Degradation of Printed Organic Solar Cells During Thermal Cycling

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Abstract:

Organic solar cells (OSCs) have attracted significant attention in recent years due to their rapid efficiency gains, low toxicity, short energy payback times, and potential for low-cost, solution-based fabrication. Their high optical absorption, lightweight and flexible design, and compatibility with upscalable techniques such as slot-die printing make them promising candidates for a future generation of solar cells, especially in the scope of space operations. Compared to conventionally used multi-junction inorganic solar cells, OSCs offer a superior power-to-weight ratio, which can reduce both manufacturing and launch costs. Short-duration space missions have already demonstrated the viability of OSCs [1]. However, the harsh conditions in space, including extreme temperatures, high vacuum, and ionizing radiation, pose significant challenges to long-term stability.

Thus, in this study, we investigate the impact of extreme temperature variation (-100 °C up to 120 °C) on slot-die printed OSCs. To simulate space-like conditions, we perform measurements in a vacuum while simultaneously monitoring device performance and thin-film morphology using operando grazing incidence small-angle X-ray scattering (GISAXS). Synchrotron-based GISAXS is nondestructive and offers a large probing area and high beam intensity compared to other scattering techniques, providing the time resolution required for this type of research. This approach enables real-time correlation between structural changes and electrical behavior under thermal stress. Insights gained from this work aim to improve the thermal stability, durability, and scalability of OSCs, advancing their viability for long-term space deployment.

Conflicts of Interest

The authors declare no conflict of interest.

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