Measuring Mobile Ions from Radiation-Induced Defects in Perovskite Semiconductors

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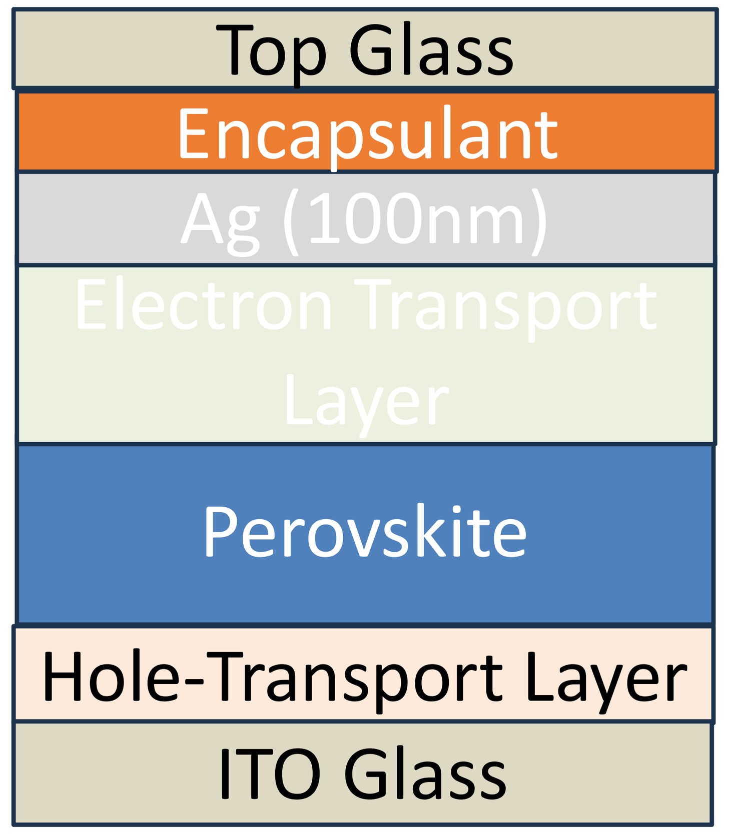
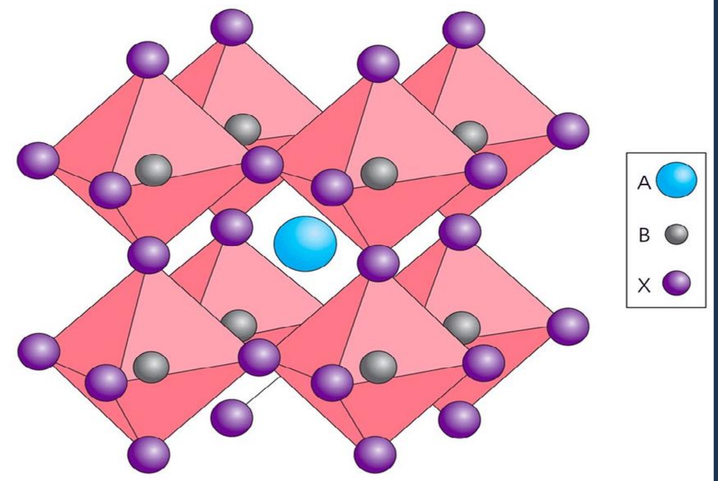
Introduction

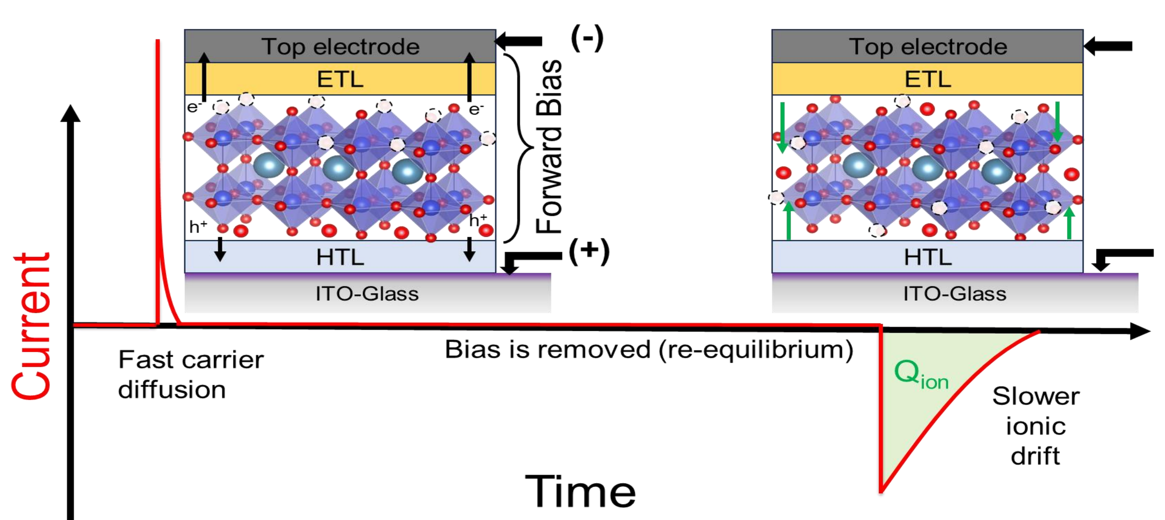
Traditional semiconductors like silicon are vulnerable to radiation-induced defects, limiting their use in radiation-rich environments such as space. Perovskites, a low-cost and versatile semiconductor, offer a promising alternative with potential for radiation-resistant diodes, transistors, and memristors. However, mobile ions in the perovskite lattice can migrate, causing defect formation and self-healing in response to radiation. This research investigates the effects of gamma rays, X-rays, and ultraviolet light exposure on perovskites by measuring ion concentration before and after exposure, using transient dark current measurements. N_0 is calculated based on integrating the transient drift current to get a total charge for mobile ions (Q_{ion}) that is divided by the material volume to determine the N_0 is ions/cm3The findings aim to improve the use of perovskites in radiation-sensitive applications, particularly in space electronics.

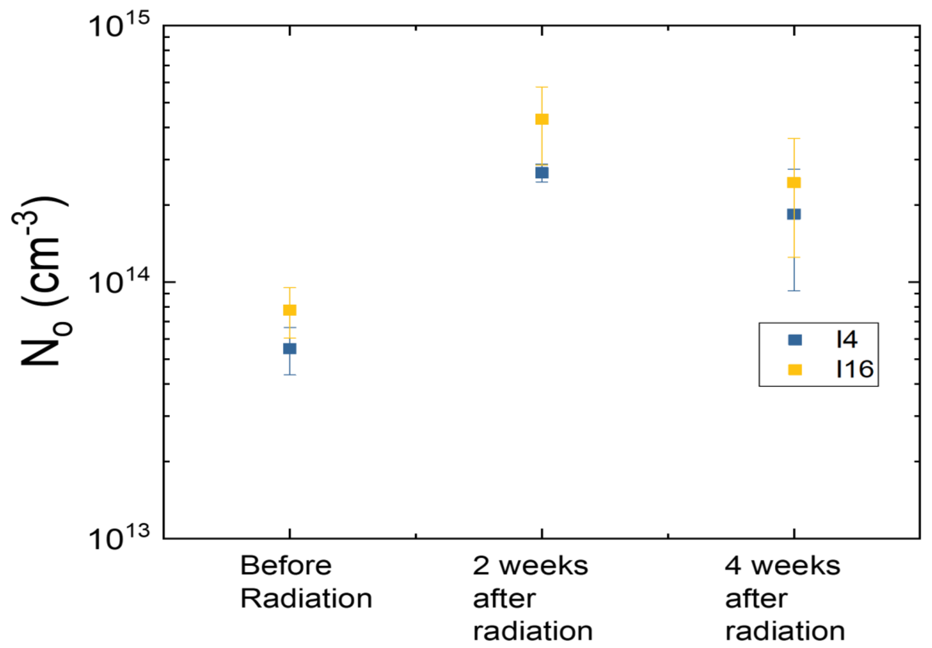




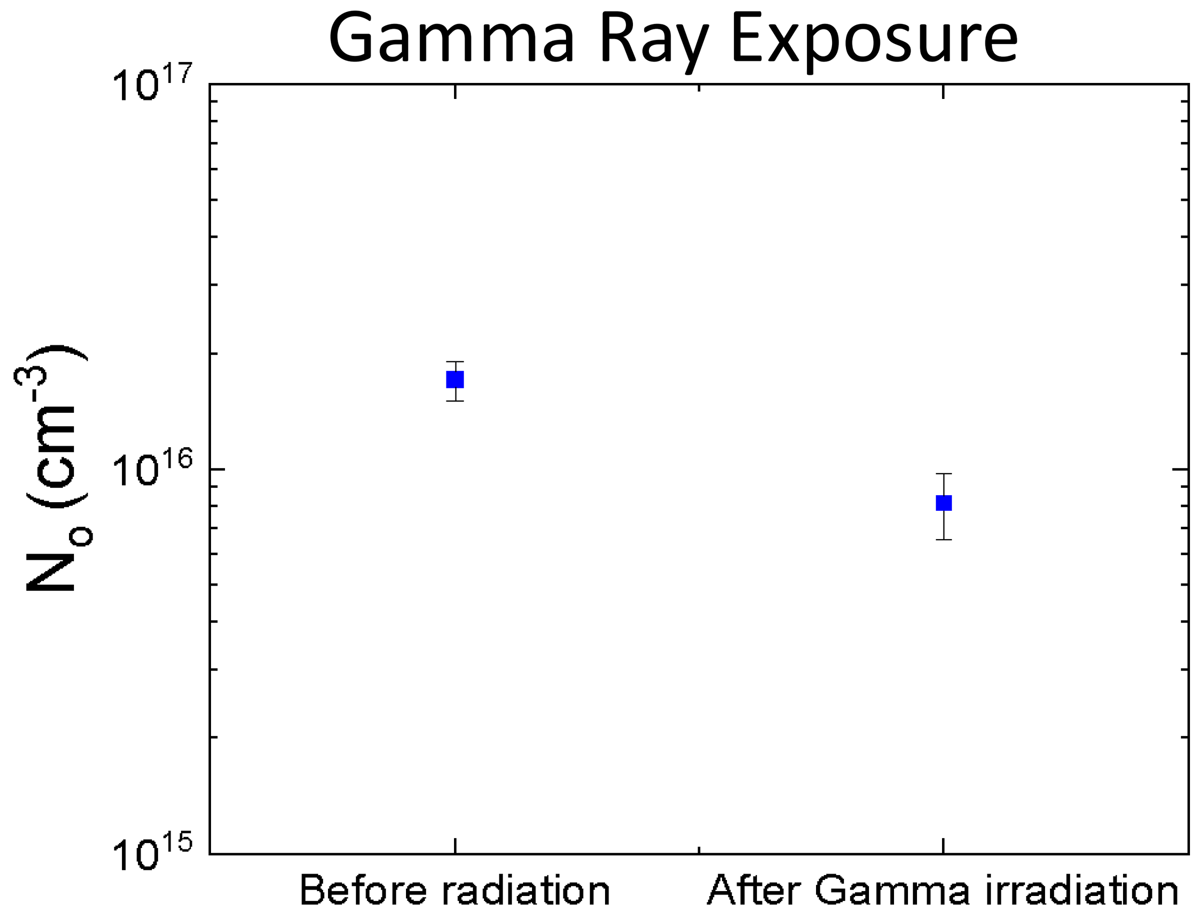
Procedure & Previous Work

- Measured initial performance of perovskite devices using the PAIOS system via transient dark current measurements
- Gamma radiation, X-ray radiation, and UV radiation exposure.
- Re-measured the irradiated devices using the same transient dark current measurements procedure.
- Compared pre- and post-radiation data to analyze the effects of the three types of radiation on ion concentration in perovskite devices.

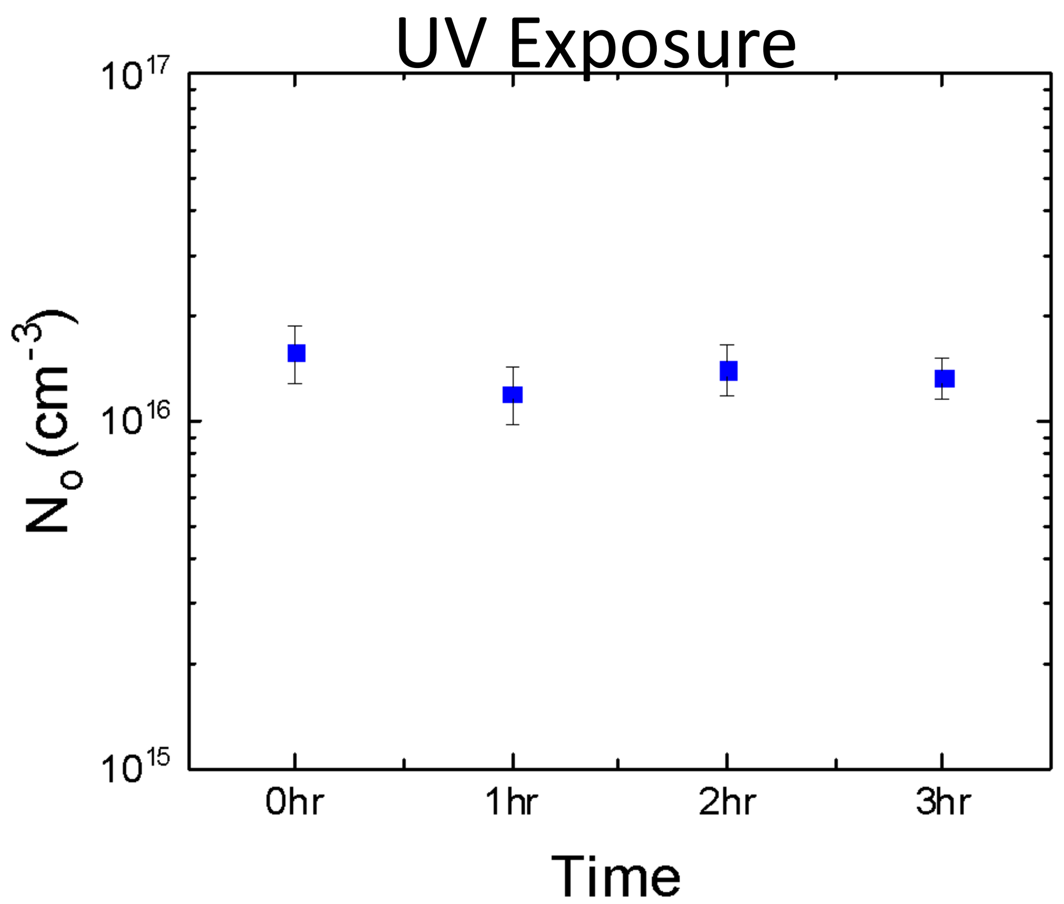




Measurements & Results



After gamma radiation exposure, the ion concentration decreased. This contrasts with the previous results, where they increased after exposure. The concentration was measured 3 days after radiation, so there is a possibility of self-healing. The experiment will be repeated to validate results.



After UV exposure, the ion concentration remained relatively consistent, suggesting that UV exposure does not have a strong effect on the mobile ion concentration of perovskites.

Conclusion & Future work

This research shows that gamma rays, X-rays, and ultraviolet light can impact ionic behavior in perovskite semiconductors, which is important for understanding device reliability in space environments. Current results indicate that gamma exposure led to a decrease in ion concentration. Additional repeated gamma tests are required to confirm whether this trend is consistent. UV exposure produced only subtle changes, suggesting limited influence on mobile ion concentration; however, extended duration and varying UV wavelength testing may be needed to further evaluate potential cumulative effects. X-ray exposure measurements are still being processed and will be analyzed using the same methodology as gamma and UV to allow direct comparison. Overall, repeating each radiation condition under identical parameters will be necessary to verify these preliminary findings and strengthen the radiation response trends observed. Also, additional, longer radiation doses will be tested to see if N_o changes as the device degrades.

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