Perovskite Photovoltaics: Addressing Stability Challenges for Real-World Applications

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Perovskite photovoltaics (PePVs) represent a rapidly advancing solar technology, having achieved power conversion efficiencies (PCEs) exceeding 26%, now competitive with traditional silicon solar cells. Their versatility makes them suitable for a broad range of applications, from low-power devices to large-scale solar farms. However, a critical hurdle to their widespread adoption remains: maintaining high efficiency and long-term stability in large-area panels under real-world environmental conditions.

PePVs exhibit sensitivity to ambient factors such as humidity, elevated temperatures, and prolonged light exposure, which significantly impact their long-term performance. Experimental observations reveal substantial degradation during summer months, primarily attributed to extended exposure to high temperatures and intense solar irradiance, often leading to lamination instability. Interestingly, this degradation demonstrates partial reversibility upon dark storage, with observed changes in the light soaking phenomenon (LSP) and improvements in electrical parameters [1]. The recovery duration is directly linked to the severity of prior degradation, with initial recovery occurring within daily dark cycles, but requiring more extended periods as degradation progresses.

This presentation will provide an in-depth exploration of the long-term performance of perovskite modules and panels deployed in outdoor environments. A key focus will be elucidating the origins of various degradation factors, distinguishing between intrinsic issues within the perovskite active layer and extrinsic challenges like lamination failure [2]. We will detail the measurement protocols employed to investigate the effects of dark storage and light soaking on panel performance and their subsequent partial recovery. Furthermore, the presentation will address the critical impact of voltage mismatch on the degradation rate of PePVs, identifying optimal connection configurations to ensure efficient long-term operation and successful upscaling. The pivotal role of lamination in preventing the ingress of external factors such as moisture and oxygen, thereby enhancing stability, will also be discussed. Continued research into the outdoor ageing process is essential to differentiate various recovery scenarios and ultimately guarantee long-term stability.

In summary, this presentation will offer comprehensive insights into the significant advancements and persistent challenges in the commercialization of perovskite photovoltaics. It will underscore the imperative for sustainable production, enhanced reliability, and robust recycling and remanufacturing strategies to firmly establish PePVs as a leading sustainable energy source in the global market.

REFERENCES

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