Thermal Stability Investigation of Triple-cation Perovskite Solar Cells for Low Earth Orbit

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Abstract:

Halide perovskite based photovoltaics are attractive for space applications owing to their excellent power conversion efficiency, radiation tolerance, ease of fabrication and earth abundance of precursor materials [1]. Though most of the studies have been focused on their terrestrial application, recently there has been a surge in the space-grade halide perovskite solar cells (PSCs). In this regard, PSCs have been examined for their performance stability in the harsh environment such as ionizing radiation, atomic oxygen, UV-radiation, extreme vacuum etc [2].

In the present investigation, we have examined the thermal stability of triple-cation perovskite solar cells for the temperature range of -150 to 150 °C for a duration of 90 minutes to mimic the low earth environment. Our study revealed that Triple-cation perovskite solar cells show promising performance stability for this temperature range with maximum performance improvement at 150 °C. A comparative study between fused quartz and soda lime glass substrates for use in the LEO environment is also carried out. We find that, whilst the fused silica substrates initially offered improved performance due to a better morphology in its ITO layer driving a superior perovskite film morphology, the wider coefficient of thermal expansion mismatch of the fused silica-based devices ultimately degrade these devices more severely in LEO conditions, relative to glass-based devices. Device physics analysis and recovery of photovoltaic performance are carried out for thermally cycled devices to understand the differences in carrier dynamics and to correlate with the morphological and interface properties modifications. Our study revealed that thermally induced morphological changes are strongly substrate dependent even for the same perovskite layer composition and greatly influence the operational stability under thermal fluctuations.

Conflicts of Interest

We declare that there is no conflict of interest.

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References

[1] Romano et al. *ACS Energy Lett.* **2022**, *7,* 2490−2514

[1] Tu, Y. et al. *Adv. Mater.33(21),* **2021**, 2006545