Evaluating the Flexibility and Durability of MAPbI3 Perovskites Films on Plastic Substrates with Natural Polymer Additives

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Background

Perovskite solar cells are highly efficient and cost-effective, making them a promising alternative to traditional silicon-based cells. Developing flexible perovskite films on plastic substrates is crucial for applications in wearable electronics and portable devices, where rigidity is a limitation. Flexible films enable the integration of solar cells into a variety of surfaces and products, enhancing their usability and expanding the potential for renewable energy adoption.

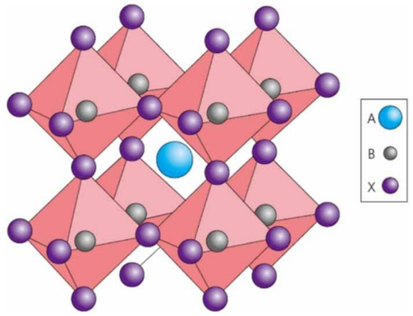

Fig 1 : Perovskite crystal structure (ABX3)

Method

Used coating techniques to coat samples. ITO-coated PET substrates were preheated followed by coating them with a 0.5 M MAPbI3 solution in DMSO, with Gellan gum or starch as additives. Post-coating, the substrates were annealed at 100° C. The films were then characterized using photoluminescence (PL) testing and electron microscopy to evaluate their morphology and optical properties.

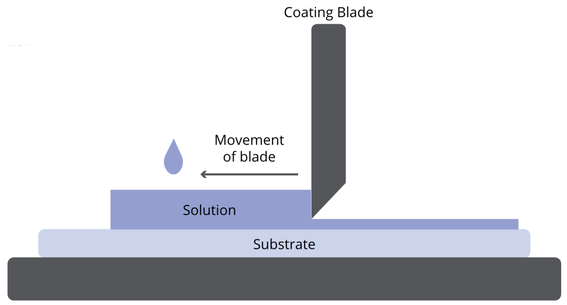

Fig 2 : Blade Coating Illustration

Challenges

- Achieving a completely flat surface on the flexible PET substrates was difficult, leading to non-uniform films with gaps, unlike the more straightforward process on glass.
- Managing the crystallization process with Gellan gum and starch additives was complex, impacting the film's consistency and quality, and requiring meticulous adjustments for better uniformity.

Results

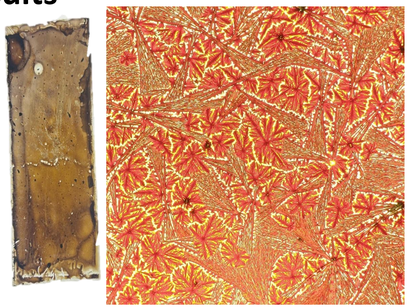

Fig 4

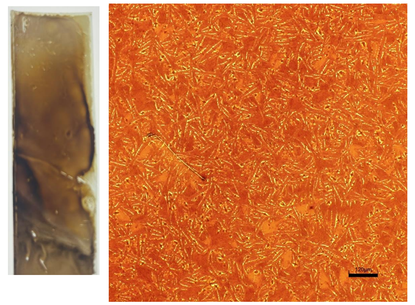

Fig 5:

Parameter	Sample 1 (Fig 4)	Sample 2 (Fig 5)
Solution Preparation	1 M MAPbI3 solution in DMSO	0.5 M MAPbI3 solution in DMSO
Coating Method	Blade coating without IPA	Blade coating with IPA application for better surface flatness
Substrate Preparation	No Preheating	Preheated ITO-coated PET substrates to 52°C
Annealing	Post-coating, substrates annealed at 100°C for 20 minutes	Post-coating, substrates annealed at 100°C for 20 minutes
Observations	Visible gaps and dendrite-like formations observed.	Fewer gaps and reduced crystallization observed.
Discussion	• Non-uniform coating due to the absence of IPA • High molar concentration led to rapid crystallization	• IPA improved surface flatness, leading to uniform coating • Lower molar concentration slowed crystallization

Future Work

• Conduct mechanical bending tests to study the flexibility of plastic substrates coated with perovskite films.
• Optimize the concentration of Gellan gum and starch additives to enhance film uniformity and mechanical properties.

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Reference: [1]]Figure 1. A typical perovskite crystal structure. reprinted from [15] https://www.researchgate.net/figure/a-typical-perovskite-crystal-structure-reprinted-from-15-with-permission-from
[2] Passmore, E. Spooner, and J. Atkinson, “Thin film deposition: Comparing Coating Methods,” Ossila, https://www.ossila.com/pages/solution-processing-techniques-comparison .
[3 panelVivian Nketia-Yawson et al., “High-mobility electrolyte-gated perovskite transistors on flexible plastic substrate via interface and Composition Engineering,” Applied Surface Science, https://www.sciencedirect.com/science/article/pii/S016943322300661X#:~:text=Furthermore%2C%20perovskite%20semiconductors%20can%20form,6%5D%2C%20%5B7%5D.

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