Study of Reverse Bias Degradation in Perovskite Solar Cells and Modules

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Abstract

Perovskite solar cells have witnessed remarkable efficiency gains over the last decade, now matching crystalline silicon at 26.1%. However, their scalability is hindered by stability concerns, notably their susceptibility to prolonged stress, particularly reverse bias voltages. Reverse bias or negative voltages can build up over cells interconnected in series due to a difference in photocurrent generation in the cells. The difference in photocurrent can be caused due to defects in the cells, or more commonly to a difference in illumination on the cells caused by partial shading. Shading can occur due to nearby buildings, trees, and other objects that can block a part of the incoming sunlight. In this study, the effects of reverse bias voltages in cells and modules interconnected in series are investigated. The cells in the module are interconnected in series with laser scribing technique using P1, P2, and P3 scribe. The aim is to understand the effects of the scribe on the reverse bias degradation of the modules. The scribing introduces new factors into the samples, such as defects near the scribing area, and it could be a starter point for degradation. Similar tests with other thin film technologies, like CIGS, reveal that degradation is initiated from the scribes, and our preliminary tests reveal a similar phenomenon with perovskites. Perovskites are known to have low reverse breakdown voltages, but the degradation can initiate at voltages lower than the breakdown voltage. Reverse bias stresses are applied on the modules mainly in two ways, altering scan speeds in a reverse scan and at constant reverse bias voltages. For further analysis, some visual characterization techniques, like electroluminescence and thermal imaging techniques, are utilized to understand the degradation phenomenon in the samples. Electroluminescence would provide insights about the deterioration of the cells, and hotspot creation can be studied with infra-red imaging.

Keywords

Perovskites, Reverse-bias, Reliability, Degradation, Shading, Modules, Up-scaling