Climate Specific Thermomechanical Fatigue of PV Module Solder Bonds

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Scientific Achievement:

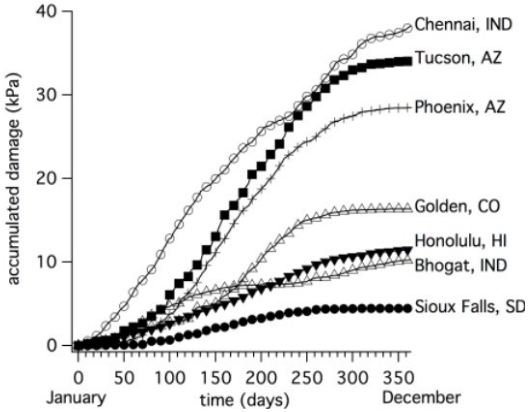
We found that the rate of solder thermomechanical fatigue damage varied significantly depending on deployment location. We also determined the number of accelerated thermal cycles to impart an equivalent amount of damage.

Significance and Impact:

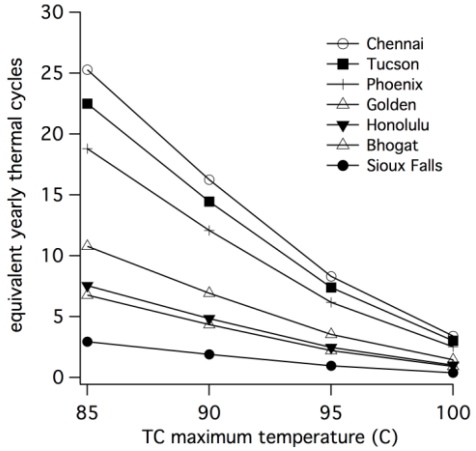
This work elucidates how deployment location can affect the rate of solder bond damage, and it provides a simple tool to calculate the rate of damage based on three simple, meteorological factors.

Research Details:

- FEM simulations of PbSn solder thermomechanical fatigue (TMF) damage where used to evaluate seven cities that represent a variety of climatic zones.
- The rate of TMF damage was shown to not rank with climatic zone, but depends on three meteorological factors.
- A physics-based empirical equation was developed that accurately calculates solder TMF according to these three factors.
- Equivalency between years in service and accelerated thermal cycling was determined and shown to vary between 630 and 100 cycles for one-year exposure for the cities investigated.



Solder damage over the course of one year's service in the seven cities examined in this study.



Number of standard thermal cycles to cause damage equivalent to one year in the field, vs. the thermal cycle maximum temperature.

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