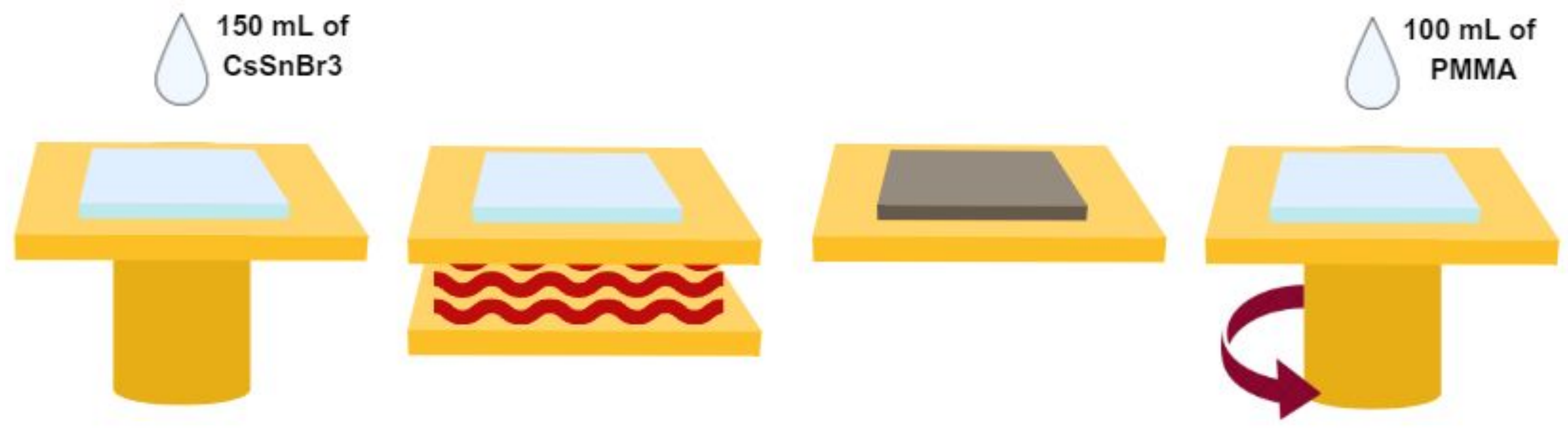
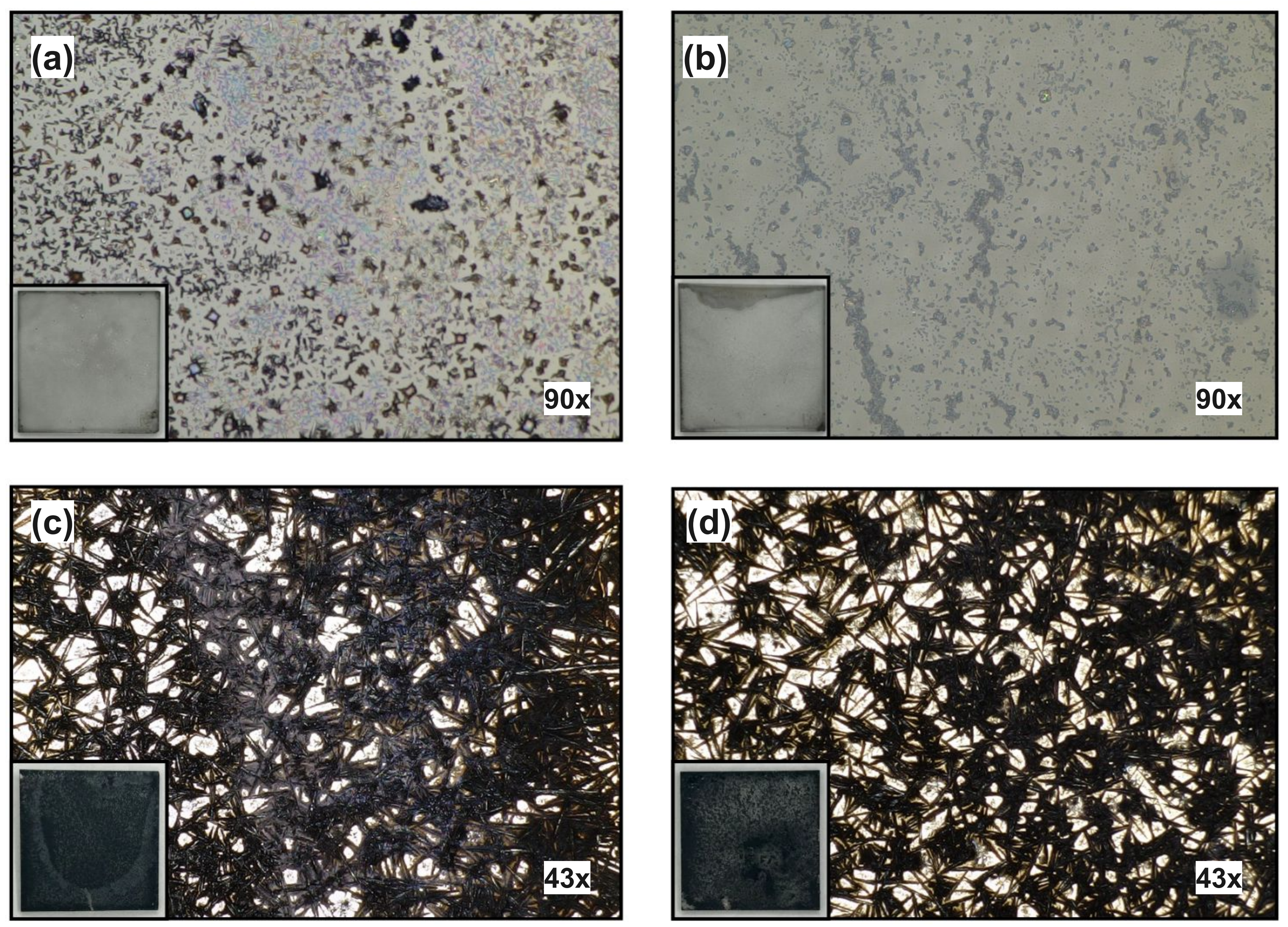
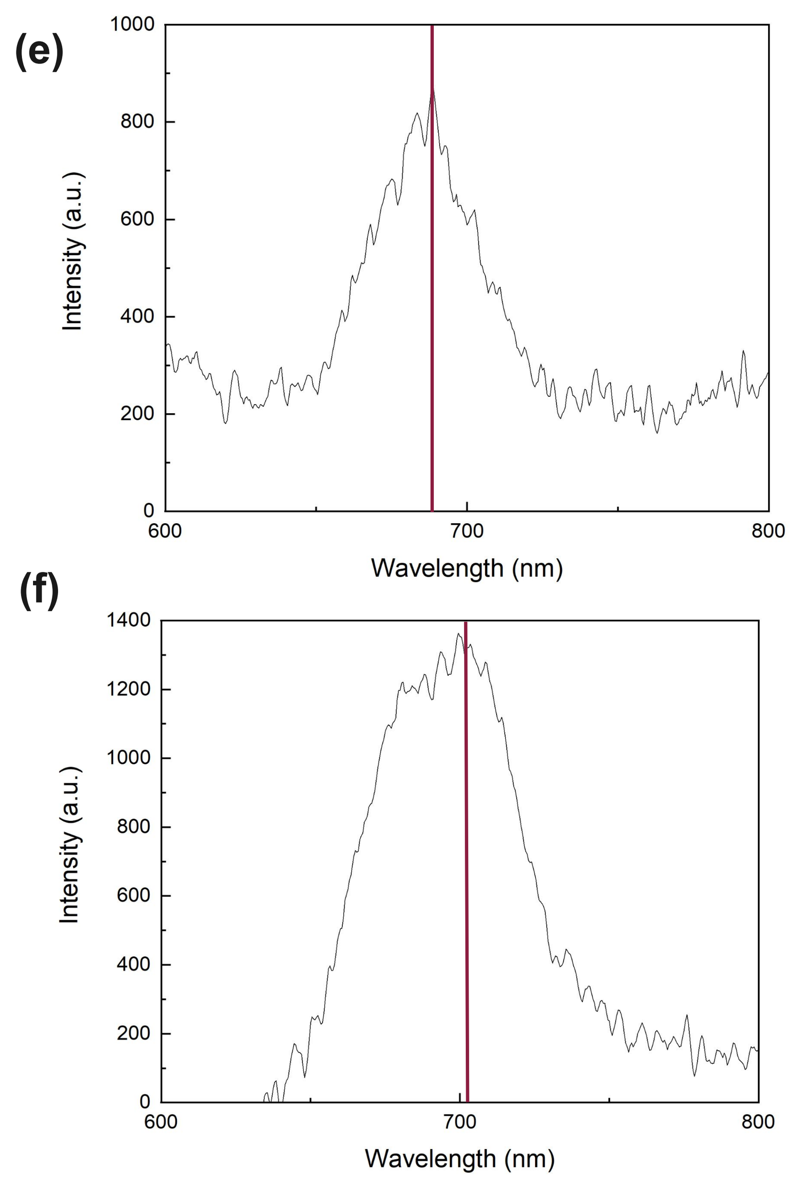


Fig. 1:
The schematic illustrates the process of drop casting and annealing CsSnBr3 (cesium tin bromide) to create the film. Initially, 150 mL of the solution is added to a clean glass slide by dropping the ink carefully on the hole surface. The glass slide is then dried on a hot plate at 100°C for 10 minutes. After done, a thin layer of PMMA i added to the slide and then spin coated.

Results





Challenges:
Create an ink that is able to dissolve completely and become uniform, achieving successful results in the PL (photoluminescence) tests.

Fig. 2:

(a) Microscope images of CsSnBr3 solution with a concentration of 1 mole. Ink was spin coated.
(b) Microscope images of CsSnBr3 solution with a concentration of 0.8 mole. Ink was spin coated.
(c-d) Microscope images of CsSnBr3 solution with a concentration of 0.4 mole. Inks were drop casted. The results revealed a more favorable structure.
(e) Photoluminescence test of sample showed in **a**, with a photon energy of 1.814 (1240/683.56)
(f) Photoluminescence test of sample showed in **c**, with a photon energy of 1.760 (1240/704.53)

Conclusions

Achieving uniform CsSnBr3 films is challenging, primarily due to the inherent formation of Sn vacancies between the grains of CsSnBr3. This arises from the self-oxidation process of Sn2+ to Sn4+.[2] Spin coating has not been successful in the process of adding ink to the slide, but drop casting has shown better, though not perfect, results, allowing for the formation of more crystals.

Future Work

- Make films with different solvents beyond dimethyl sulfoxide for stability characterization.
- Research different recipes with different B-site cations.
- Work on an ink that can completely dilute and become uniform
- Perform successful photoluminescence tests on the slides, analyze the data, and make improvements based on the results.
- Collect characterization of films.

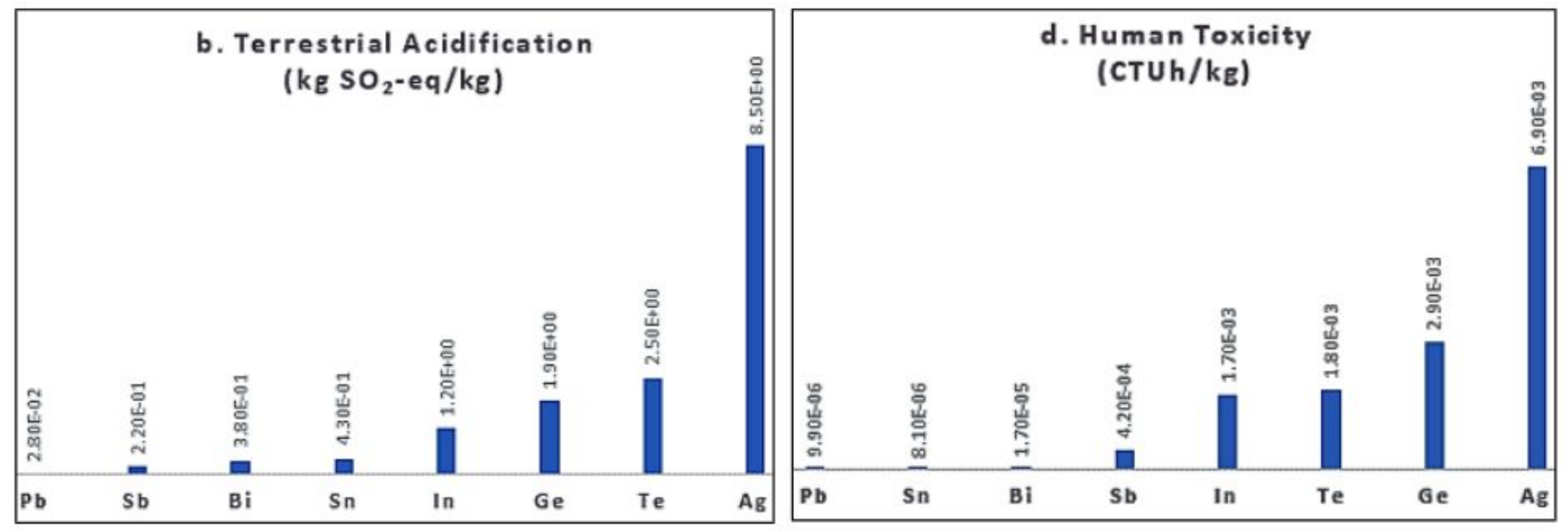


Fig. 1:
Comparison of the impacts of Pb and other potential lead-free perovskite alternatives in relation to terrestrial acidification and human toxicity.[4]

References

1. *Nat Commun, 2020, 9, 310*
2. *ACS Energy Lett. 2022, 7, 8, 2807–2815*
3. *Chem. Sci. 2016, 7, 4548-4556*
4. *J. Mater. Chem. C, 2021,9, 67-76*

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