# From Lab to Orbit: Ground-Based Validation of Perovskite Solar Cells under Simulated Space Stressors

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## Abstract:

To address the growing need for reliable evaluation of photovoltaic materials in space environments, the Space Environment Simulation and Research Infrastructure (SESRI) provides a state-of-the-art ground-based platform capable of simulating nine critical space factors. Coupled multi-physics experiments are supported to investigate complex environmental interactions that are otherwise unachievable in isolated testing conditions. Based on this platform, preliminary validation studies on the environmental effects of perovskite solar cells (PSCs) have been conducted. By employing a vacuum-interconnected experimental chain—integrating material fabrication, environmental exposure, and microscopic characterization within an ultrahigh vacuum system—we have developed a decoupled analysis method that eliminates atmospheric interference. This closed-loop research paradigm enables accurate identification of intrinsic material responses to space stressors, providing reliable ground-based data for lifetime prediction and space qualification of PSCs.

## Keywords:

Perovskite solar cells, space environment simulation, degradation mechanism, high vacuum-interconnected platform.