

Encapsulation Design to Enable Durable and Long-lasting Photovoltaic Solar Cells

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Introduction

Perovskite solar cells (PSCs) offer sustainable solar energy where a perovskite (ABX_3) layer absorbs light. However, PSCs are unstable with water. The study investigates various polymer-based encapsulants on the perovskite layer using a pressure cooker to simulate underwater environments.

Materials & Methods

Fig. (1) Layers of the PSC. Encapsulants (UV resin or polymer) were applied and UV-cured or laminated at 140°C and 11 psi for 6 minutes.

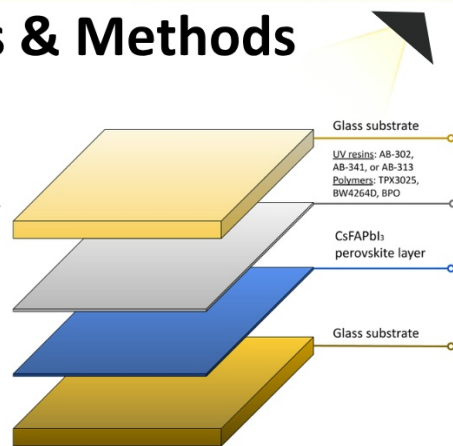
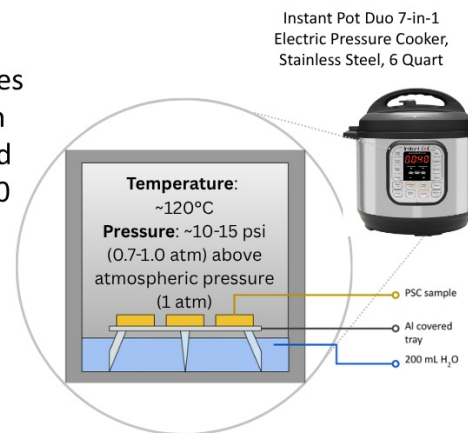
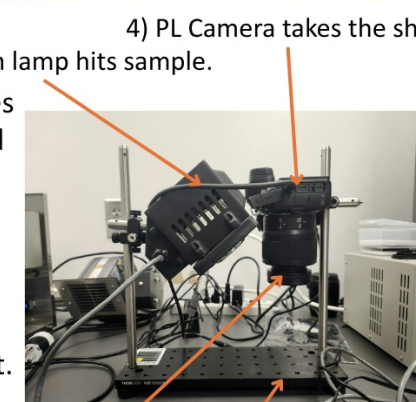


Fig. (2) PSC samples were placed on an aluminum-covered tray above the 200 mL waterline. Samples were pressure-cooked with ~5 min cook time at high pressure.



2) Green light from lamp hits sample. 4) PL Camera takes the shot.

Fig. (3) PSC samples were characterized via PL imaging, producing an electronic image where the sample absorbs the light and then reemits it.



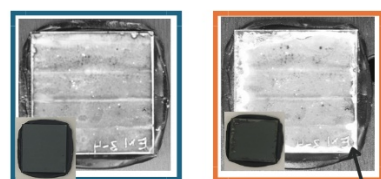
3) Filter prevents absorption of green light showing a black and white image.

1) PSC placed here.

Results

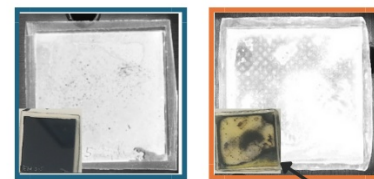
Photoluminescence (PL) imaging of Samples (1) rubber (control), (2-4) polymer, (5-7) polymer with rubber edge seal, (8-10) UV resin and PSCs before and after pressure cooking. The pictures show PSCs before (blue) and after (orange) trials with their corresponding appearance on the lower left corner. Brighter areas denote higher light emittance with the exception of degraded areas (yellow) where encapsulants are revealed.

(1) Rubber



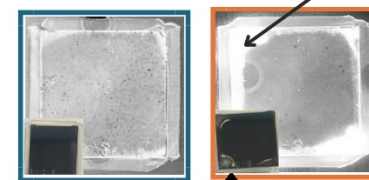
Brighter edges due to degraded PVK revealing the rubber from behind.

(2) BW464D



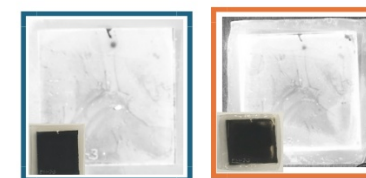
Almost 75% degradation from moisture. Most of the encapsulant shows through producing a brighter image.

(3) BPO

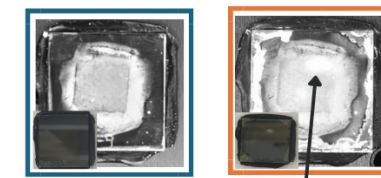


Brighter edges due to degraded PVK revealing the encapsulant. Degraded edges due to moisture.

(4) TPX3025

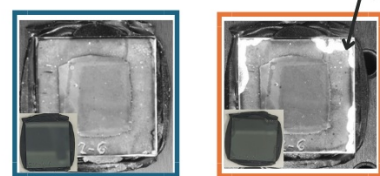


(5) BW464D (edge sealed)



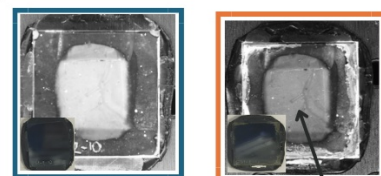
Brighter activity indicates higher emittance.

(6) BPO (edge sealed)



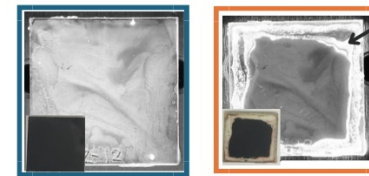
Brighter edges due to degraded PVK revealing the encapsulant behind.

(7) TPX3025 (edge sealed)



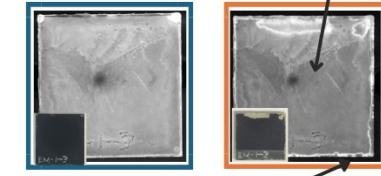
Darker shade shows weaker emittance of light.

(8) AB-313



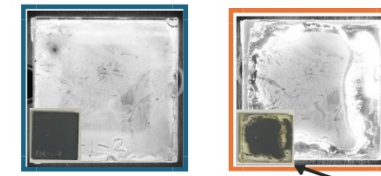
Brighter edges due to degraded PVK revealing the encapsulant behind.

(9) AB-341



Darker shade shows weaker emittance of light. Slightly deteriorated edges due to moisture ingress.

(10) AB-302



Degraded edges

Conclusion

PL images and physical inspection show that polymer encapsulants best preserve the PVK layer, while UV resins performed worst. With respect to the control, polymers are slightly better, edge-sealed variants are inconclusive, and UV resins show clear edge degradation.

Future Work

- Improve encapsulant design on PSC edges to preserve perovskite layer.
- Test encapsulated PSC samples in different pressures and temperatures.

Acknowledgments

I would like to thank Dr. Nicholas Rolston for his invaluable support, Marco Casareto for his guidance, and to the rest of Rolston Lab researchers for the warm collaboration and camaraderie. I am also grateful to Arizona State University's FURI program for making the research possible.

