Halide Perovskite Solar Cells: Operating Stability and Luminescence Imaging Characterisation

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Perovskite solar cells (PSCs) have emerged as a highly promising photovoltaic technology owing to their rapidly increasing power conversion efficiencies and potential for low-cost fabrication. Despite these advantages, their commercialization is severely constrained by limited long-term stability. PSCs are particularly vulnerable to environmental stressors such as humidity, thermal fluctuations, and continuous illumination, which can induce performance degradation over timescales ranging from hours to months, depending on material composition, device architecture, encapsulation strategies, and operational conditions [1]. Identifying the origins and evolution of these degradation processes is therefore critical for improving device reliability.

In response to these challenges, the solar cell research community has increasingly turned to optical imaging techniques, particularly luminescence-based methods, for materials and device characterization [2]. Methods such as photoluminescence (PL) and electroluminescence (EL) imaging provide non-destructive, spatially resolved insights into key optoelectronic properties, including bandgap variations, charge-carrier recombination dynamics, and defect distributions. Importantly, PL imaging can be applied throughout the entire device lifecycle, enabling in-situ monitoring during film formation as well as operando analysis under realistic operating conditions. By using these advanced characterization tools, researchers can gain deeper insights into charge transport mechanisms and degradation processes, facilitating the development of more stable and efficient PSCs.

References

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