Temperature Effect on J-V Hysteresis of Perovskite Mini Modules

Nadeesha Katakumbura, Manoj Rajakaruna, Amirhossein Rahimi, Abasi Abudulimu, Ebin Bastola, Zhaoning Song, Yanfa Yan, Randy J. Ellingson

Wright Center for Photovoltaics Innovation and Commercialization (PVIC), Department of Physics and Astronomy
University of Toledo, Ohio, 43606, USA

Background

- Perovskite solar cells have attained efficiencies of over 25% for small area devices, and due to their low cost and scalability, numerous studies have demonstrated the ability to scale up to fabricate large-area mini modules, achieving efficiencies of over 20% [1]
- Due to their low-cost, high power conversion efficiencies, high specific power, high flexibility, and ease of fabrication, they are regarded as promising materials for terrestrial and space photovoltaic applications. [2]
- This preliminary study aims to investigate the behavior of hysteresis loss of perovskite solar cells under varying temperatures, thermal cycling, with the goal of assessing it's effect at space-like environments.

Irradiance-Temperature dependent JVTI measurement system [3]

Optimum parameters	
Convenient temp range	-20C to 120 °C
Temp difference top and bottom of cell	0 to ±5 °C
10 °C step time	3 to 4 minutes
Full range sweep	~60 minutes
Temperature tolerance	± 0.1°C (light off) + 3°C (light on)
JV sweep time (FW and RW)	~8 sec
Number of data points	100

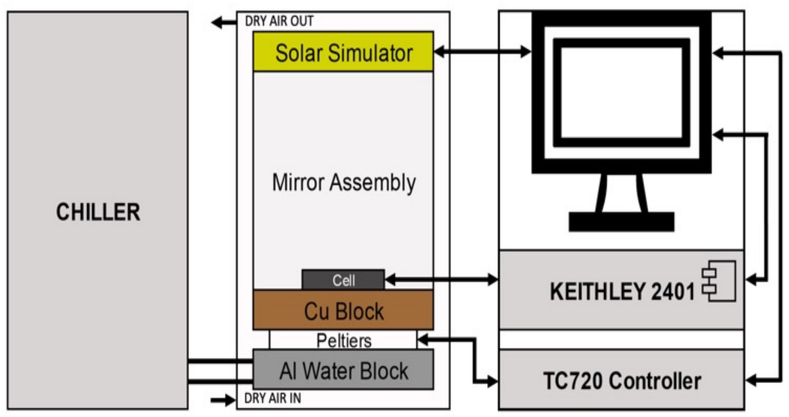

Figure 1. Optimum parameters and schematic of the JVTI measurement chamber

Hysteresis behavior

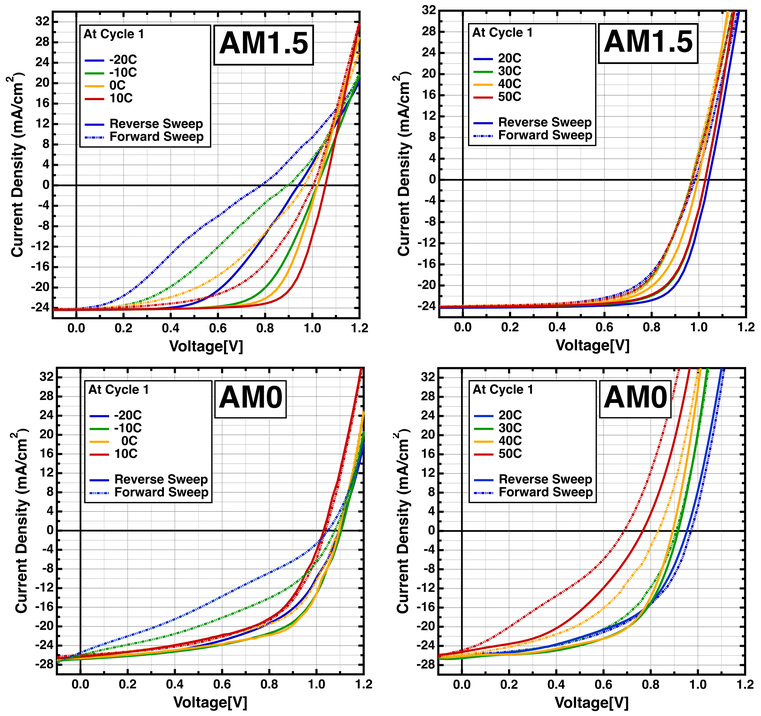

Figure 2. Hysteresis behavior from -20C to 50 C

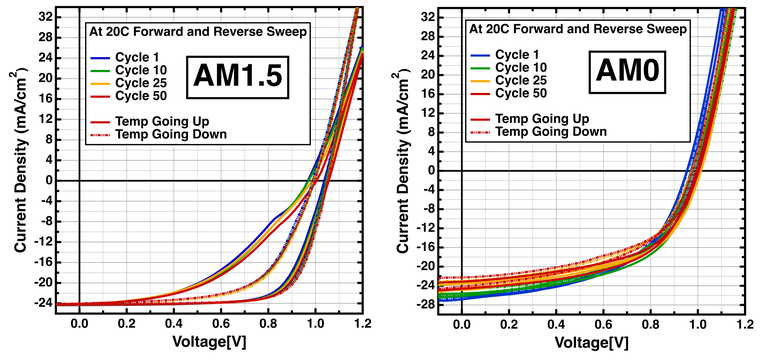

Figure 3. Hysteresis behavior over different thermal cycles under both cold to hot and hot to cold conditions at 20C.

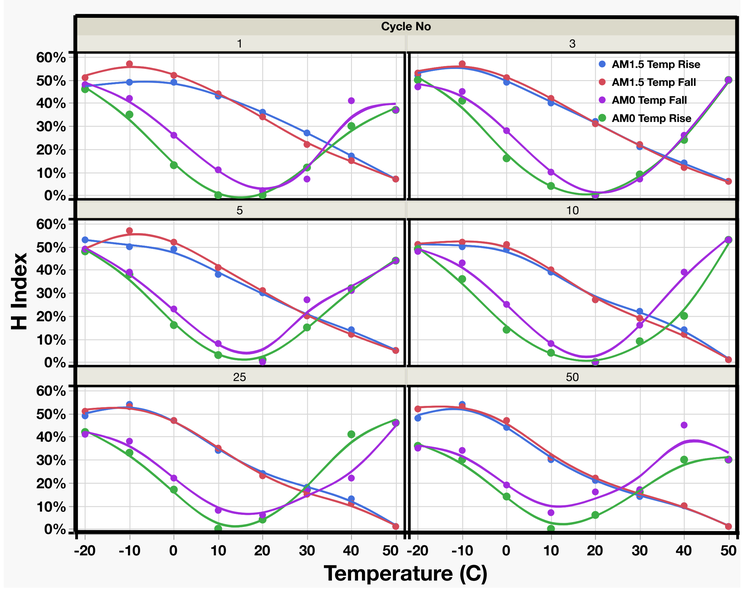

Figure 4. H index variation from cold to hot and hot to cold through thermal cycling.

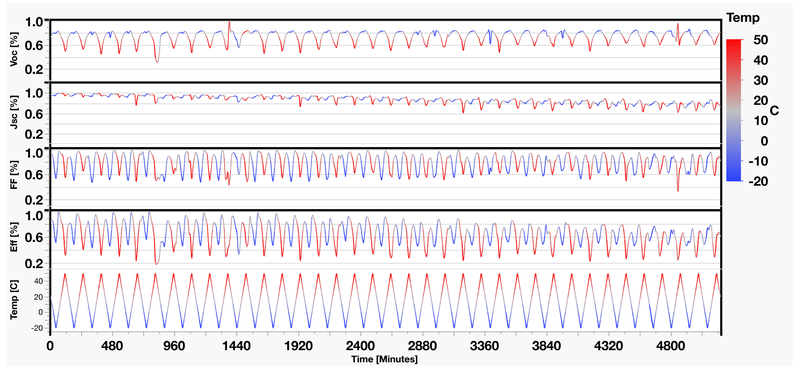

Figure 5. Normalized thermal cycling under AM0

Conclusion

- Effect of temperature variation on the behavior of Hysteresis is more significant under AM0 than that of AM1.5 for Perovskite Mini Modules.
- During thermal cycling, at each temperature, cold to hot tend to showcase higher H Index than that of hot to cold case.
- Morphological alterations and ion mitigation when temperature varies from cold to hot can affects the transport and recombination of charge carriers more within the perovskite layer, influencing this hysteresis behavior.
- This effect tend to reduce as the number of thermal cycling increases, any how the overall H index behavior is slightly affected by the thermal cycling.

Acknowledgements

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References

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[2] Y. Rong *et al.*, "Tunable hysteresis effect for perovskite solar cells" *Energy Environ. Sci., 2017,10, 2383-2391*, doi:https://doi.org/10.1039/C7EE02048A
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