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ASSESSMENT OF THERMO-MECHANICAL FAILURES OF PHOTOVOLTAIC MODULE COMPONENTS FOR IMPROVED RELIABILITY

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ABSTRACT

Although the production and utilization of photovoltaic (PV) modules continue to grow monotonically, the long-term reliability of these modules still remains a concern due to untimely failure. The breakdown of the module is induced by thermo-mechanical fatigue loading caused by temperature cycling as well as transients associated with passing clouds. This paper evaluates the failure mechanism of PV module assembly in operation with a particular focus on the assessment of the mechanics of failure of its integral components. It discusses the failure mode of solar cell interconnections, packaging materials and other components with a view to presenting ways of improving the assembly thermo-mechanical reliability. Based on the evaluation of thermal cycling tests and field failures of some modules, this study found that solder joint failure is the most critical. Further analysis of the structure of PV solder joints reveals that the growth of the intermetallic compound (IMC) in the solder joint during the operation of the PV module contributes significantly to the failure of the module. Therefore an in-depth understanding of the formation of IMC in solder joint is necessary. Also, the inclusion of IMC in the model employed to simulate and analyze the module failure mode offers potential to providing vital information which when utilized can result in the manufacture of systems with increased thermo-mechanical reliability and mean-time-to-failure (MTTF).

KEYWORDS: *Crystalline Silicon Solar Cells; PV Modules; Reliability; Thermo-Mechanical Failures*

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