Objectives: Design of Multijunction Perovskite PV for Reliability

Track 1: Space-based Energy Conversion Systems - Perovskite PV has the highest specific power of any PV technology (W/kg)

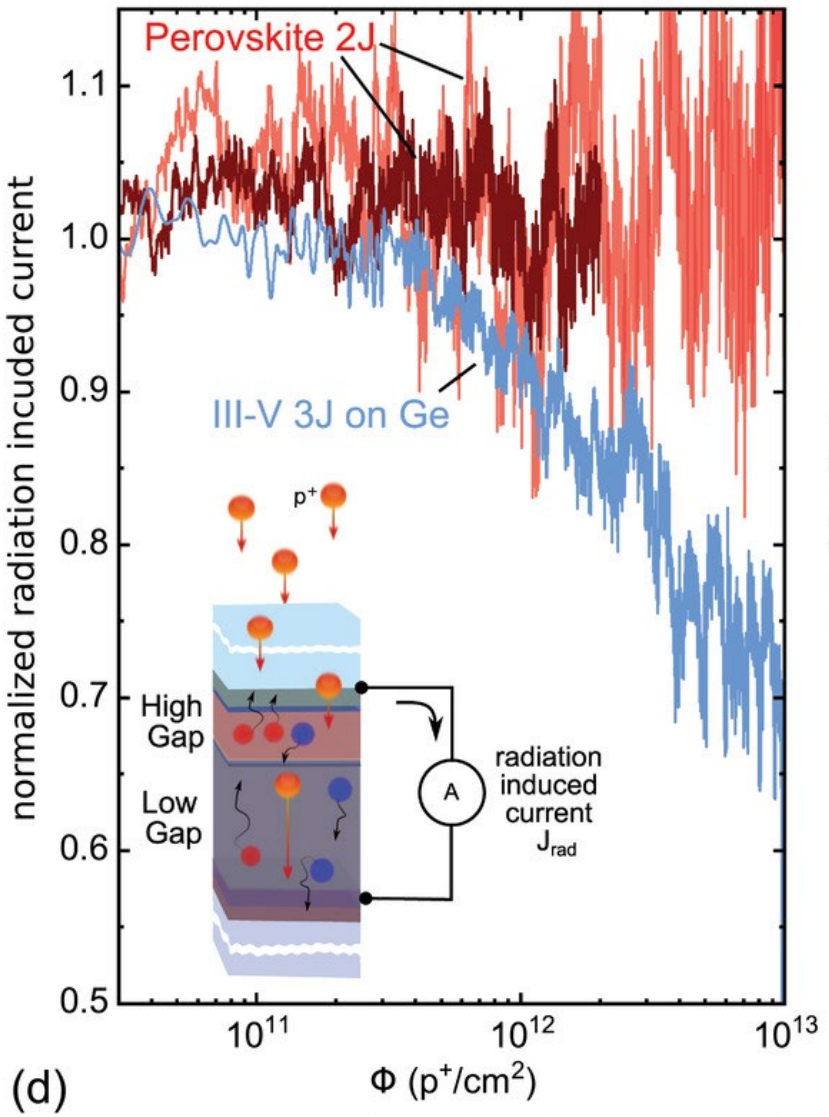
As a multijunction technology, it can significantly improve power density under AM0 incident sunlight and enable high volumetric power density

The technology can be designed to minimize surface reflection and thermal signatures

Perovskite PV has retention of power output following high flux irradiation

There is a need to better improve reliability to enable higher lifetime energy harvesting yield over a simulated 10-year mission

Proton radiation hardness

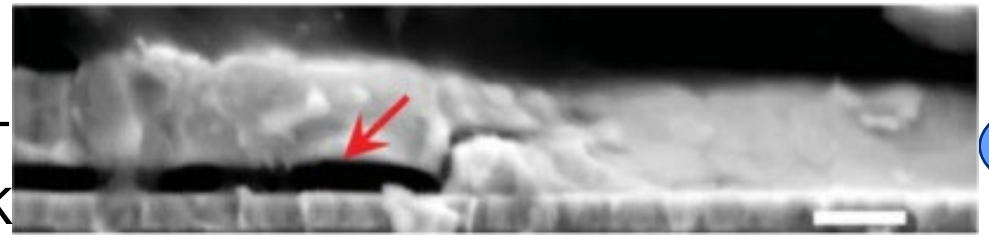


F. Lang *et al., Advanced Energy Materials,* 2021

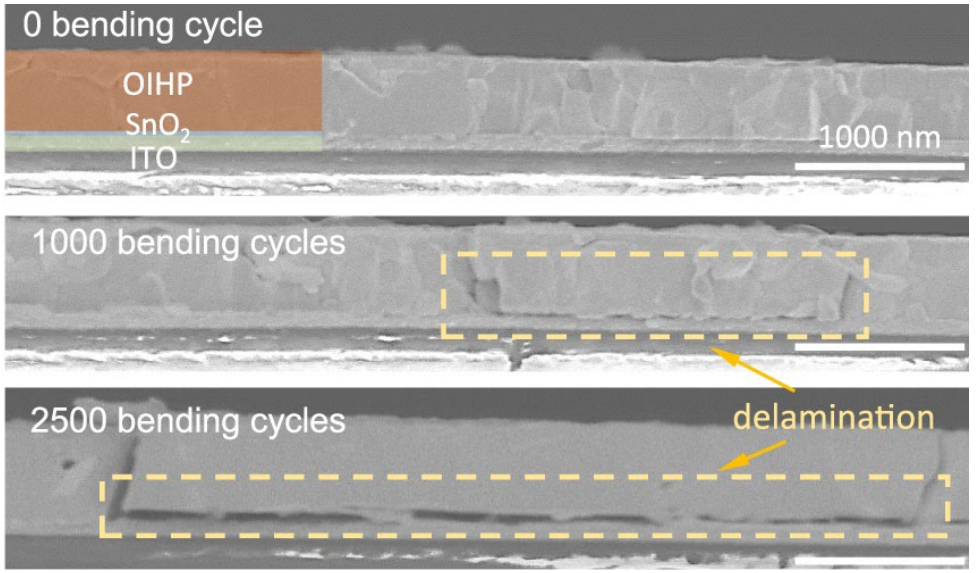
ASU Ira A. Fulton Schools of Engineering nicholas.rolston@asu.edu https://rolston.lab.asu.edu/

Mechanical Failure in Perovskite Solar Cells

After 757 hours of illumination

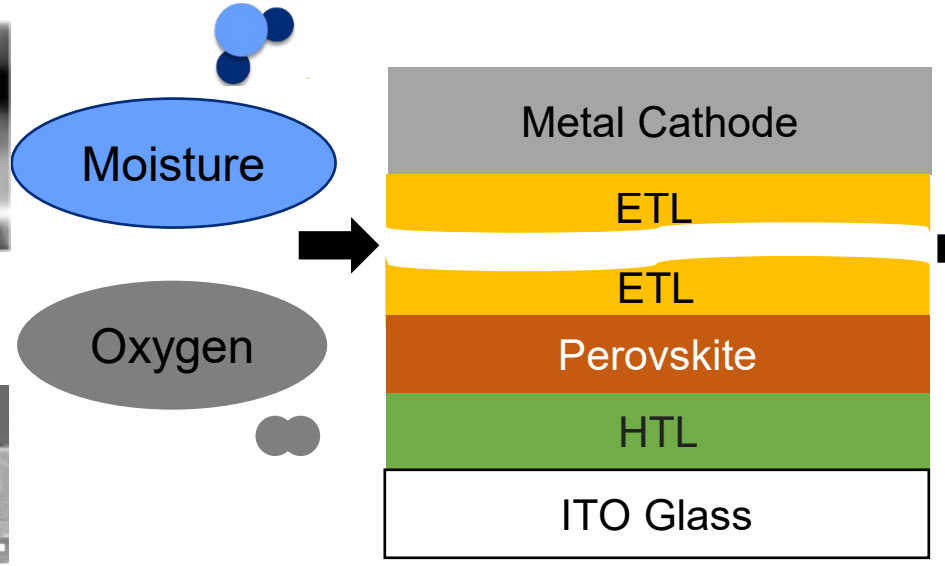


Z. Dai et al, Science, 2021



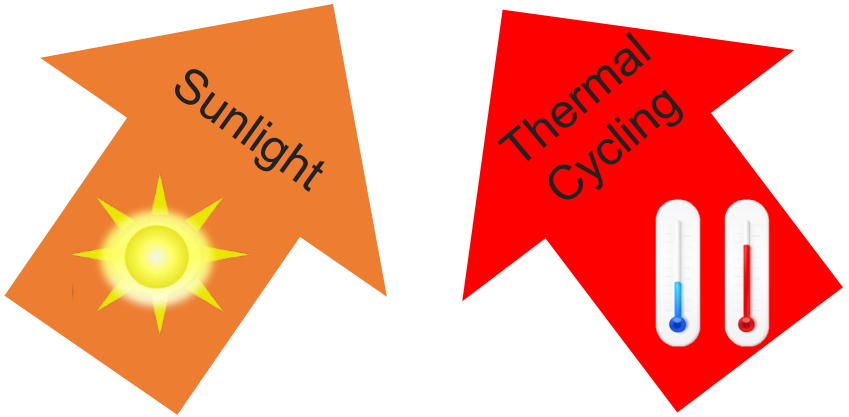
Q. Dong et al, Nature Communications, 2021

Environmental stress causes mechanical stress that induces delamination when $G > G_c$



Effects of delamination:

- Efficiency reduction
- Ion migration
- Device failure



M. Li *et al., Energy Advances*, 2024

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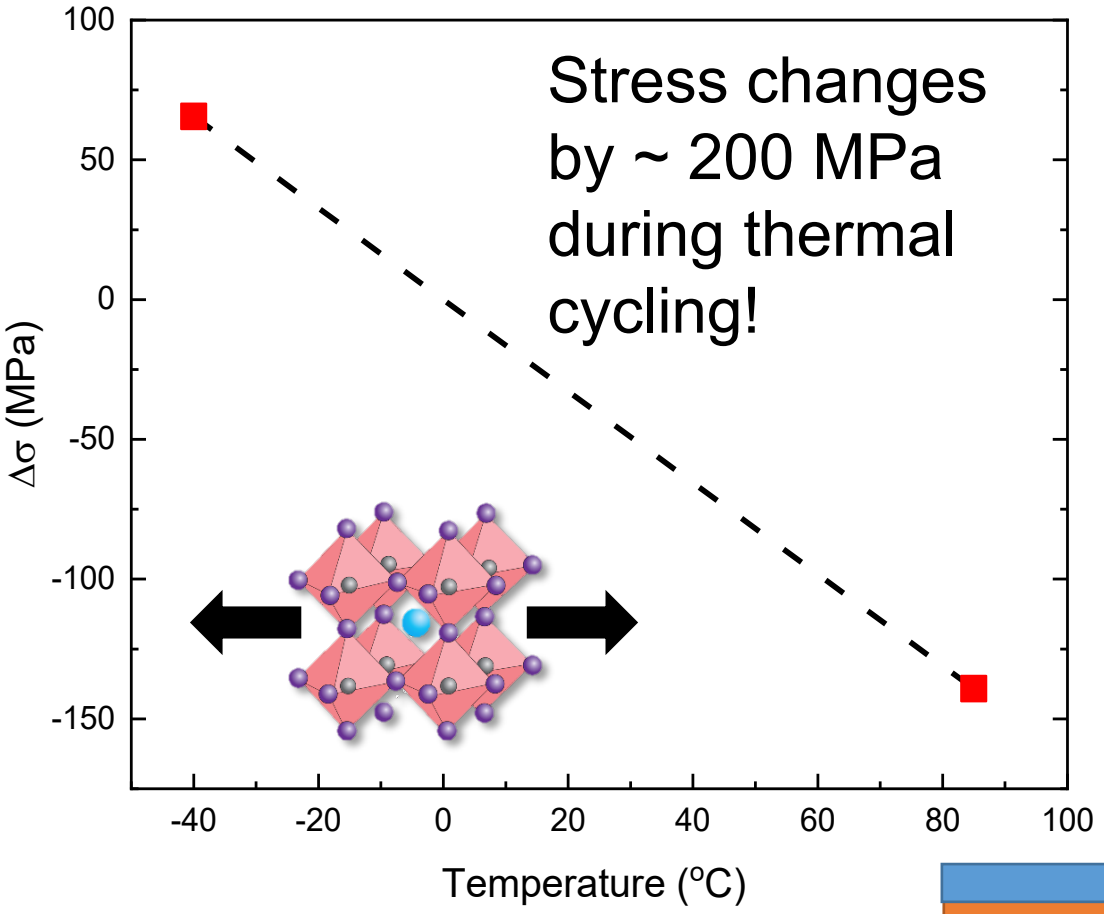
Tensile Film Stress Accelerates Degradation



Damage propagates if:

$$G \approx \frac{\sigma^2 h}{E} \geq G_c \text{ [J/m}^2\text{]}$$

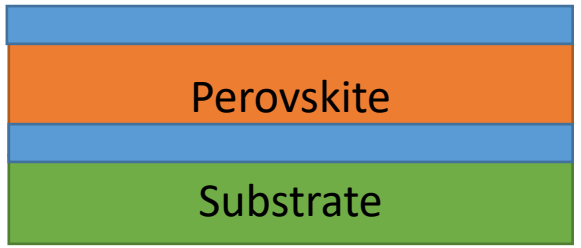
mechanical "driving force"

Fracture energy

σ = tensile film stress

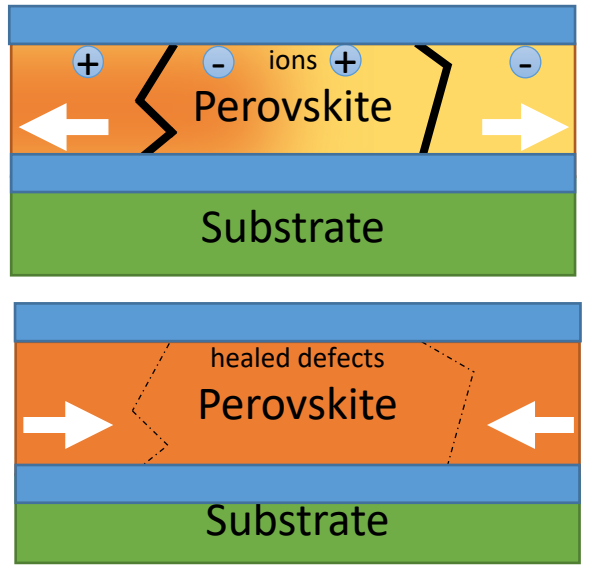
h = film thickness

E = film modulus



Tensile stresses thermal

Compressive stresses intrinsic



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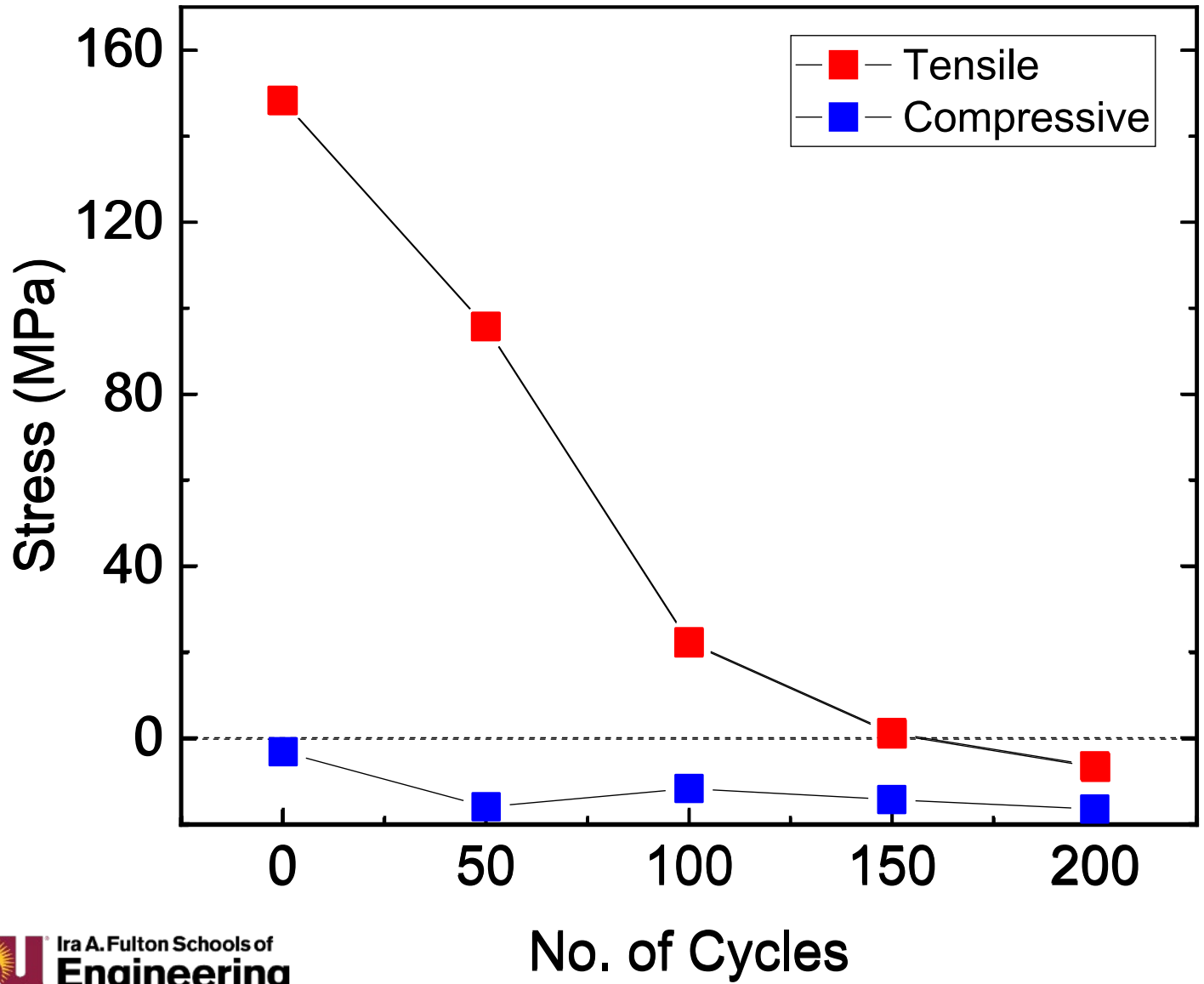
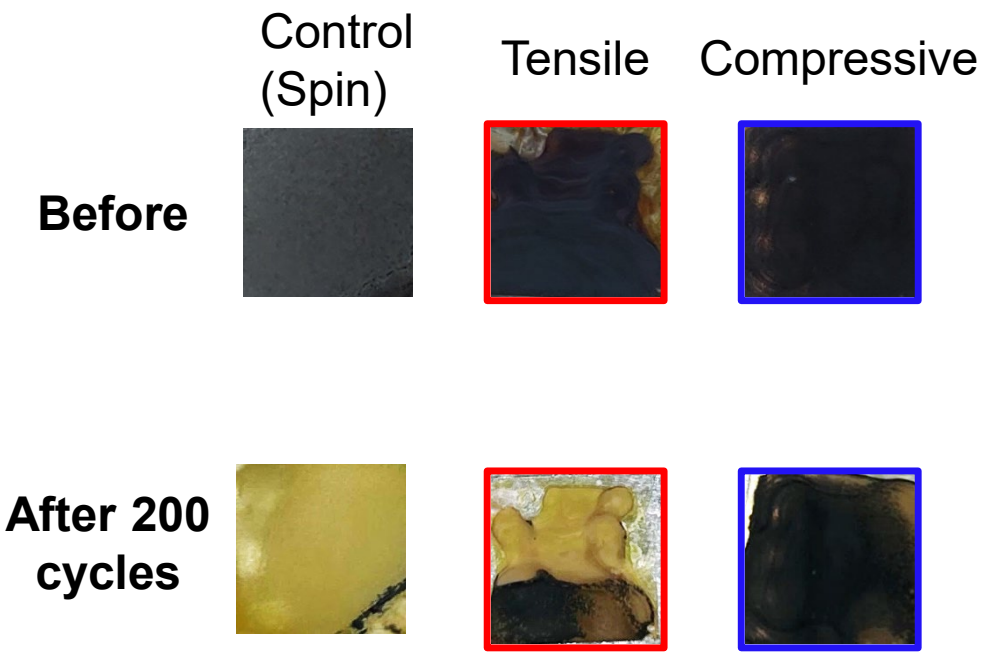
Compressive Films More Stable in Thermal Cycling

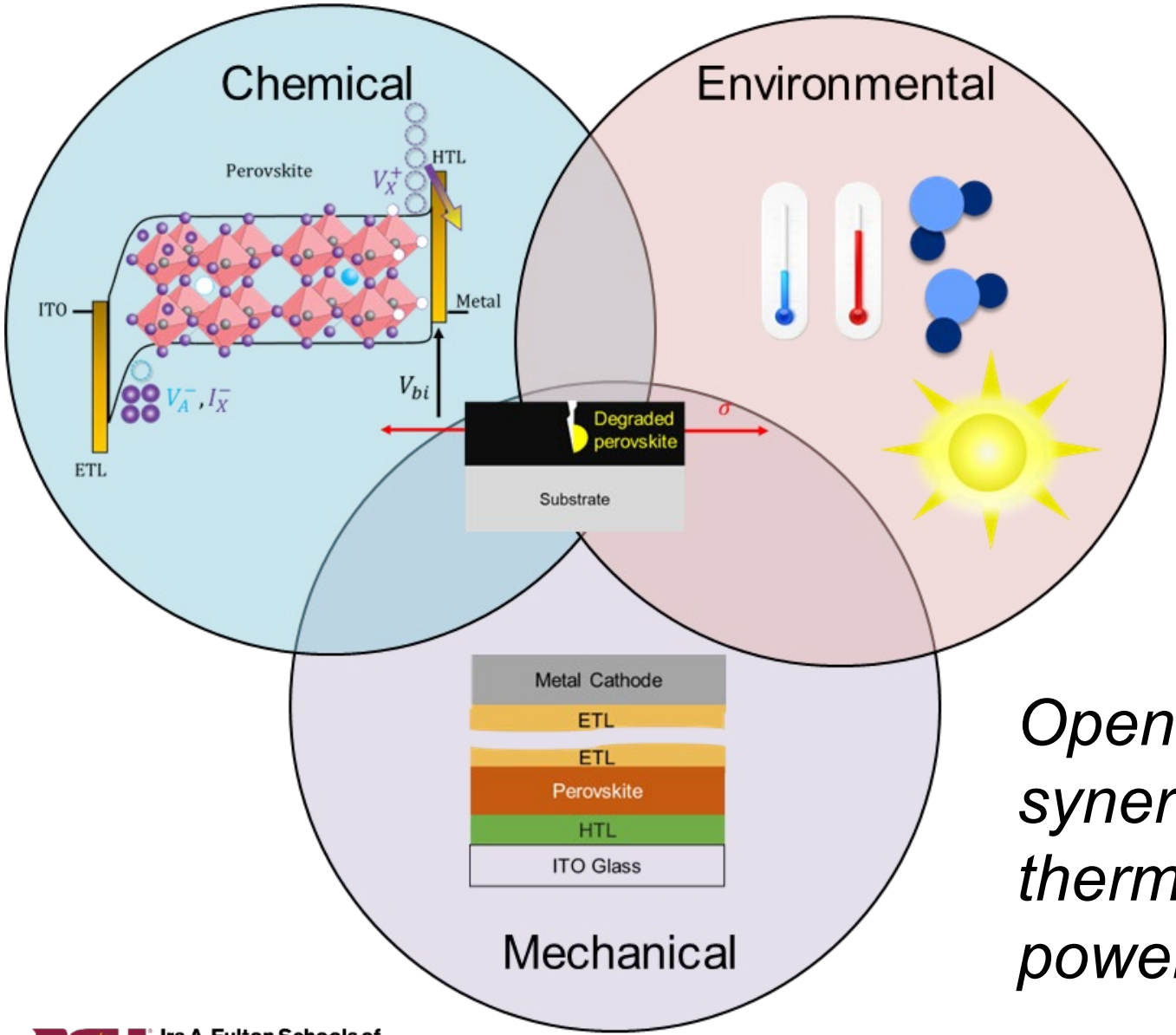
Samples cycled between -40°C→85°C and film stress measured in ambient





M. Ahmad *et al., ACS Applied Materials and Interfaces,* 2023

Research Plan: Enabling Operational Stability in Perovskite Tandem Multijunction Devices by Understanding Stressors



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Open to collaborations to leverage synergy with teams who have optics, thermal management/conversion, and power electronics backgrounds!

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