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EFFECT OF INTERMETALLIC COMPOUNDS ON THERMO-MECHANICAL RELIABILITY OF LEAD-FREE SOLDER JOINTS IN SOLAR CELL ASSEMBLY

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ABSTRACT

The solder joints in crystalline silicon solar cell assembly undergo thermo-mechanical degradation during the device lifetime. The degradation is accelerated by the formation and growth of intermetallic compound, IMC, in a solder joint which contains copper and tin as alloying elements of the solder. This investigation quantifies the contribution of the presence of IMC in the joints on the reliability of the assembly. The study employs finite element modelling (FEM) to simulate the nonlinear deformation of SnAgCu solder joints in two models of crystalline silicon solar cell assembly. One of the models contains IMC in the interface joints between solder and copper ribbon while the other, which is the control, does not contain IMC in the joints. The degradation of the solder material is simulated using Garofalo-Arrhenius creep model. The geometric models were subjected to accelerated thermal cycling utilising IEC 61215 standard for photovoltaic panels. Analysis of the results of the creep strain profiles of the two models indicate that the deformation amplitude in the solder joint containing IMC is higher than that in the solder joint containing solder only. Similarly, it can be observed from the plot of strain energy density against load step that the solder joint containing solder+IMC have considerable higher strain energy density compared to solder only joint. This infers that the presence of IMC significantly impacts the thermo-mechanical reliability of the assembly joints. The results also demonstrate that IMC decreases the mean-time-to failure (MTTF) of the assembly joints.

KEYWORDS: Crystalline Silicon Solar Cells, Solder Joints, Reliability, Intermetallic Compound, Fatigue Failures