Printable, radiation-tolerant $CsPbCl_3$ perovskite films using open-air blade coating

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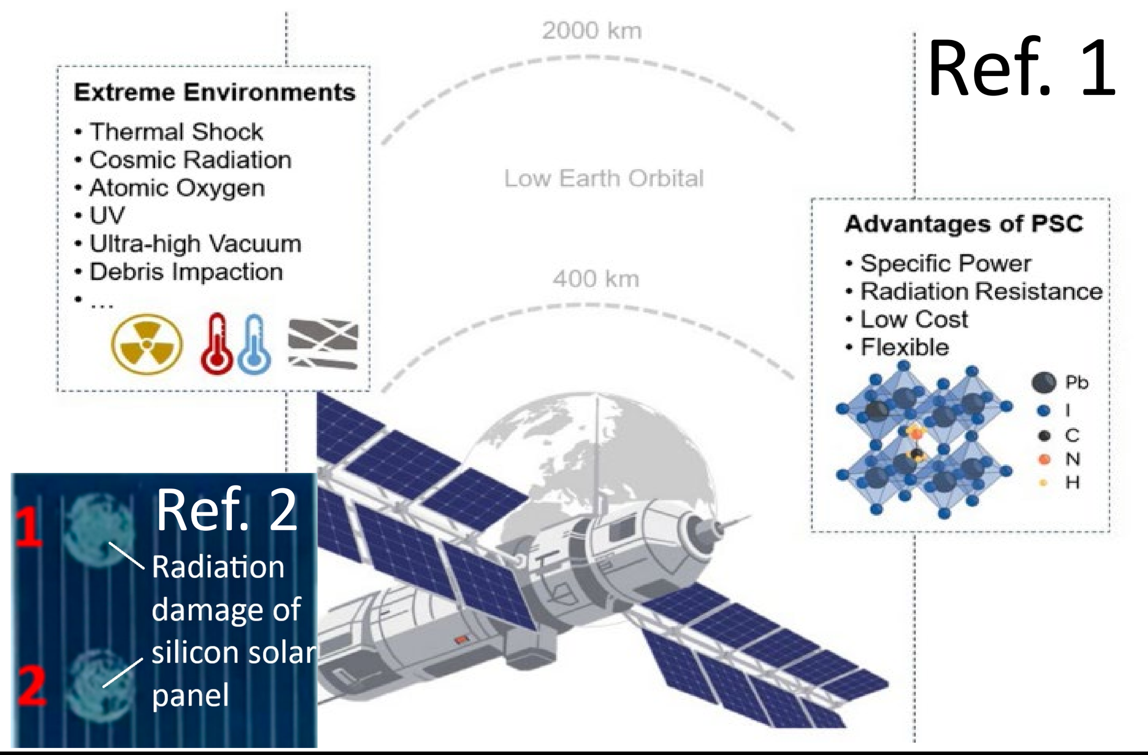
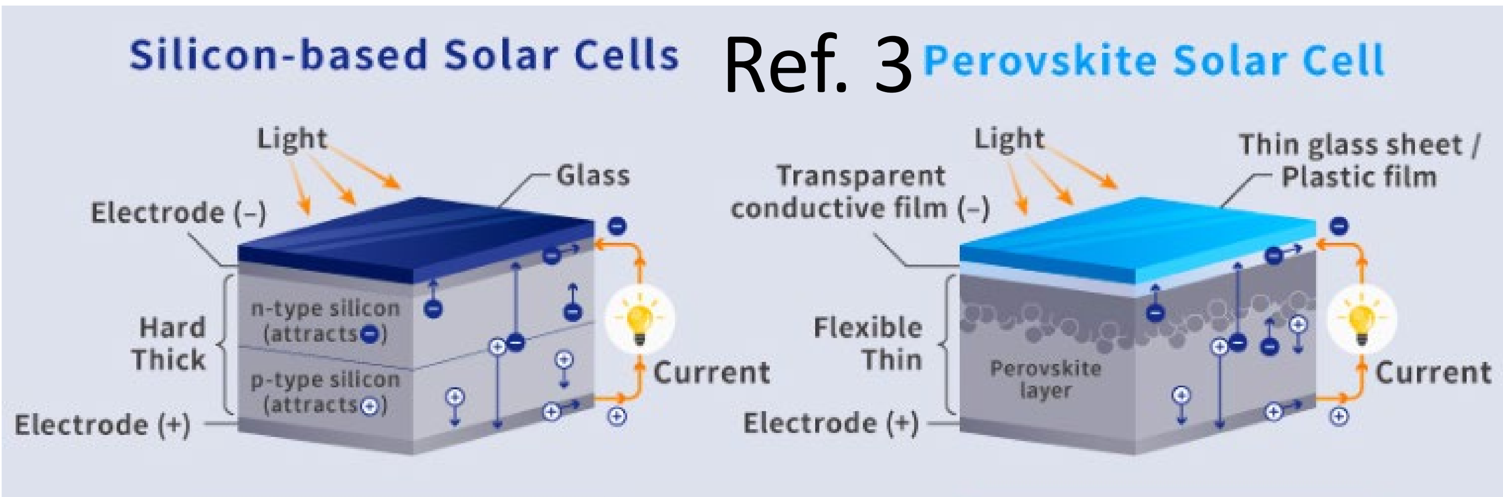
Background/Manufacturing:

Why are perovskites potentially useful? What is blade coating and why choose it?

Perovskite solar cells have less carbon footprint than silicon, are lighter, and are (theoretically, after mass production is achieved) also cheaper. Unlike silicon, perovskite also has high radiation hardness, meaning the solar cells are efficient and stable during constant absorption of high-energy particles and require minimal maintenance and repairs. $CsPbCl_3$ is chosen to be studied due to its inorganic composition and high radiation hardness. These properties make it very interesting for applications in spacecraft. The goal of this research is to find the optimal parameters for blade coating $CsPbCl_3$ perovskite that would result in the most efficient thin films. Blade coating slides the solution across a substrate using a knife, resulting in a uniform spread. It can produce perovskite in a low-cost, low-waste, efficient, and scalable way. It is very tunable and is great for manufacturing large area perovskite, which is important for mass production.

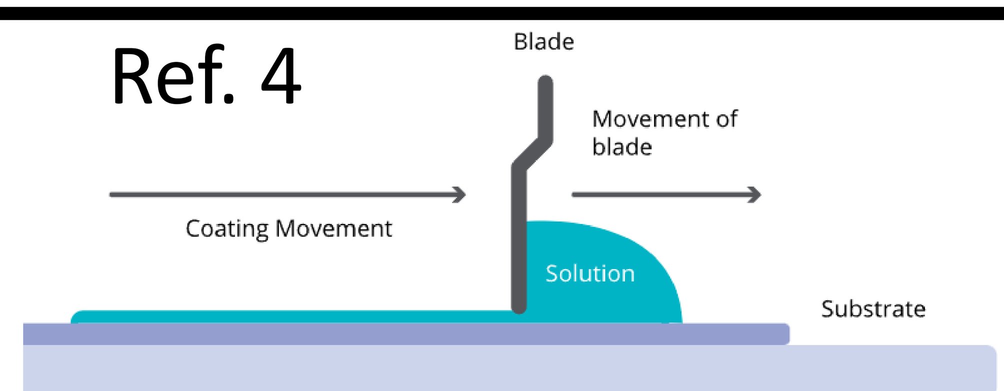




20% or more	Conversion efficiency	20% or more
Inflexible	Flexibility	High
Heavy	Weight	Light
High	Cost	Inexpensive
High	Durability	Low

Methods:

How are the perovskite samples produced?

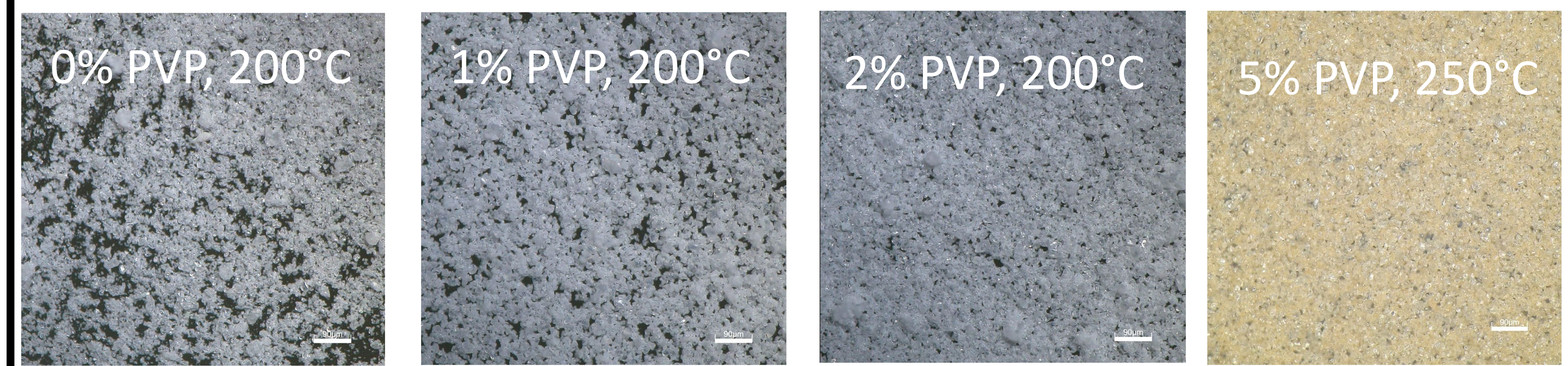


The $CsPbCl_3$ prerequisites are put into a ball miller to thoroughly mix with ethanol (as a solvent) and PVP, an additive to make the solution viscous and more spreadable. The solution is then spread across glass substrates using a blade coater and then placed on a hotplate to induce phase formation. Film quality is assessed by a profilometer for uniformity, photoluminescence for band gap energy and impurities, and X-ray diffraction to see any indications of phase formation.

Results:

What was learned?

The optimal range of many blade coating parameters were discovered. Experiments showed the optimal blade height to be around 1200µm and the optimal blade speed around 2mm/s. In terms of ball milling, a frequency of 20Hz for 50 minutes resulted in a well-mixed solution. A ratio of 1mL of ethanol per mole of $CsPbCl_3$ proved effective. In terms of how much percentage of the mass of $CsPbCl_3$ solution to put as an additive, 1% was first used but 2% was found to result in more uniformity, and current tests are now testing 5%. Adding 2% PVP caused the $CsPbCl_3$ solution to become more viscous, which both caused it to be easier to mix in the ball miller for a more uniform solution and easier to spread evenly with the blade coater. For the temperature of the hotplate, a temperature of above 250°C seemed to induce crystallization and turn the samples from white to orange, further testing will need to be done to know if this positively or negatively effects PL response.



Future Work:

What's next?

Double and triple coating will be tested to see if it results in a more uniform thin film.
Narrowing the optimal temperature range to within 50°C and narrowing the additive percentage range to within 5% is also important future work. Other types of additives besides PVP, such as PEG, might also be tested.

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3 - "A Thin, Flexible Coating to Generate Power! What Is a Perovskite Solar Cell? [5 Minute Read]." *AI Think - Learning Aisin's Now and Future*, www.aisin.com/en/aithink/innovation/blog/006050.html.
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