Investigation of Degradation in Perovskite Solar Cells Using Thermal Hysteresis of Photocurrent

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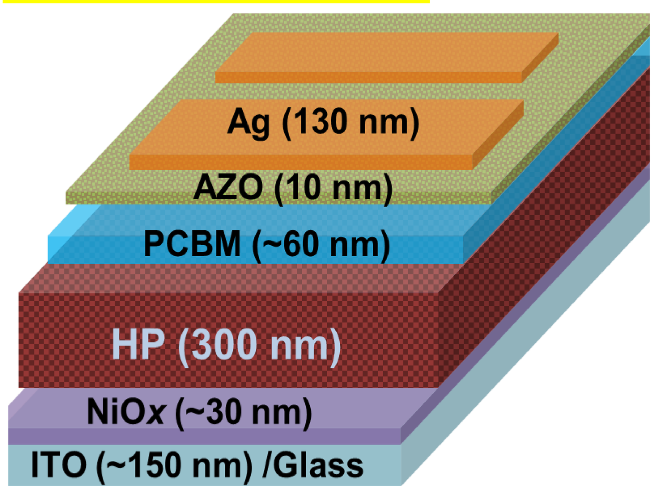
Introduction

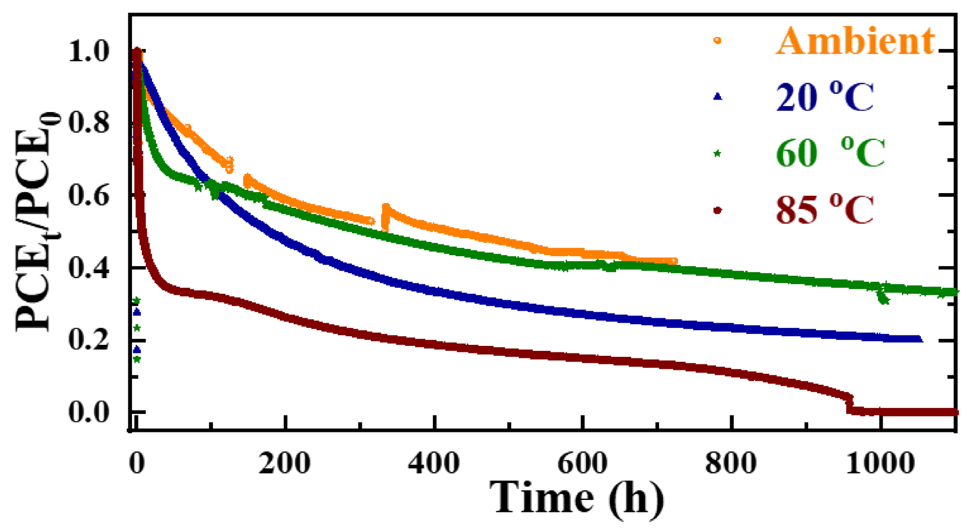
- Investigating the degradation mechanisms of perovskite solar cells (PSCs) is essential for addressing long-term stability challenges.
- This study explores PSC deterioration through the lens of thermal hysteresis in photocurrent (THPC) and thermally activated ionic migration.
- Capacitance analysis highlights the accumulation of interfacial ionic charges and the activation of defects during photo-thermal stress.
- The results reveal a direct link between PSC degradation and thermally induced charge dynamics, emphasizing their role in limiting device stability.

Experimental

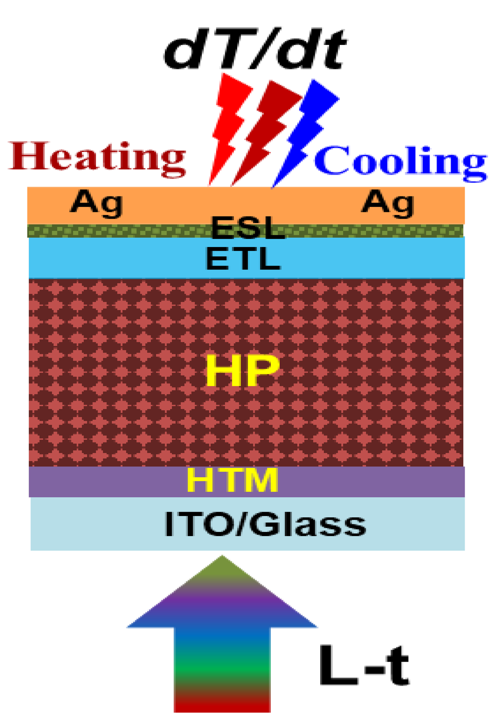
Device structure



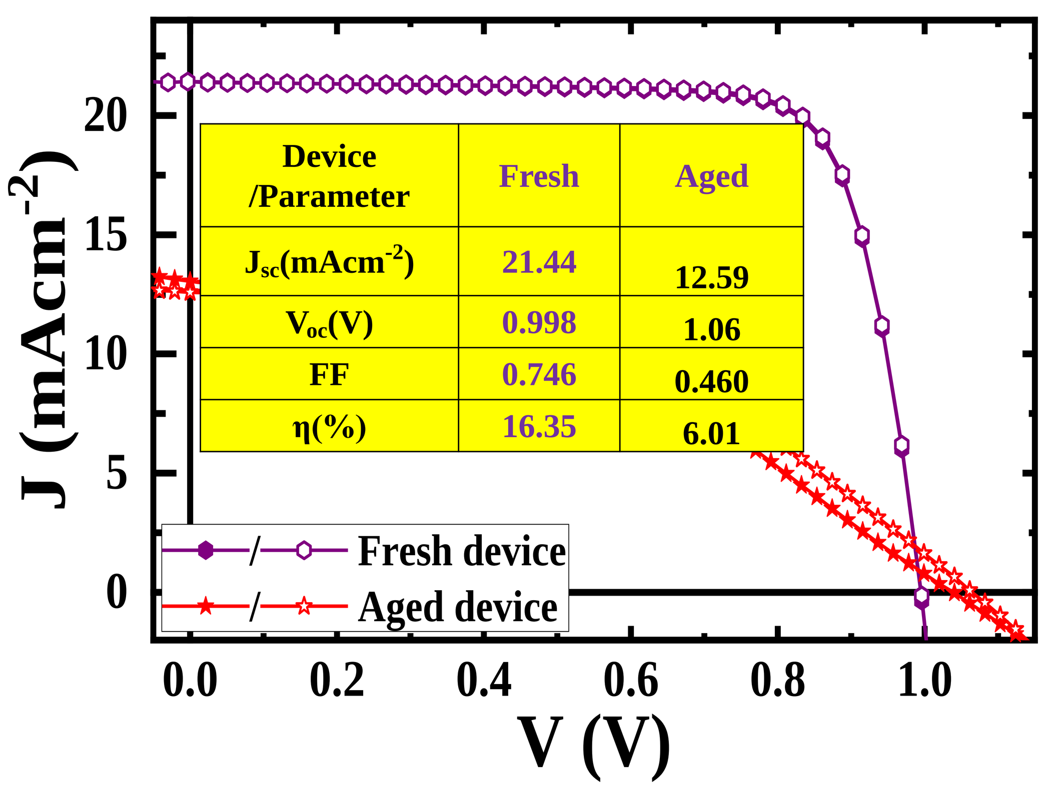
The operational stability of the devices at different temperatures under 1 sun



Schematic of the THPC spectra measurement

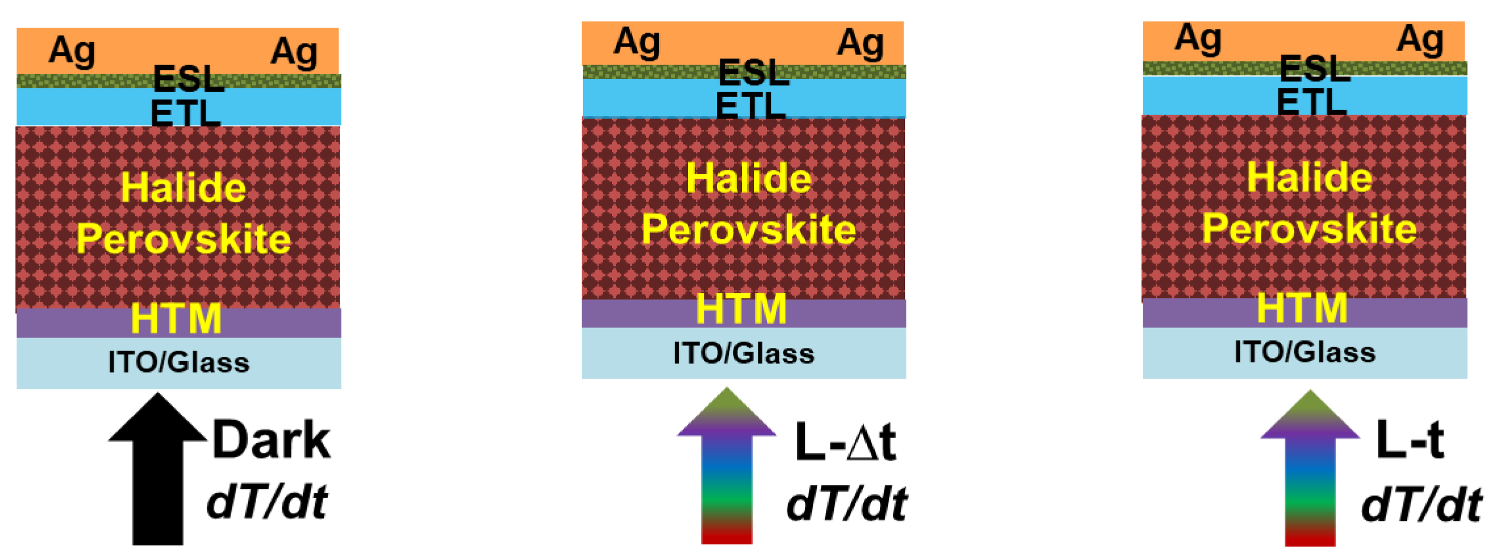


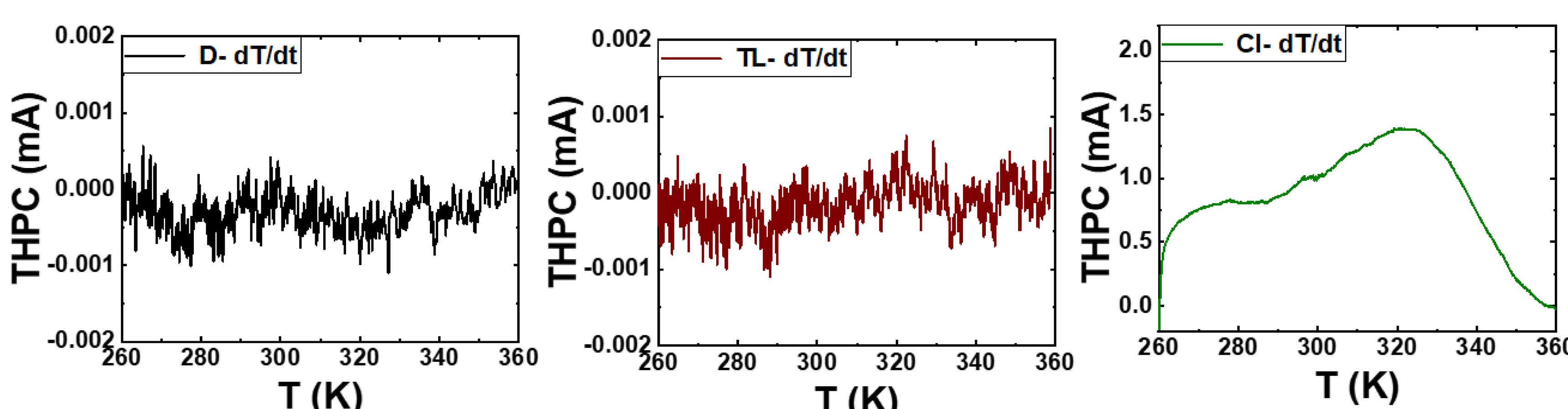
J-V curves of fresh and aged PSCs



Device /Parameter	Fresh	Aged
J_{sc}(mAcm^{-2})	21.44	12.59
V_{oc}(V)	0.998	1.06
FF	0.746	0.460
η(%)	16.35	6.01

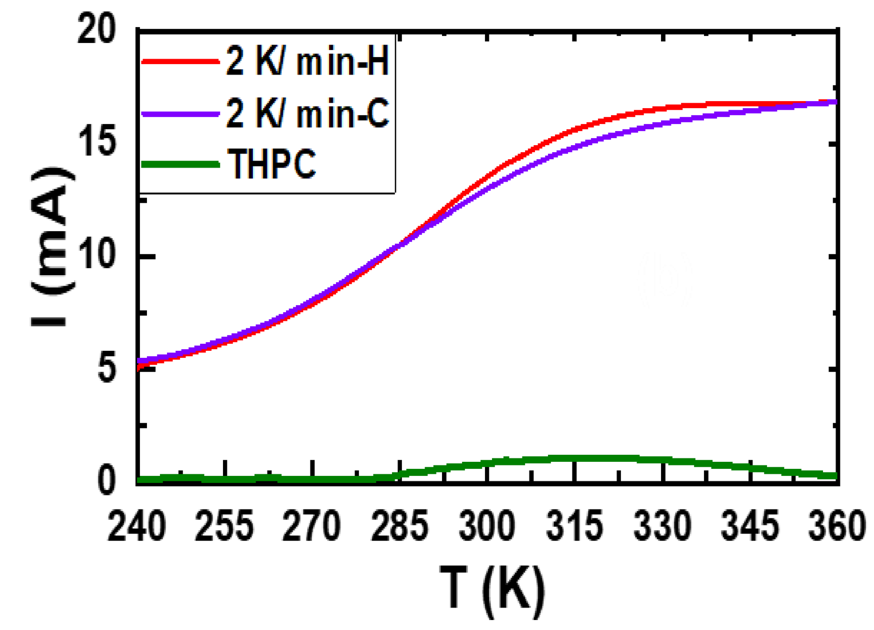
- Schematic of the THPC measurement and corresponding spectra

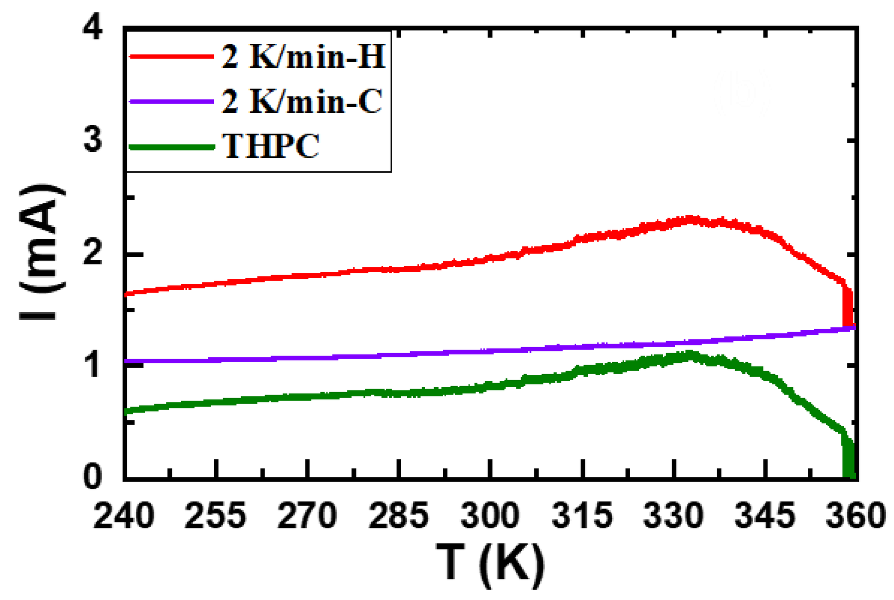




Device Results and Analysis

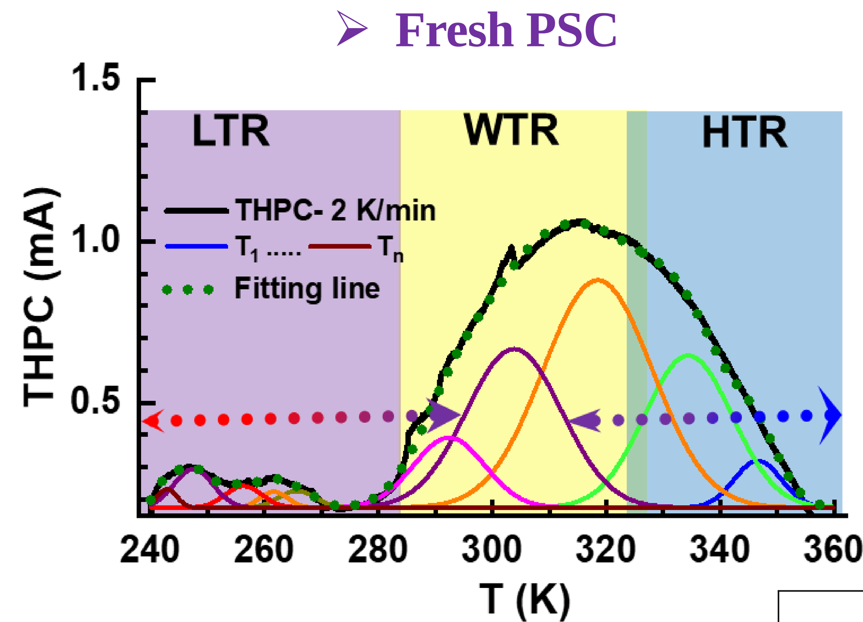
- THPC spectra of the fresh-PSCs under temperature drifting rate (2 K/min)



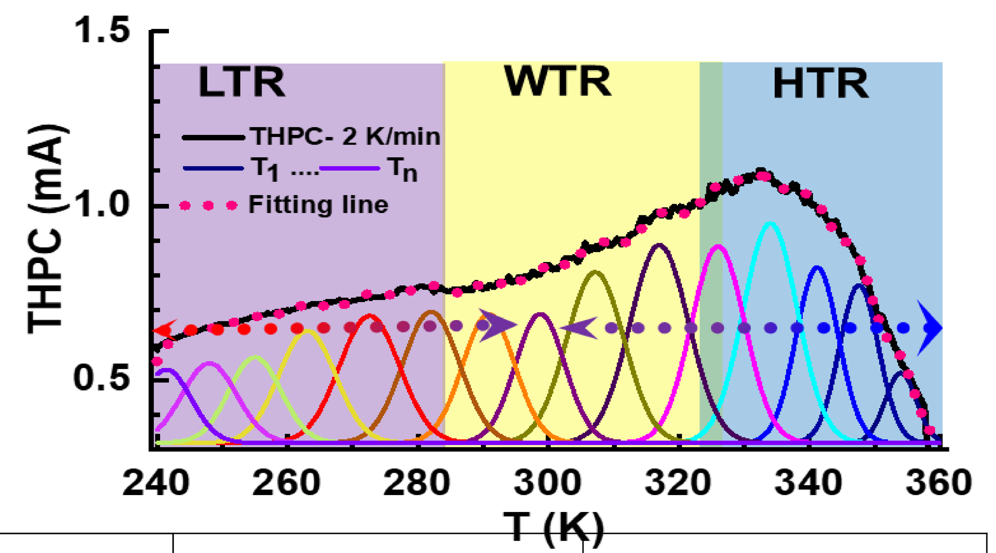


- Fitting by multiple peak analysis methods

  - Fresh PSC



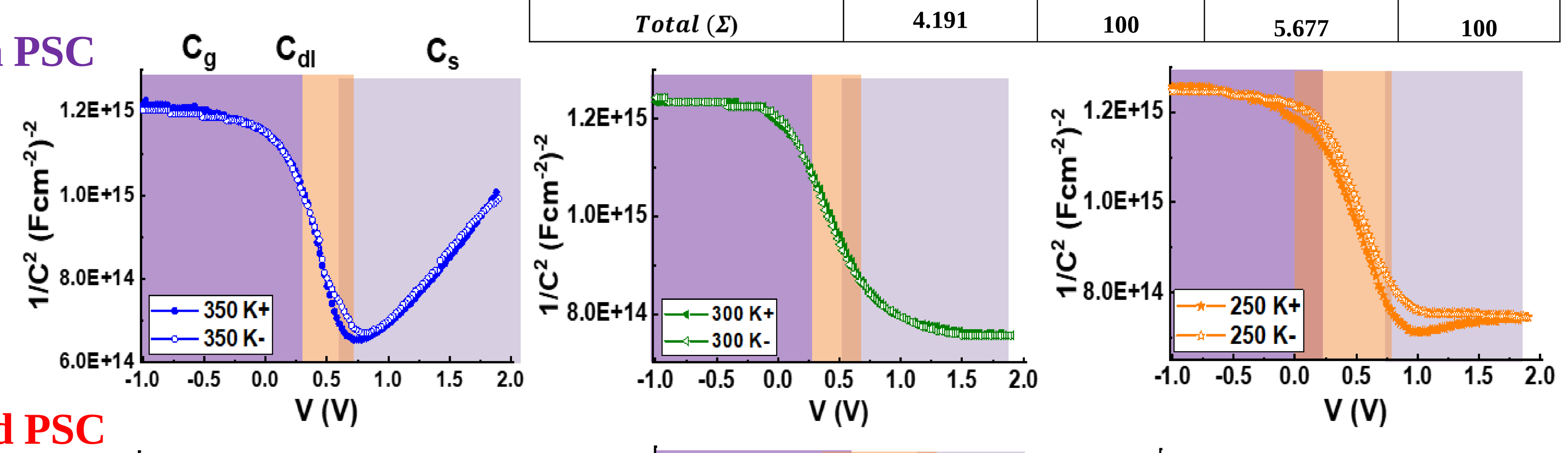
  - Aged PSC



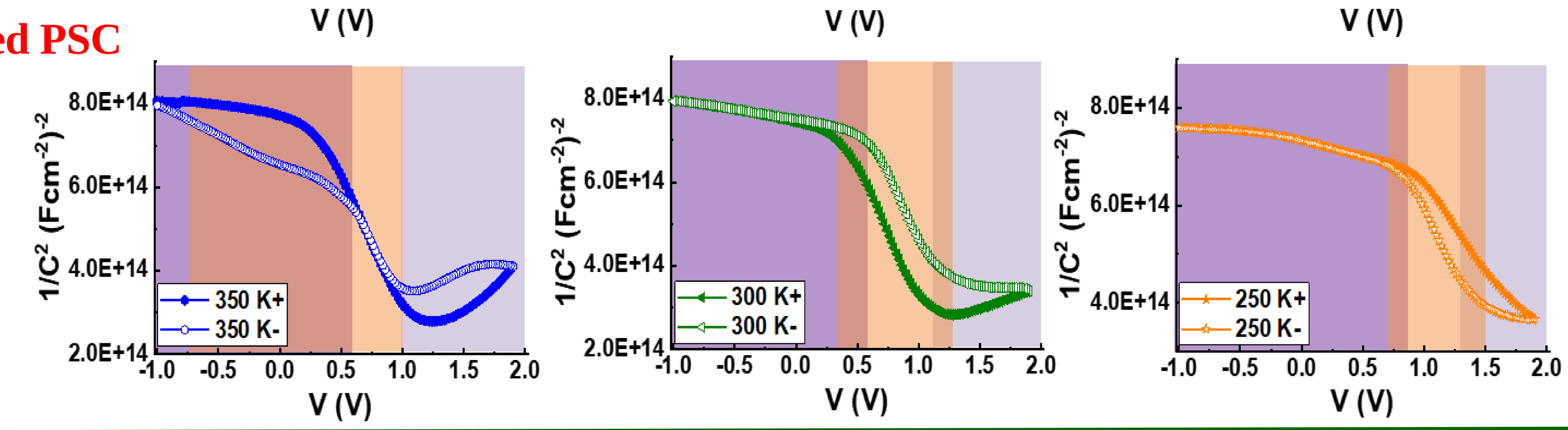
Thermal drifting rate (2 k/min) Temperature Range ↓	Fresh		Aged	
	Q_{THPC} (mC)	Q_{THPC} (%)	Q_{THPC} (mC)	Q_{THPC} %)
LTR (240-283 K)	0.429	10.24	1.927	33.95
WTR (283-323 K)	2.452	58.52	2.105	37.08
HTR (323- 363 K)	1.309	31.24	1.644	28.97
Total (Σ)	4.191	100	5.677	100

- Capacitance and Device Degradation

  - Fresh PSC



  - Aged PSC



Summary

- THPC emissions with a complex thermally active charge or ion accumulations due to interfacial deterioration.
- These photoactive mobile charges are more pronounced in aged PSC with higher charge densities.
- Capacitance analysis demonstrates that the thermally triggered charge accumulation is more pronounced in aged PSC.
- THPC plays a detrimental role in losing photo-current in the degraded PSCs.

Ref :

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