A Multi-Pronged Approach to Understanding Environmental Stability Challenges in Perovskite Photovoltaics

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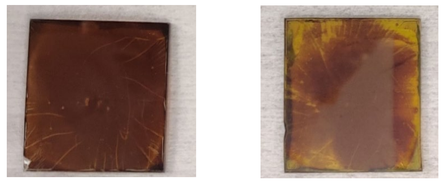
Objective & Research question

This project aims to Identify perovskite solar cells' efficiency and stability by exploring chemical compositions and processing. It addresses ion migration, moisture sensitivity, and examines the effects of UV radiation and vacuum. The goal is to develop a metric for tolerance based on efficiency retention after exposure.

Background

Perovskite photovoltaics are more cost-effective, lightweight, and flexible than silicon cells but suffer from rapid degradation and shorter lifespans. My research aims to improve their efficiency and stability by exploring chemical compositions, processing, and the effects of UV radiation and vacuum. In low Earth orbit, satellites are exposed to UV radiation within the 200-400 nm range, with intensities up to 13 times ground-level sunlight due to reduced atmospheric shielding. The goal is to develop strategies to enhance durability and establish a tolerance metric based on efficiency retention

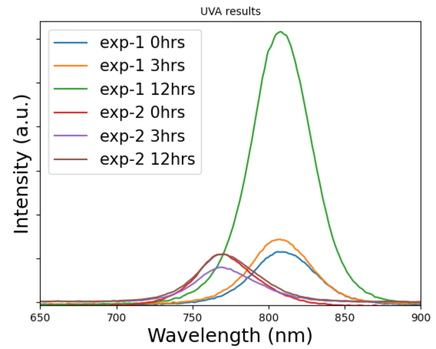


(a) (b)

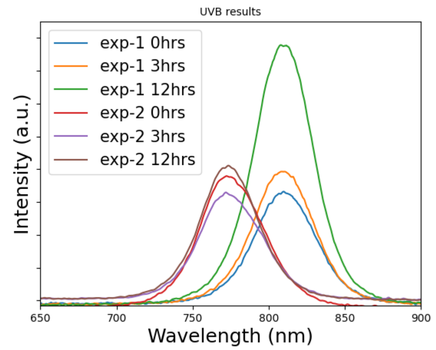
(c)

Fig-2: Experiment-2 samples of methylammonium-lead-iodide
a) UVA, b) UVB, c) UVC

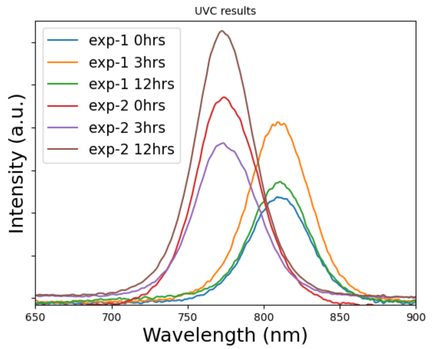
Results



Graph-1:UVA exp-1 & exp-2 results



Graph-2: UVB exp-1 & exp-2 results



Graph-3: UVC exp-1 & exp-2 results

Experiment-1 (ex-1) : Samples were of Cesium Formamidinium Lead Iodide
Experiment-2 (ex-2) : Samples were of methylammonium-lead-iodide

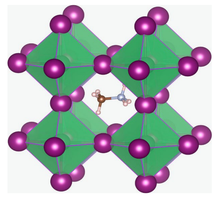
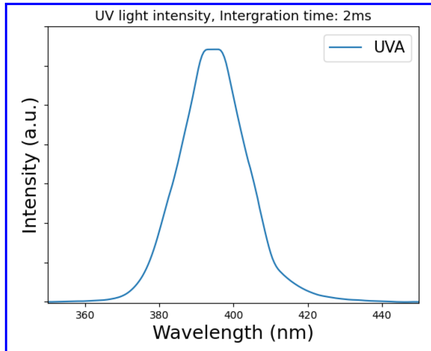
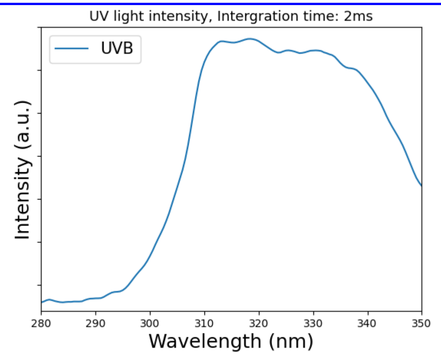


Fig-1: Methylammonium-lead-iodide structure

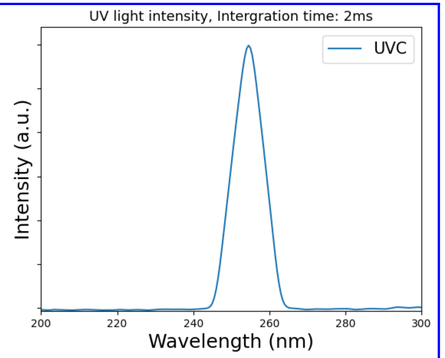
Additional experiments include samples coated with a PMMA layer, which serves as a protective barrier and significantly slows the degradation of the perovskite material. Recent findings indicate that PMMA coating can substantially reduce visible damage to perovskite, allowing it to remain effective for extended durations.



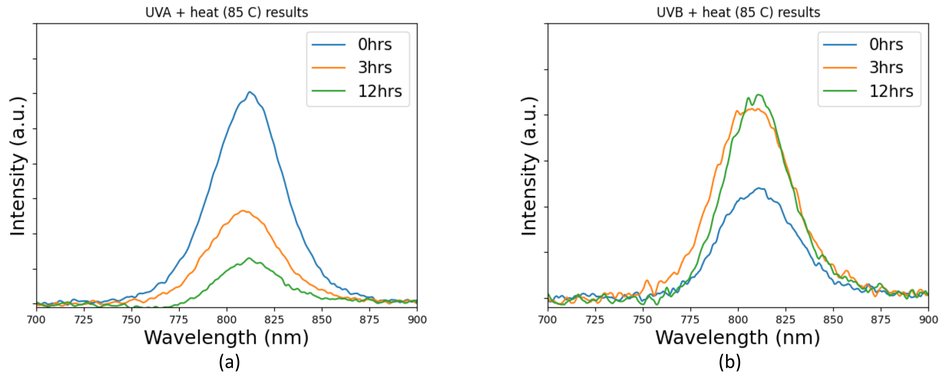
Graph-4: UVA intensity



Graph-5: UVB intensity



Graph-6: UVC intensity



Graph-7: Cesium Formamidinium Lead Iodide samples exposed to UV radiation at a constant temperature of 85°C.
a) UVA
b) UVB

Methods & Instruments

- Photoluminescence (PL) spectroscopy
  - Used to determine the band gap of a material by analyzing the light emitted from the material when it is excited by a light source
- Olympus Microsocpe
- UV lamps emitting specific wavelength of UV light.
- Hot plate- further simulating the space environment

Future Work

- Conduct additional experiments to validate the current findings.
- Investigate the effects of various perovskite compositions with PMMA coating.
- Analyze the combined influence of UV light and heat conditions.

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