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Characterization & Reliability Challenges of New Generation Solar PV Modules

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Abstract

The rapid emergence of high-efficiency Photovoltaic (PV) technologies - such as perovskites, tandem architectures, TOPCon, HJT, and large-format modules - poses new challenges for accurate characterization and long-term reliability assessment. While these devices promise unprecedented performance gains, their unconventional materials, optical properties, and degradation pathways require significant updates to existing measurement standards and testing infrastructures. This talk presents the key technical hurdles encountered in electrical, and optical characterization of next-generation PV modules, including spectrum-dependent measurements, instability under illumination, temperature-sensitive performance, and the need for advanced solar simulators capable of reproducing complex spectral profiles.

Reliability challenges such as moisture sensitivity, ion migration, encapsulant compatibility, and emerging failure modes in larger and thinner module formats are examined in the context of harsh climates, including desert conditions. Finally, the presentation outlines ongoing efforts in international standardization, accelerated testing development, and advanced diagnostics that aim to ensure bankability and field durability of future PV technologies. The goal is to provide a clear roadmap connecting laboratory characterization, reliability science, and global deployment of next-generation solar modules