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Perovskite mini modules: over 30 years of lifetime projected via thermal stress testing

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April 24, 2024

Abstract

The stability of methylammonium lead iodide ($MAPbI_3$)-based flexible perovskite (PVK) mini modules was studied under thermal stress. For this purpose, PVK mini modules, consisting of 10 serially connected cells with an aperture area of 9 cm^2, were subjected to elevated temperatures of 85, 95, and 105 for 4000 h. The photovoltaic (PV) parameters of PVK mini modules were periodically measured by interrupting the thermal stress tests. Evolution of series resistance, short circuit current, and fill factor showed monotonic reduction, whereas shunt resistance and open circuit voltage depicted three stage degradation: (i) initial rapid degradation; (ii) quasi stable range; and (iii) gradual monotonic degradation stages, which are the indication for the presence of several degradation mechanisms. Using the experimental data, activation energy (E_a) of degradation was studied by adopting the Arrhenius model. E_a of 1.062 eV (102.5 kJ/mol) was obtained for the maximum output of the total device. Device lifetime, which is defined as the point where the efficiency has reduced to 80% of its initial value, 30.6 years was estimated, i.e., performance loss of around 0.65% per year, at module temperature of 45.

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