

# Purifying Perovskite Solar Cell Precursors

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## Motivation

Perovskite is a semiconductive crystalline material.

1. Has the general formula  $ABX_3$
2. Used in solar cells
3. As efficient as silicone solar cells<sup>1</sup>

Perovskite Solar Cell Goals:

1. High efficiency
2. Degradation resistance<sup>1</sup>

High purity is required for these goals, which can be achieved by crystallization<sup>1,2</sup>. Crystallization is challenged by:

1. Coordination
2. Solubility

Thus, we attempted to form perovskite with various precursor and solvent combinations.

## Theory

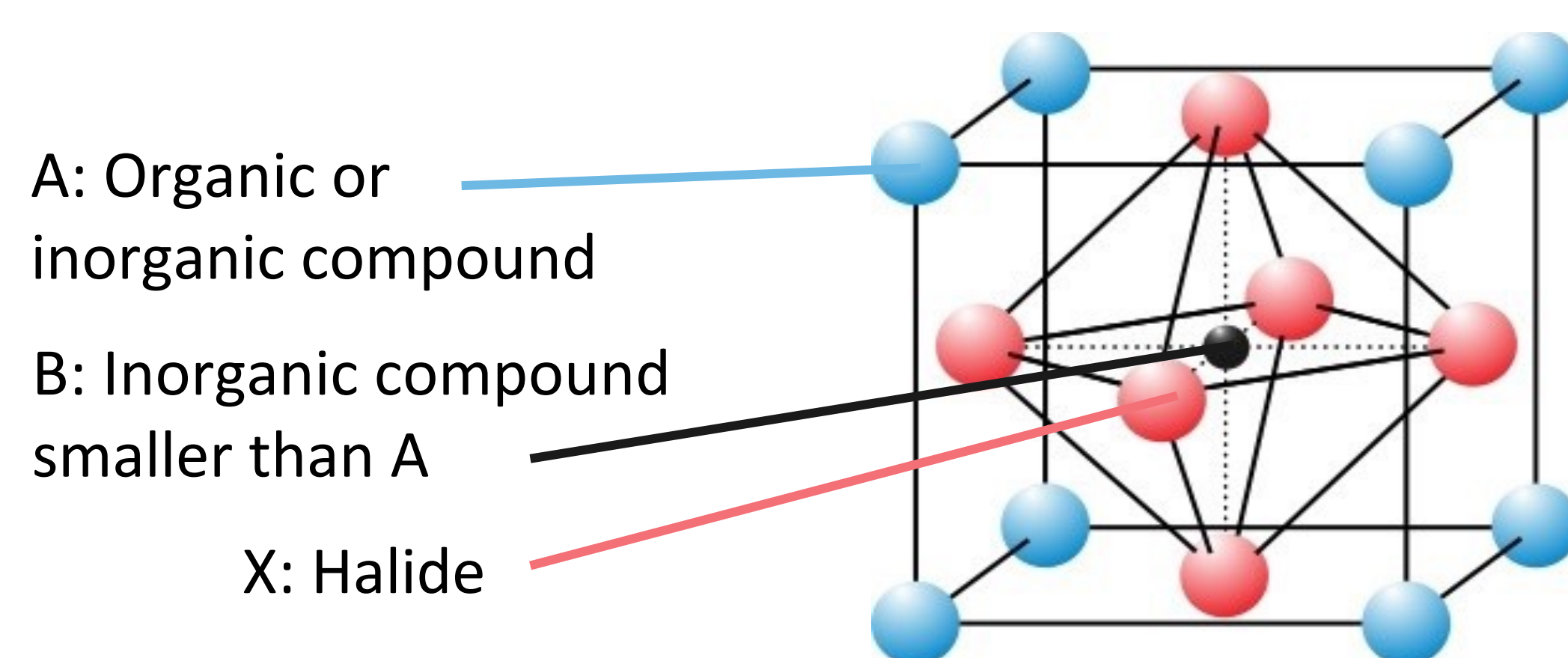
The SONIC method<sup>1</sup>:

1. Takes advantage of perovskite's solubility behavior
2. Grows high purity perovskite single crystals
3. Retains high purity perovskite single crystals

There are 3 main variables that can be changed<sup>2</sup>:

1. Precursors used
2. Solvent used and at which molarity
3. Anti-solvent used

Below is a diagram of a perovskite. The general formula  $ABX_3$  can be visualized in its face-centered cubic unit cell<sup>2,3</sup>:



## SONIC Crystallization Technique

Various combinations of solvents and precursors were tried:

A: Formamidinium and Cesium (mixed 9:1 and 1:1)

B: Lead

X: Iodide

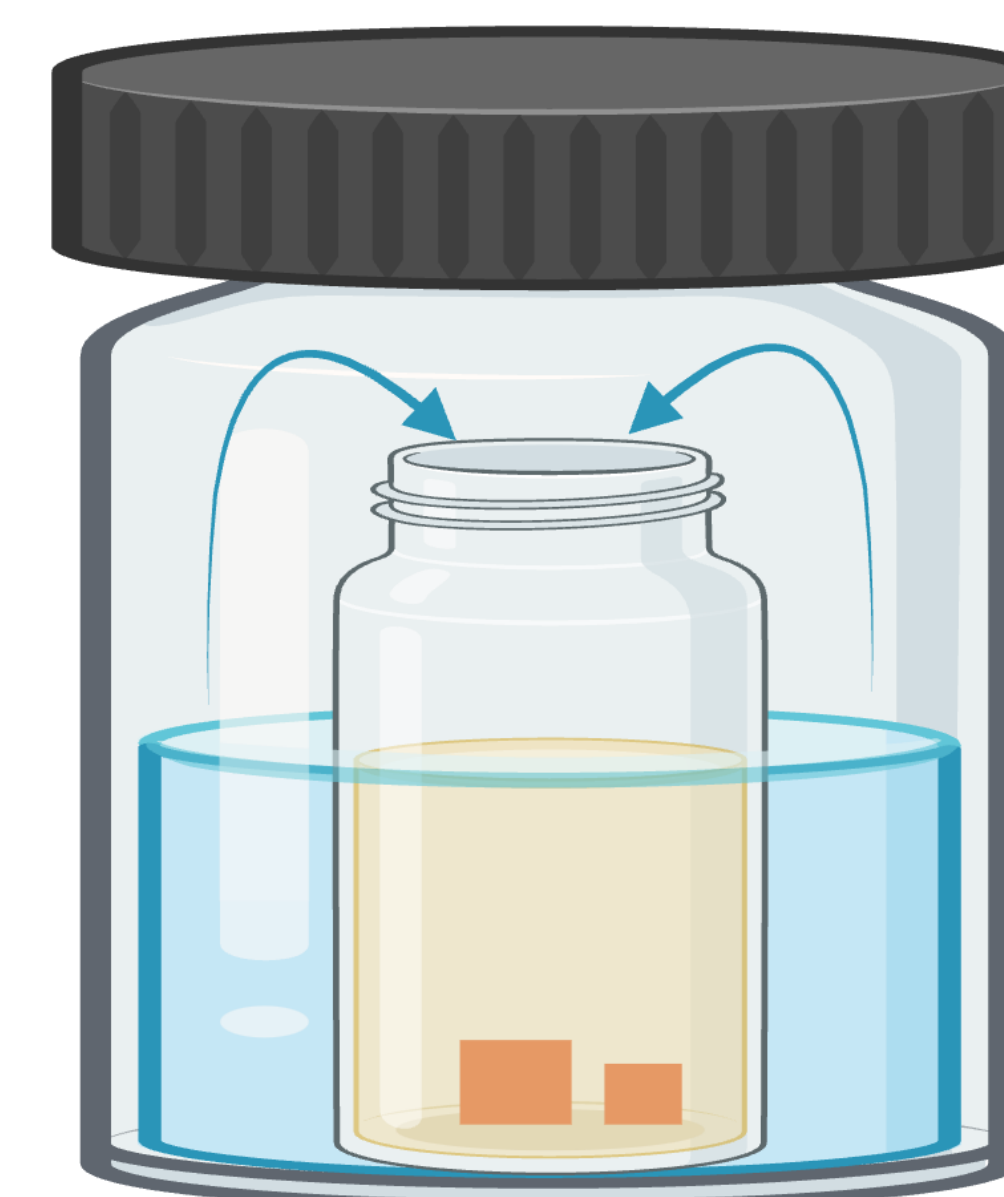
Solvent:

2-Methoxyethanol  
Dimethylformamide (DMF)  
Dimethyl sulfoxide (DMSO)  
Gamma-Butyrolactone (GBL)

Antisolvent:

Chlorobenzene  
Toluene  
Methyl Acetate

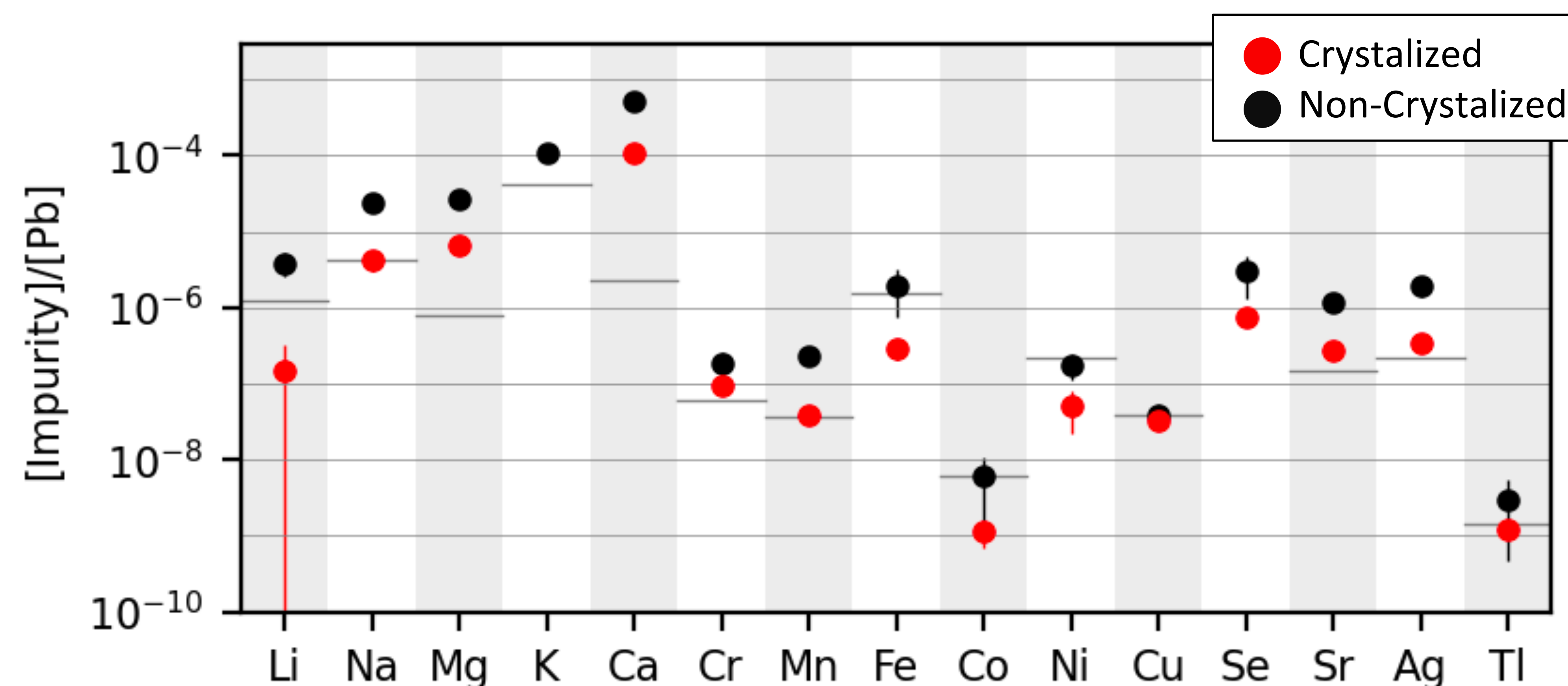
Perovskite Crystal  
Solvent  
Anti-Solvent



SONIC setup is left in a bed of sand for 7-14 days before crystals are done growing



## ICPMS Reveals Substantial Purification



Impurity levels present in the perovskite prior to crystallization were significantly greater than the levels present after crystallization was completed for almost all elements measured in ICPMS

## Results and Future Work

**The 9:1 Formamidinium:Cesium Lead Iodide (FACsPbI<sub>3</sub>) crystal using GBL as solvent produced the highest purity crystals when anti-solvated in toluene or methyl acetate.**

Overall, our work presents:

1. A technique for crystallizing perovskite
2. A combination of precursors and solvents that make high purity and quality perovskite

Future Work:

1. Make perovskite films to test efficiency and degradation in presence of light and heat
2. Compare the efficiency and degradation of perovskite films made with or without Cesium



Left: Perovskite with Cs in active phase, capable of photovoltaics

Right: Perovskite without Cs, incapable of photovoltaics

Cesium is capable of stabilizing perovskite in its active phase.

## Acknowledgements

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### References

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- [2] Li, Zhen, Yang, Mengjin, Park, Ji-Sang, Wei, Su-Huai, Berry, Joseph J., & Zhu, Kai (2016)
- [3] [https://www.researchgate.net/figure/Schematic-of-the-prototypical-perovskite-unit-cell-blue-A-black-B-red-X-3\\_fig1\\_375040085](https://www.researchgate.net/figure/Schematic-of-the-prototypical-perovskite-unit-cell-blue-A-black-B-red-X-3_fig1_375040085)