

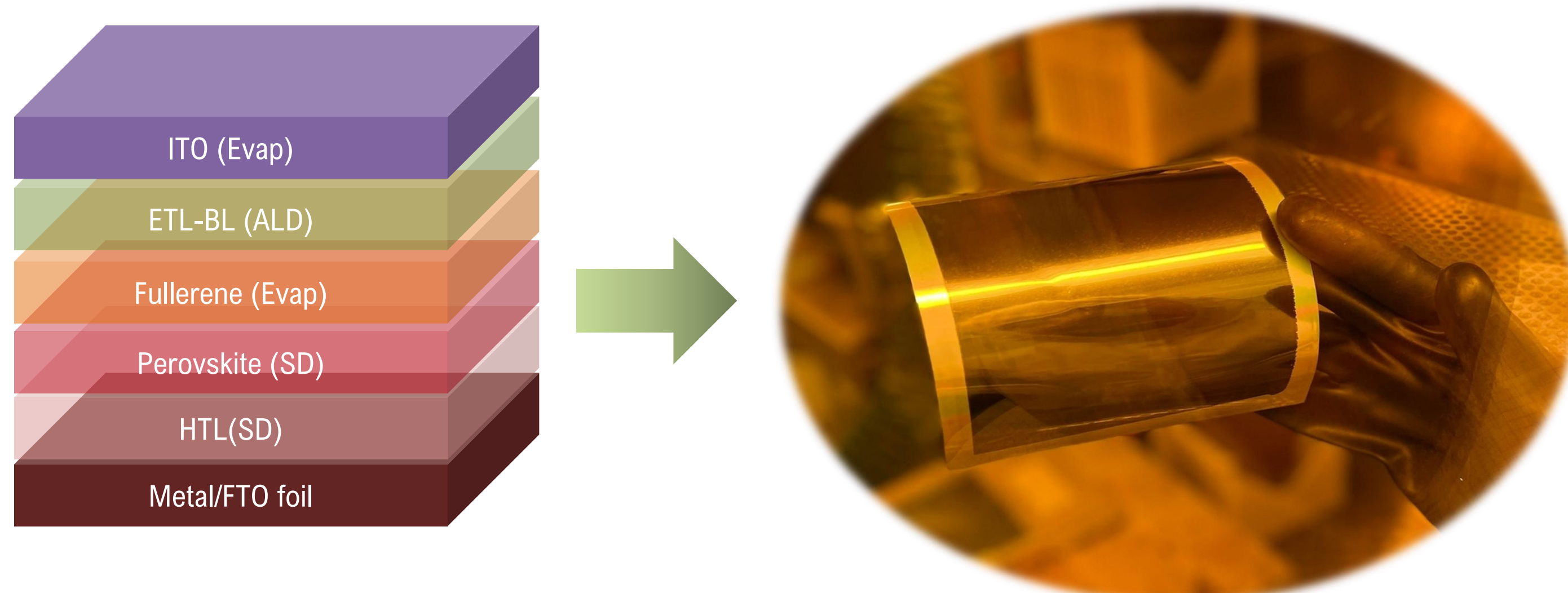
LONG-TERM STABILITY OF FLEXIBLE PEROVSKITE SOLAR CELLS VIA LOW-TEMPERATURE ENCAPSULATION

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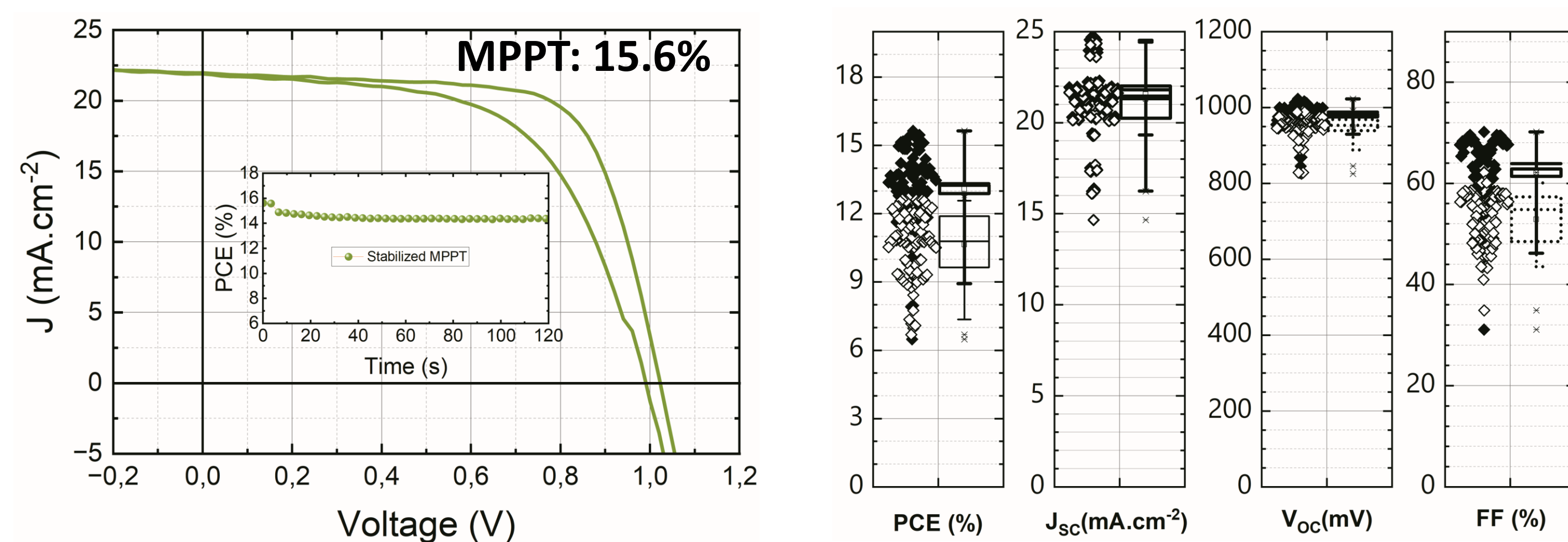
This work presents flexible perovskite solar cells (PSCs) fabricated on Metal/FTO foil substrates using ambient-compatible, scalable processes. Devices showed power conversion efficiencies over 15% and strong thermal and environmental stability. After over 1500 hours of thermal and damp heat stress, encapsulated PSCs maintained PCE above 10% with no degradation. The study demonstrates the potential of advanced mild encapsulation for durable, flexible PSCs suitable for real-world deployment and roll-to-roll manufacturing.

S2S Process-Scalability for R2R



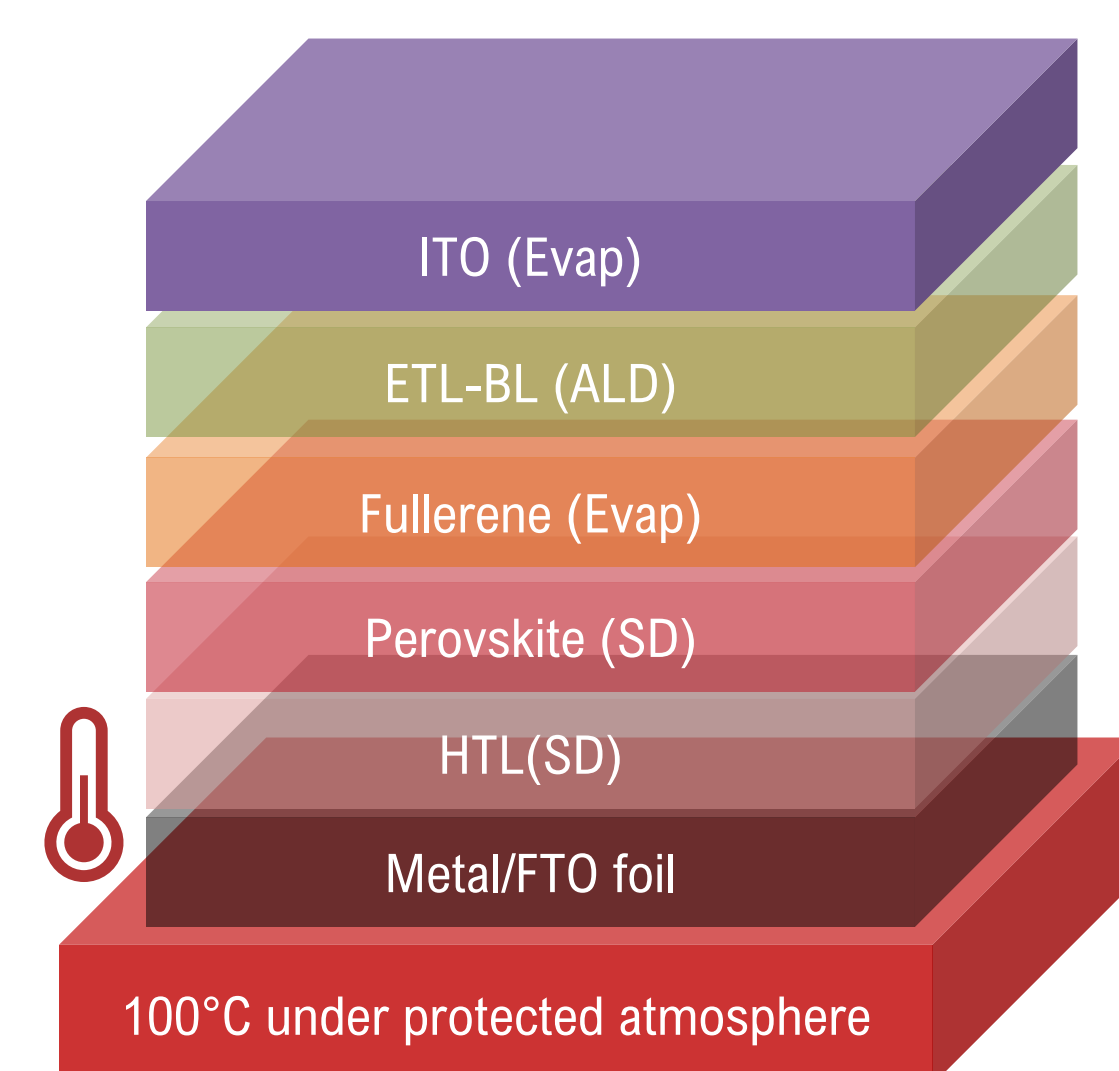
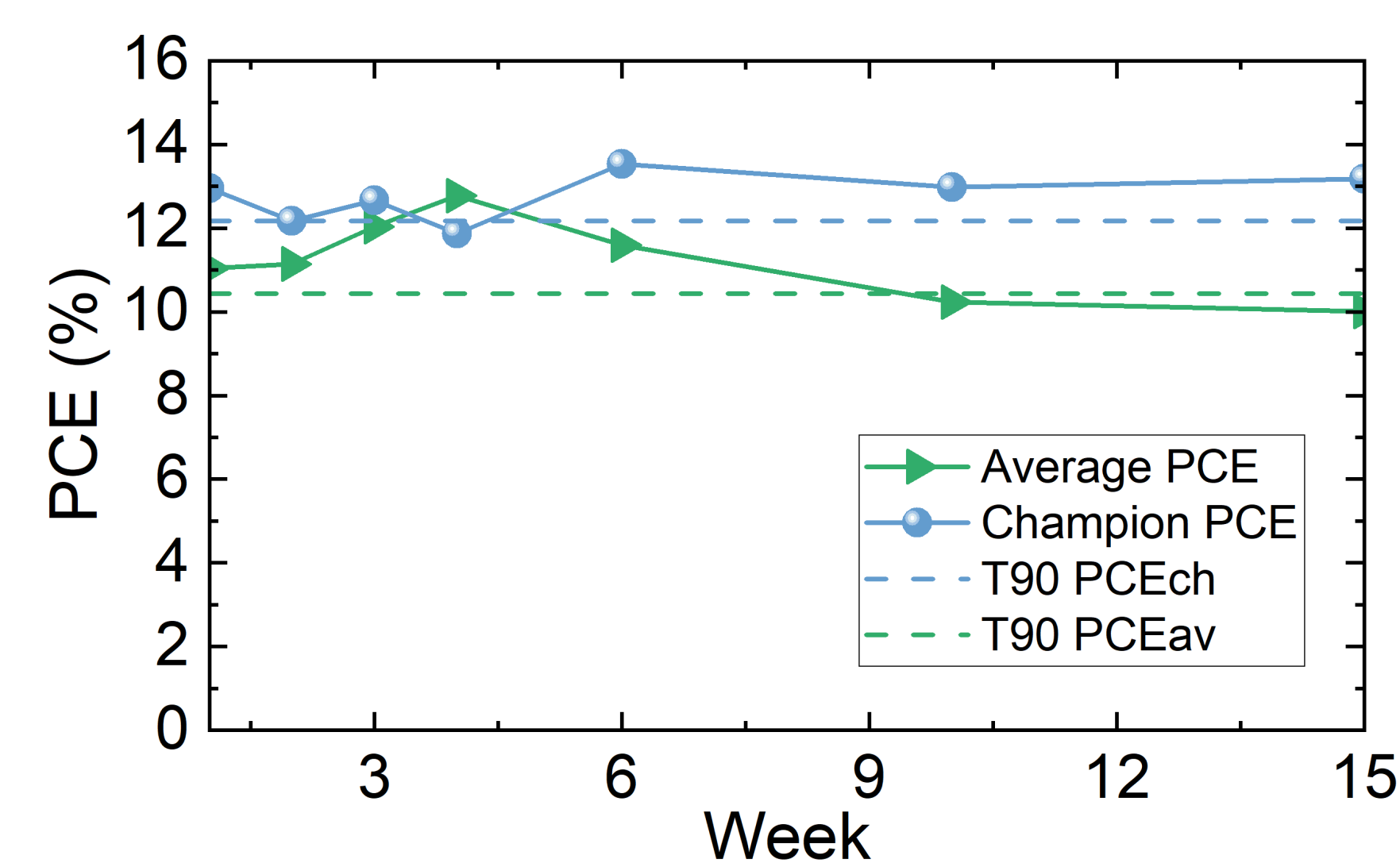
Scalable solvent systems

- S2S ambient slot-die cells up to 15.6% PCE
- Implementation of passivation & additives & interface layers needed to reduce the hysteresis and increase FF



Thermal Stability of Perovskite cells

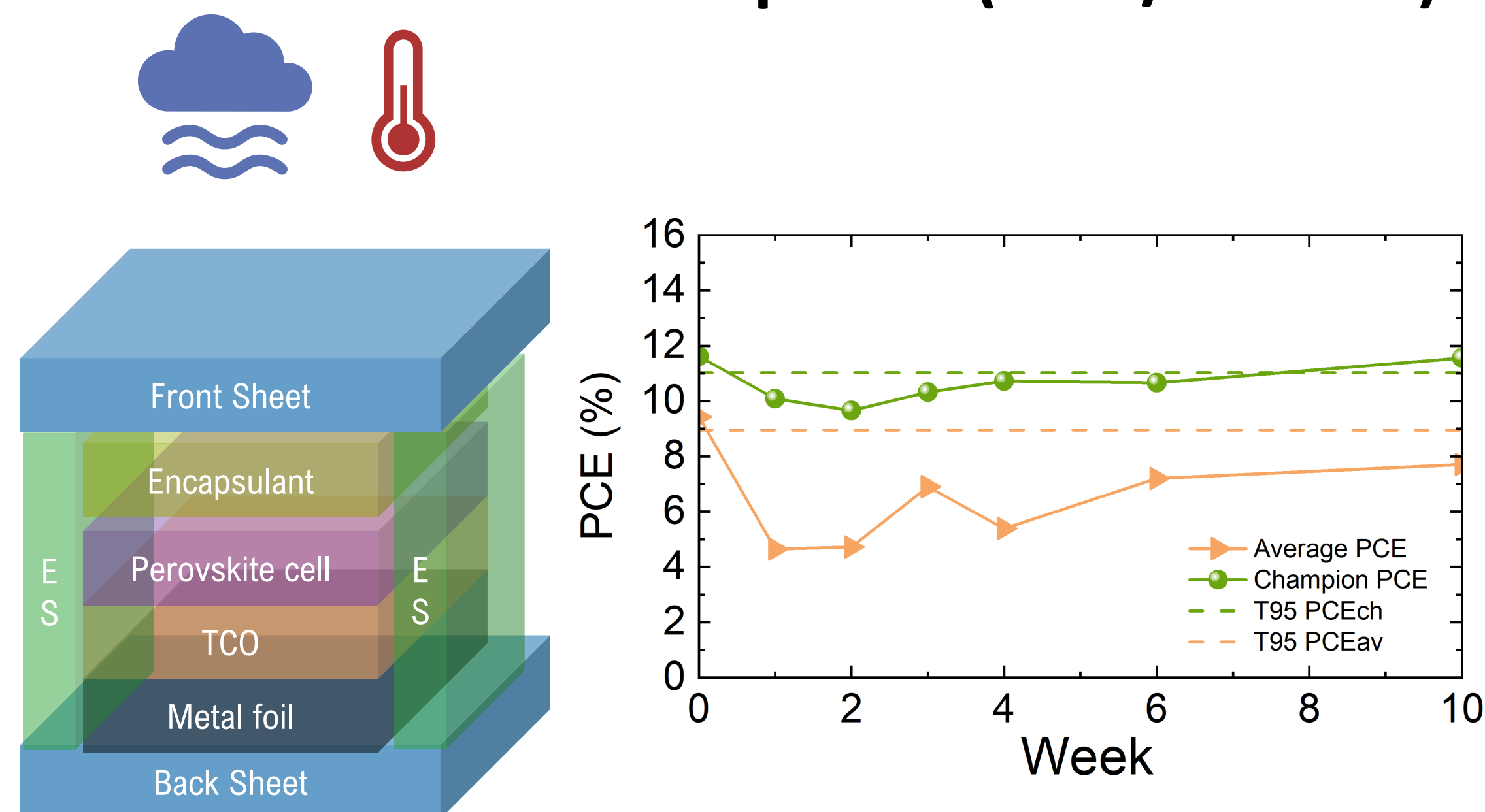
Champion cell efficiency	Average cell efficiency
T(0h): 13.7%	T(0h): 11.0%
T(2500h): 13.2%	T(2500h): 10.0%



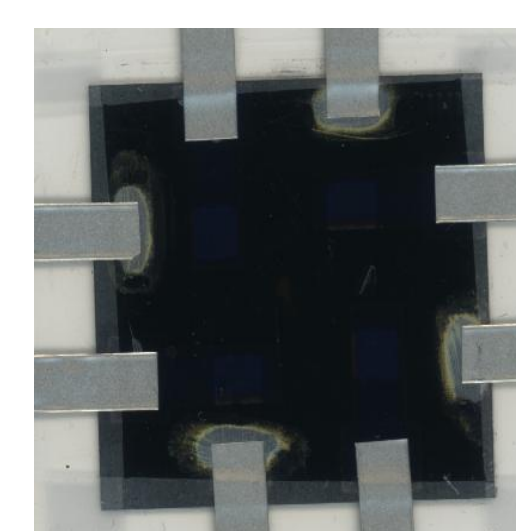
Thermal stress at 100°C for over 10 weeks

- S2S ambient processed non-encapsulated cells
- Measurement statistics over 10 cells Champion cell efficiency
- Main reduction in J_{sc} and FF, Flat V_{oc} profile

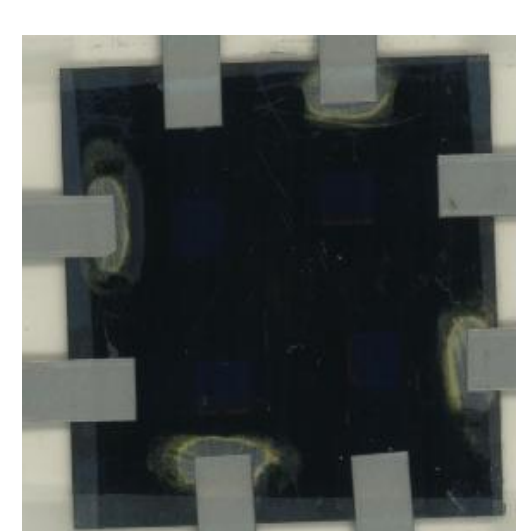
Damp heat (85°C/85% RH)



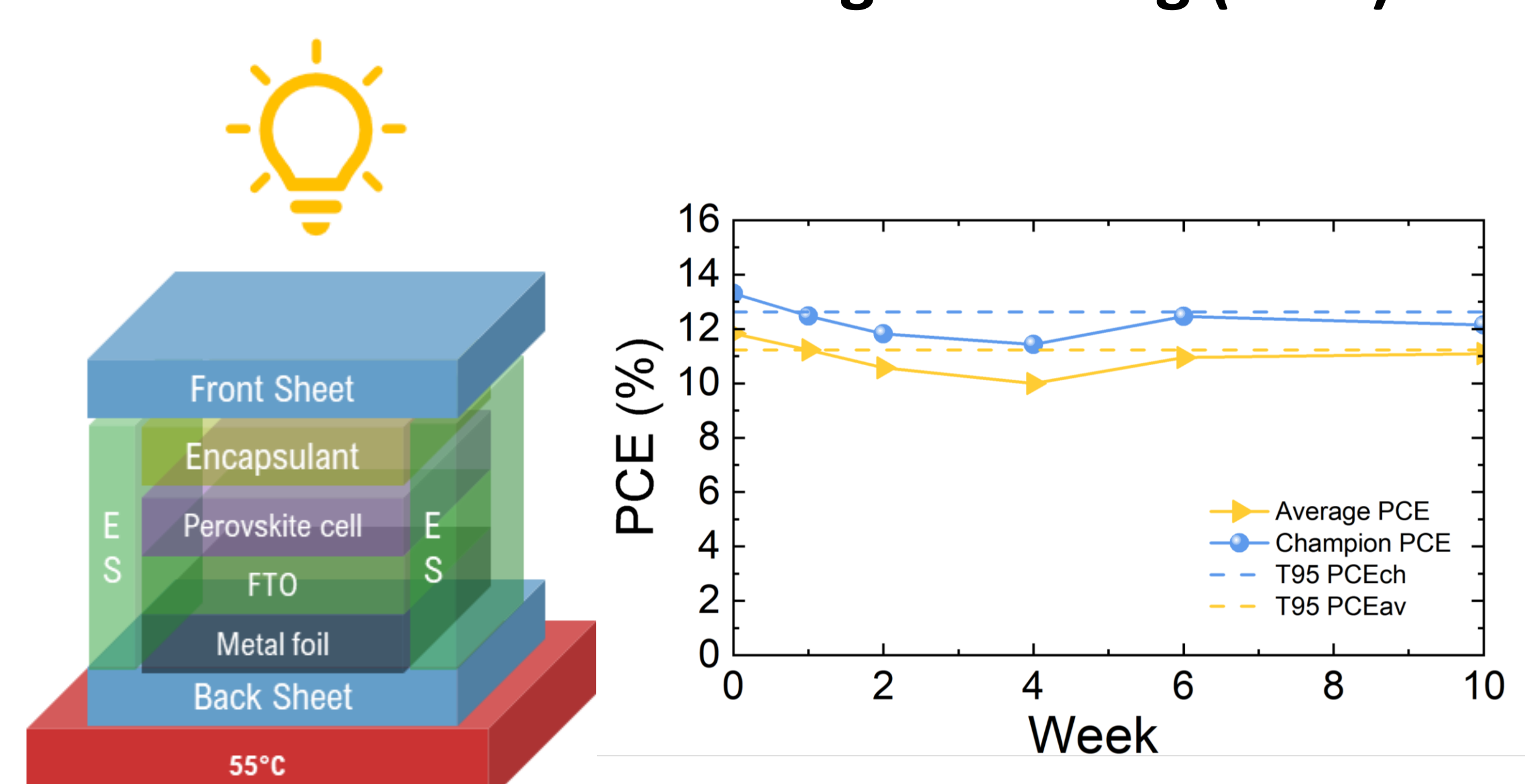
Week 1



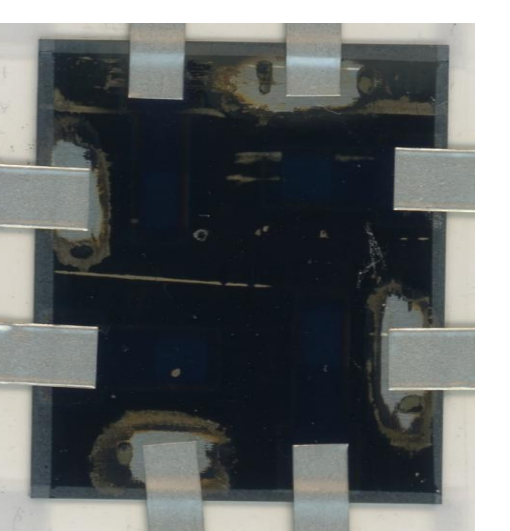
Week 10



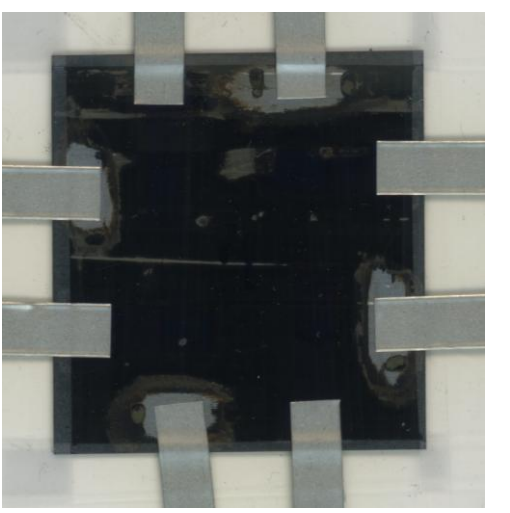
Light soaking (55°C)



Week 1



Week 10



Champion cell efficiency	Average cell efficiency
T(0h): 11.6%	T(0h): 9.4%
T(1000h): 10.7%	T(1000h): 7.2%

Damp heat and light soaking with temperature

- Mild encapsulation strategy maintained >10% PCE under damp heat (85°C/85% RH) and continuous light soaking for over 1500 hours
- Main reduction in J_{sc} and FF, Flat V_{oc} profile

Champion cell efficiency	Average cell efficiency
T(0h): 13.3%	T(0h): 11.8%
T(1000h): 12.5%	T(1000h): 10.9%

Conclusions

- Successfully fabricated flexible PSCs on Al-based substrates using ambient-compatible, scalable S2S processing.
- Over 15% PCE with high reproducibility on 15 × 15 cm² flexible substrates.
- Non-encapsulated devices retained ~96% of initial efficiency after 3000+ hours of thermal stress, showing strong intrinsic stability.
- Promising route toward scalable, durable, and environmentally stable flexible PSCs for real-world applications.