Fracture Mechanics-Based Simulation of PV Module Delamination

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ABSTRACT

Photovoltaic (PV) cells are rapidly growing as a renewable alternative to fossil fuels like coal, oil, and natural gas. However, greater adoption has also reduced government subsidies, placing the onus of making solar panels economically competitive on innovative research. While multiple methods have been considered for reducing costs, with each reduction in cost comes the associated peril of reduction in quality and useful lifetime. Several problems considered solved have now resurfaced as potential failure mechanisms with the introduction of cheaper PV cell technologies. However, to remain economically viable, PV modules will not only have to become cheaper, they will have to maintain 25-year lifetimes. To help predict the impact of design changes on PV module lifetimes, we designed a software tool that models the growth of delamination, one of the most common pathways to failure within a PV module. We use a simplified model of a PV cell, examining the stress and strain distributions in a vertical slice of a representative cell, and have based our code on pre-existing fracture mechanics software that simulates crack propagation in plane stress or plane strain using the finite volume method (FVM). This simplification of a real PV cell is expected to allow researchers to identify effective material candidates more quickly and cheaply.

KEYWORDS

PV Modules, Delamination, Solar Cell Lifetime, Fracture Mechanics, Phase Field