Perovskite Solar Cell Stress Response on Shape-Memory Alloy and Glass Substrates

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Introduction

Perovskites (PVSKs) are a family of materials rising as stars in solar cell research. Appealing for their low cost and tunable properties, this technology is an excellent renewable energy source. Long-term stability remains a major to manufacturing. This research investigates the stability of PVSKs on Shape-Memory Alloys (SMAs) to make flexible, lightweight, and even stretchable solar cells tailored for space applications.

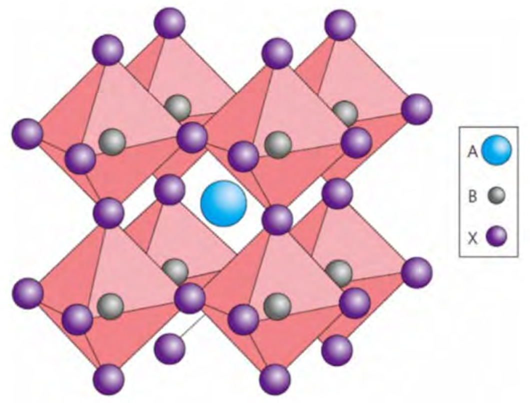

Fig. 1: PVSK crystal structure (ABX_3).

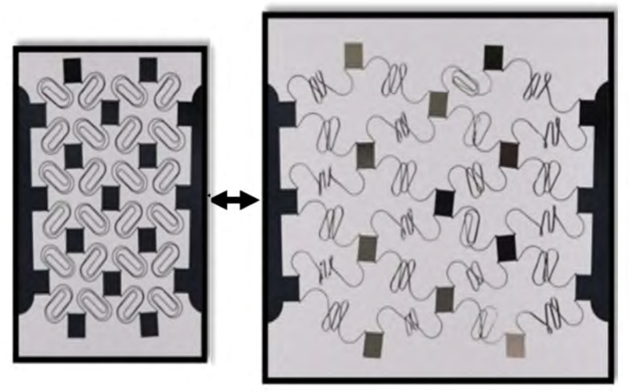

Fig. 2: Stretchable electronic schematic.

Methods | Light and Heat Stress Testing

- Light intensity: 0.5 suns
- Hot plate: 90˚C
- N2 gas flow into & out of box
- Total stressing time: 10 hours

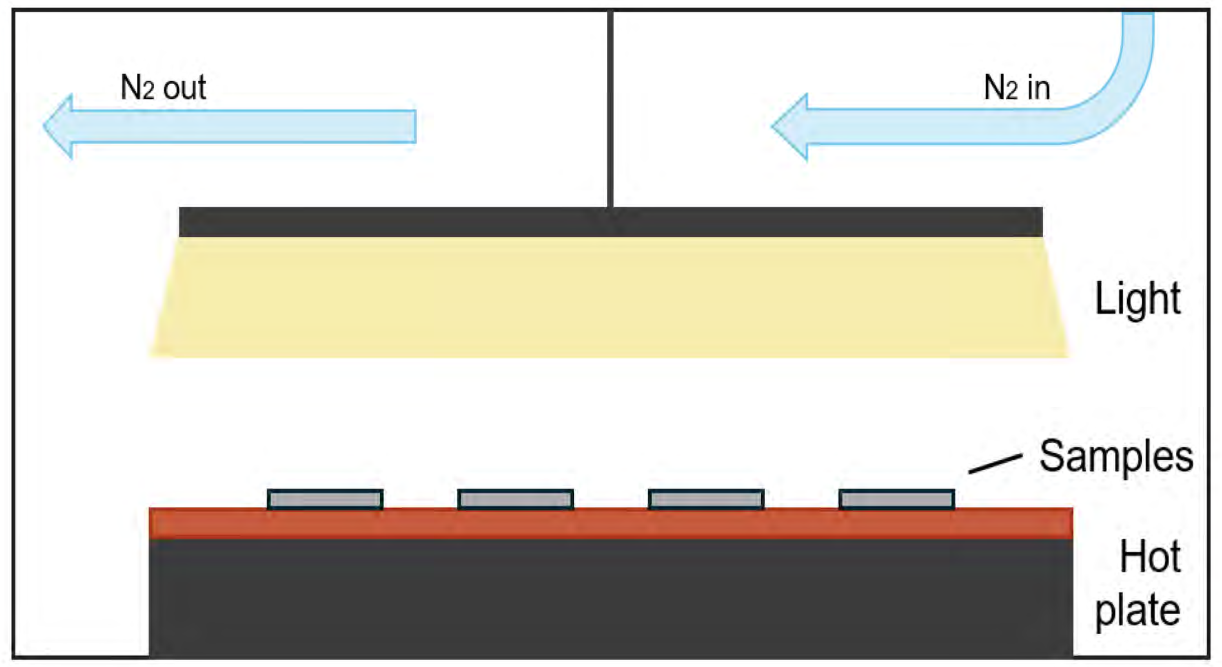

Fig. 3: Illustration of the combined light and heat stress testing setup.

Research Question

How do perovskites behave differently under stress when they are coated on shape-memory alloys rather than glass substrates?

Results | Emission Spectra and Bandgap

Photoluminescence spectroscopy (PL) measured the emission spectra for samples at each hour of stress testing. The variance noted in the SMA samples indicates a dynamic system in the PVSK.

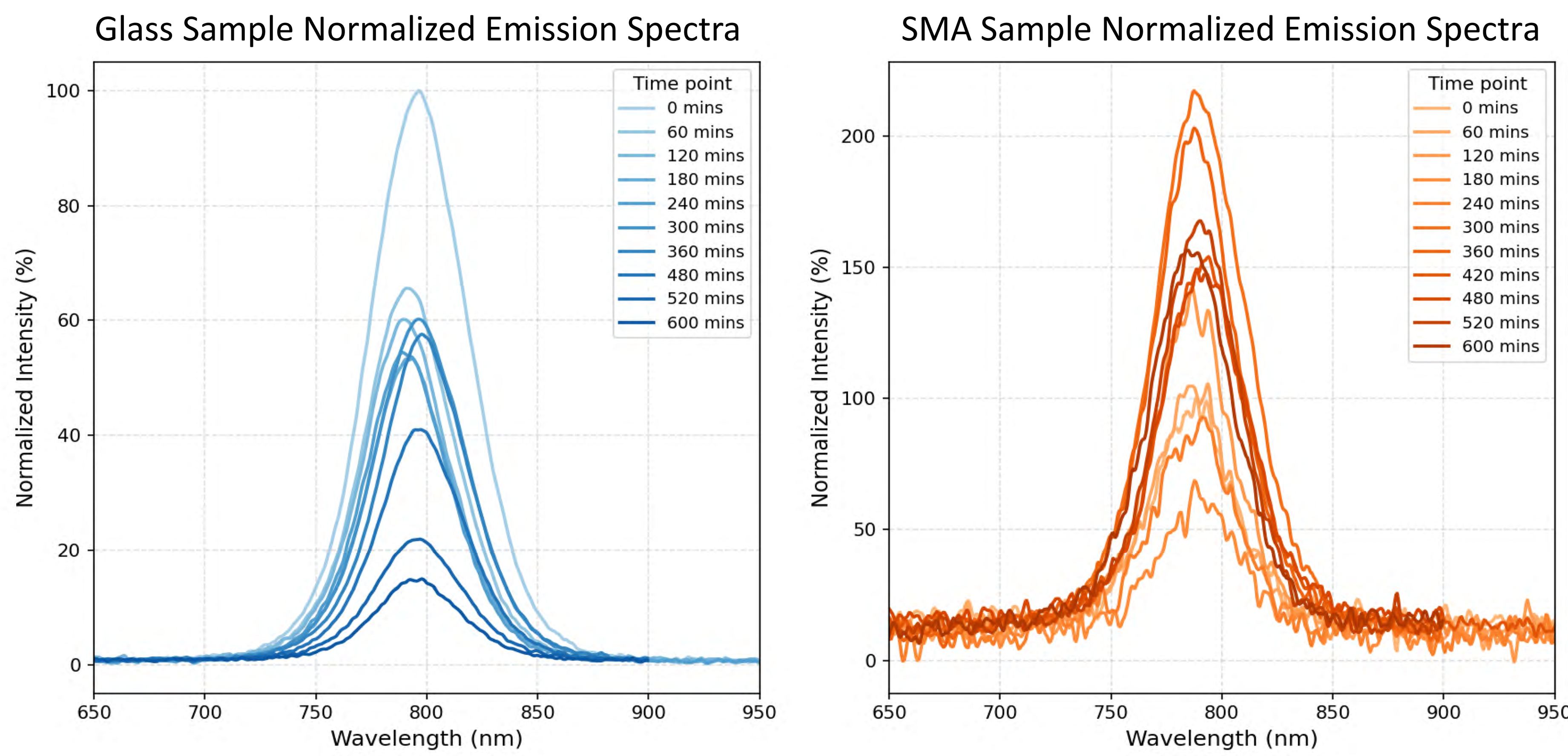

Fig. 4a & 4b: Normalized PL emission spectra of PVSK samples on glass (left) and SMA (right). Note the y-axis difference for SMA.

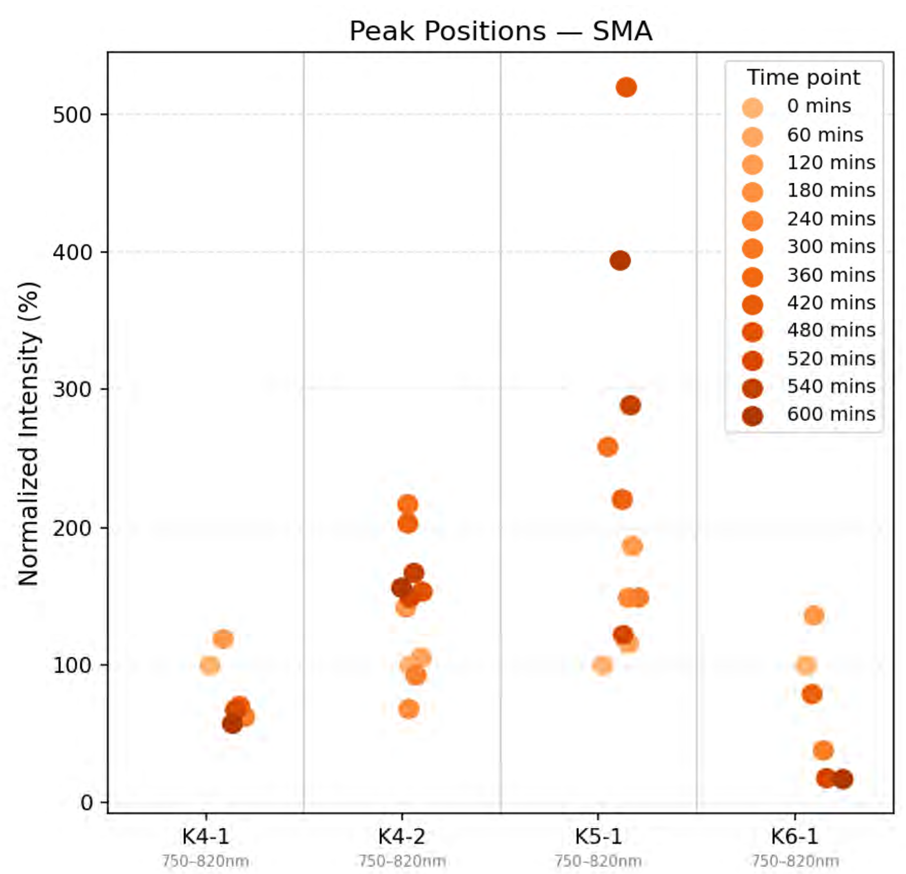

Fig. 5: Graph of only peak positions of the normalized SMA PVSK emission spectra. Vertical alignment indicates no bandgap shifts.

Bandgap Shifting is indicative of permanent changes in the thin film.

Substrate	Avg. Wavelength	Avg. Bandgap
Glass	784 – 792 nm	1.57-1.58 eV
SMA	786 – 801 nm	1.55-1.58 eV

Little to no bandgap shifting indicates **good stability in both substrate types.**

Results | Scanning Electron Microscopy (SEM)

SEM imaging before and after stress shows how the crystal structure changed on each substrate type.

- Starburst pattern on each substrate indicates correct structure
- Post-stress, glass showed much more dendrite formation (indicated by light dots across the structure.)

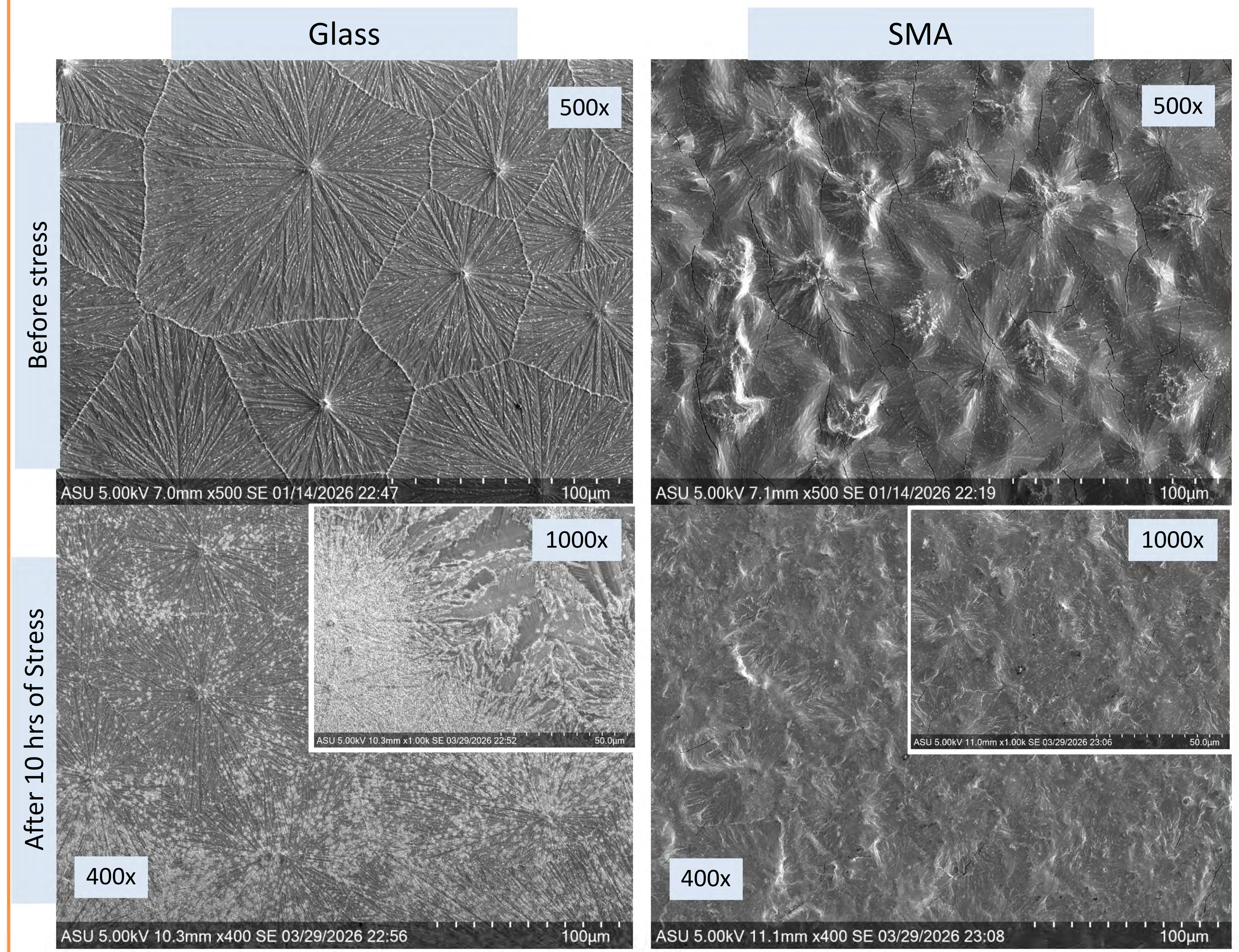

Fig. 6: SMA images of glass (left) and SMA (right) samples before and after 10 hours of light/heat stress.

Conclusions and Future Work

- PVSKs on SMA have a more chemically dynamic system as compared to their glass counterparts
- SMA PVSKs are strong contenders for flexible, lightweight, and durable power systems
- Further research will investigate encapsulation and devices.

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References
Figure 1: Fabrication of β-Cyclodextrin-Assisted Tungsten Trioxide Nanosheets and Their Remarkable Adsorption, Photocatalytic Performance, and Biomedical Properties. Journal of Cluster Science. 10.1007/s10876-024-02647-4.
Figure 2: Expertise. https://khanjur.com/services/ (accessed 2025-04-02).

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