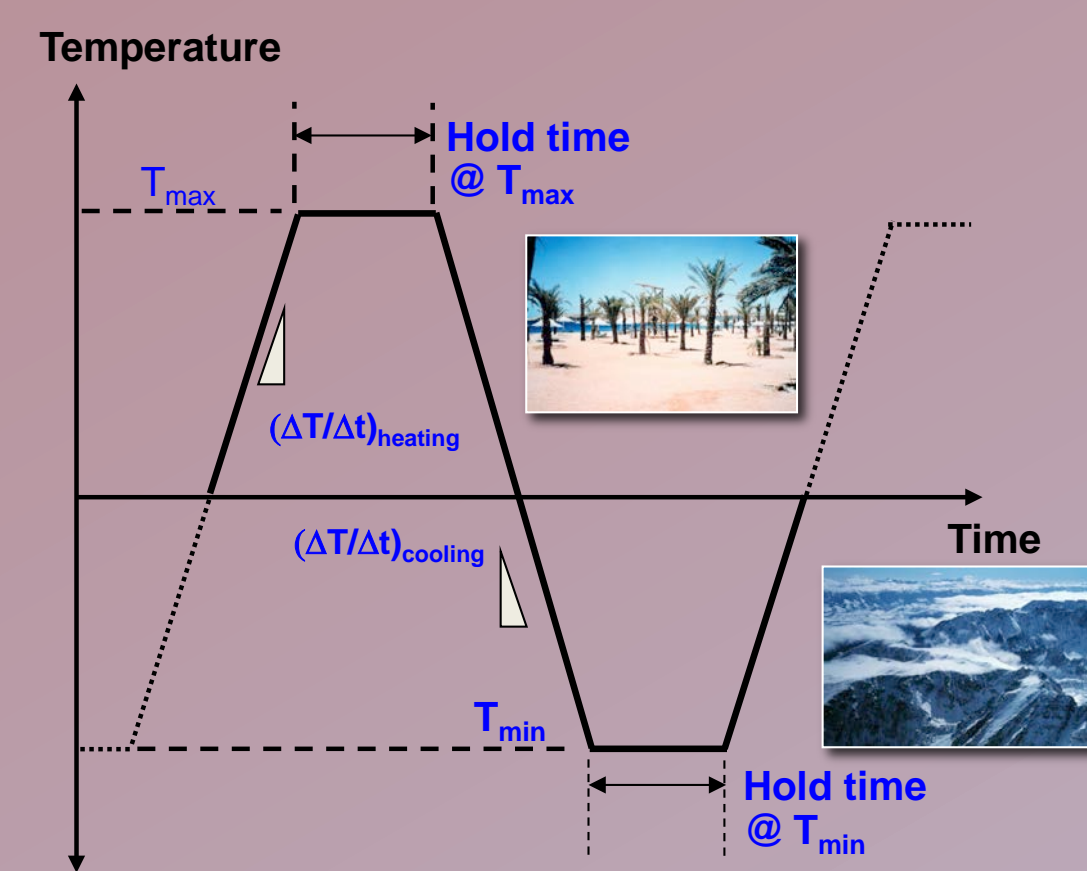


Use of the TurboSiP[®] Software to Predict the Long-Term Reliability of Solder Joints on Photovoltaic Systems

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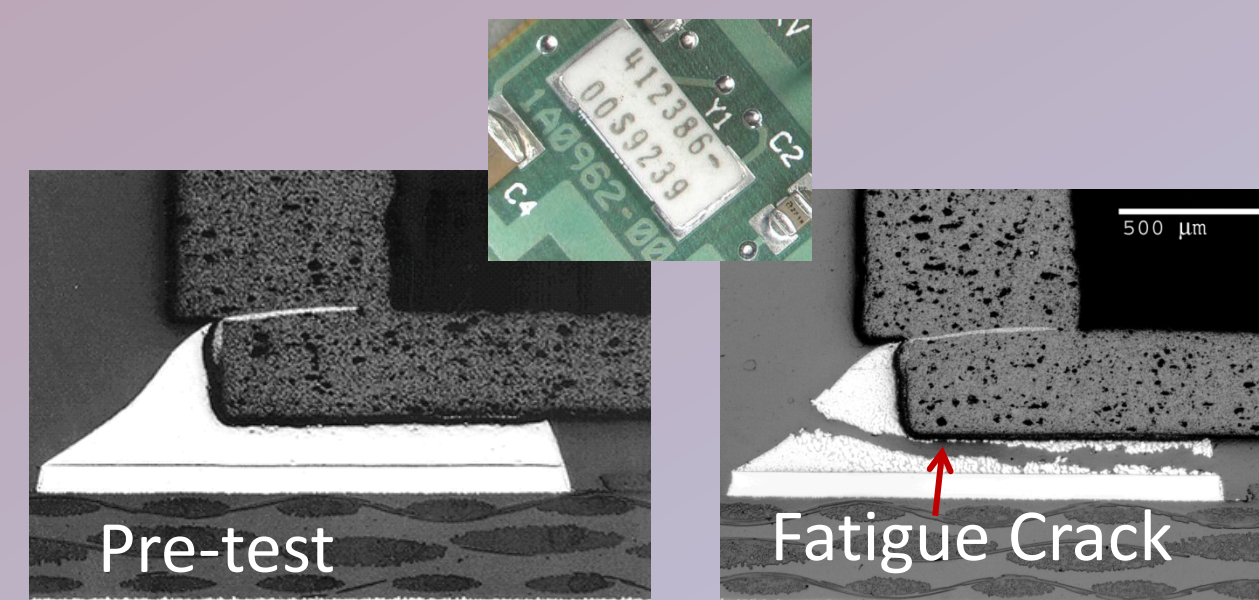
ABSTRACT

The TurboSiP[®] software predicts the thermal mechanical fatigue (TMF) of commonly used solder joints. The input parameters are package materials, interconnection design, solder alloy (Sn-Pb or Pb-free), and the environment. This computational tool was used to predict the TMF lifetimes of (a) collector circuit solder joints used in photovoltaic solar panel systems as well as (b) 1206 chip capacitor and (c) 14 I/O SOIC package solder joints on the printed circuit boards of the inverter module. All interconnections were analyzed as having the eutectic Sn-Pb solder. A service temperature cycle was defined from data logger parameters. Accelerated aging test conditions were also evaluated in the software. The TurboSiP[®] predicted lifetimes for the collector circuit as well as convention component solder joints that were more-than-adequate to meet the customer's requirements.



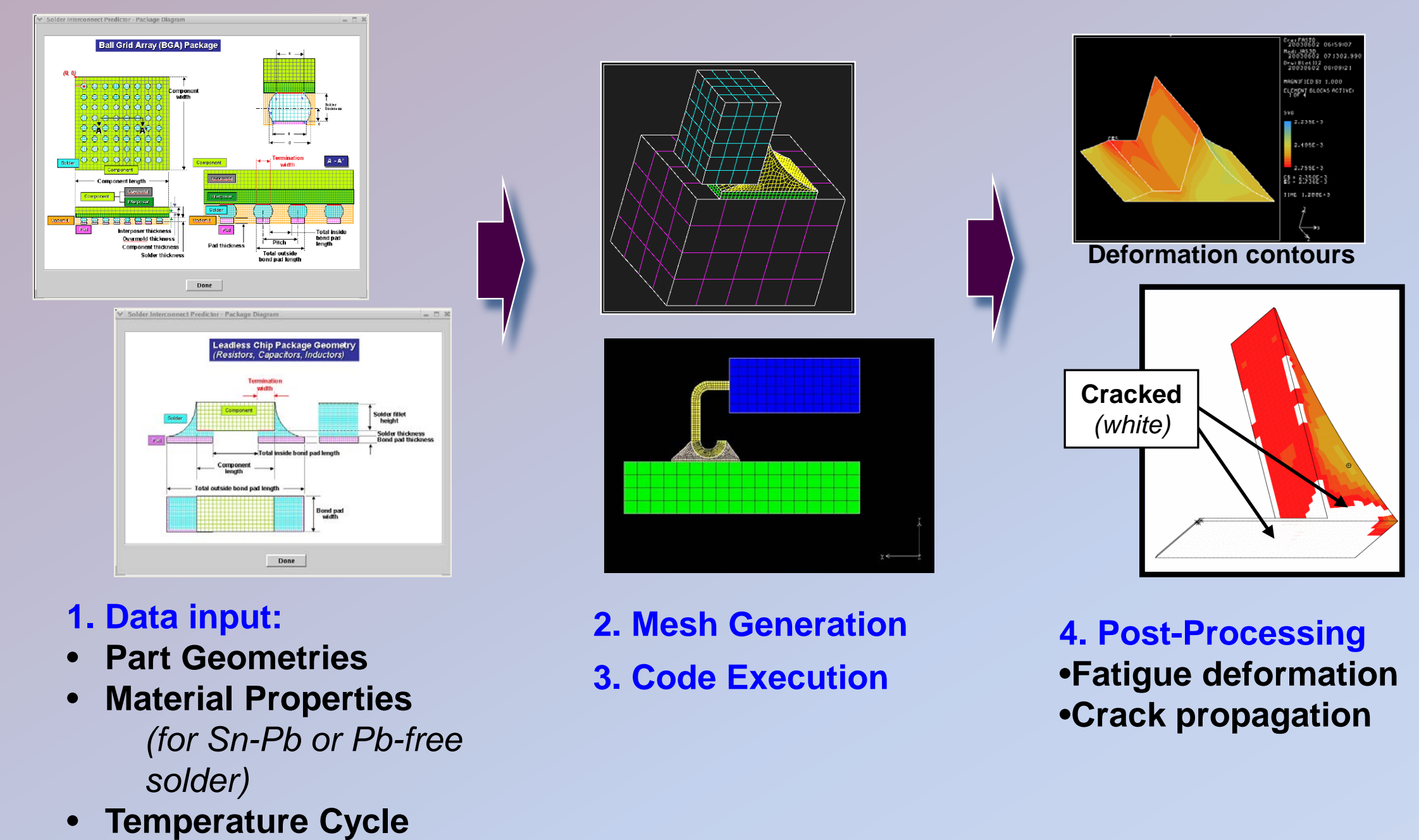
Temperature cycles are used to represent outdoor environments

Thermo-mechanical fatigue of solder joints is observed during thermal cycling.



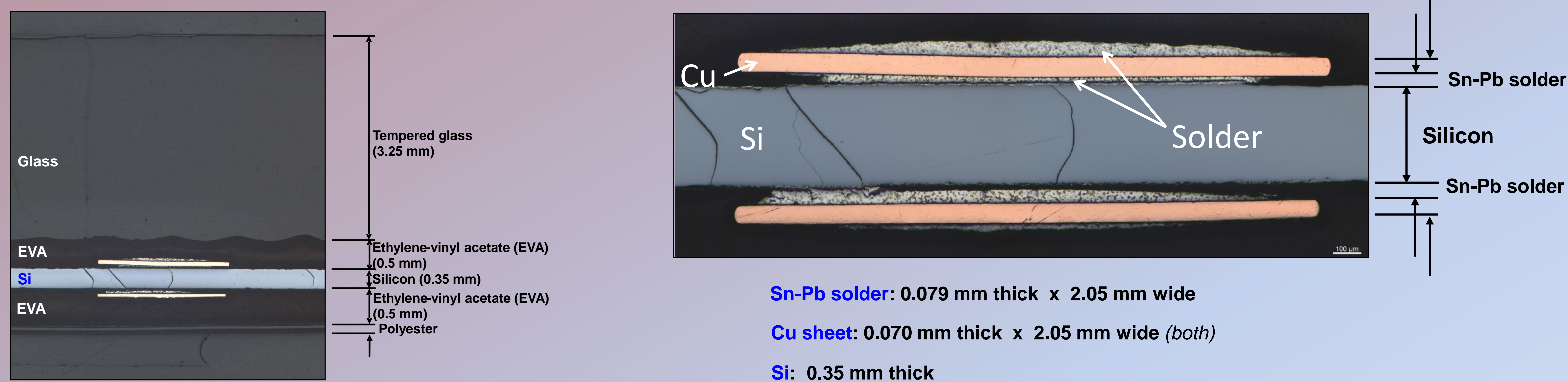
1000 cycles -55C to 125C

TurboSiP is used to calculate component response to thermal cycling stress

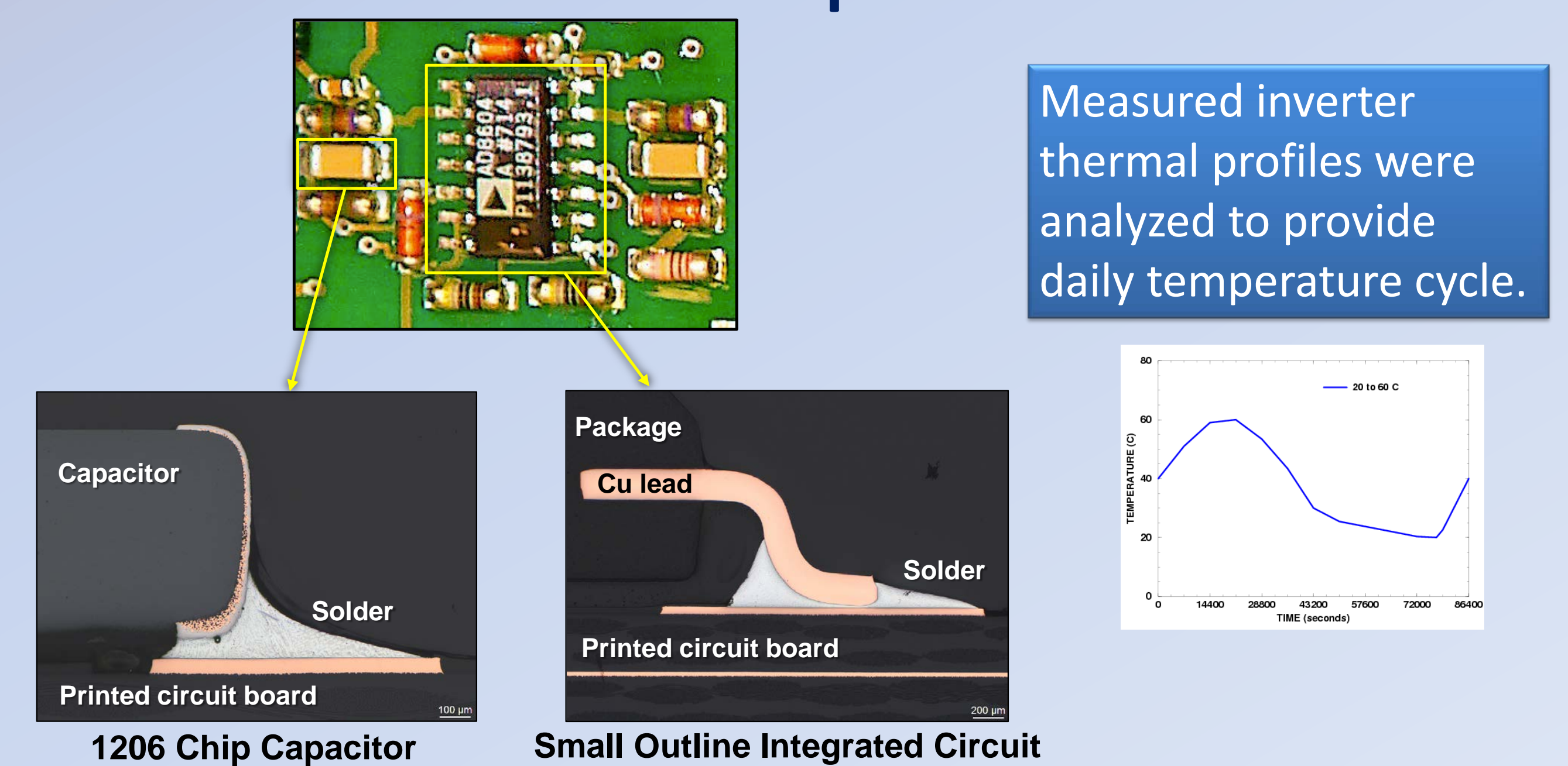


Analysis

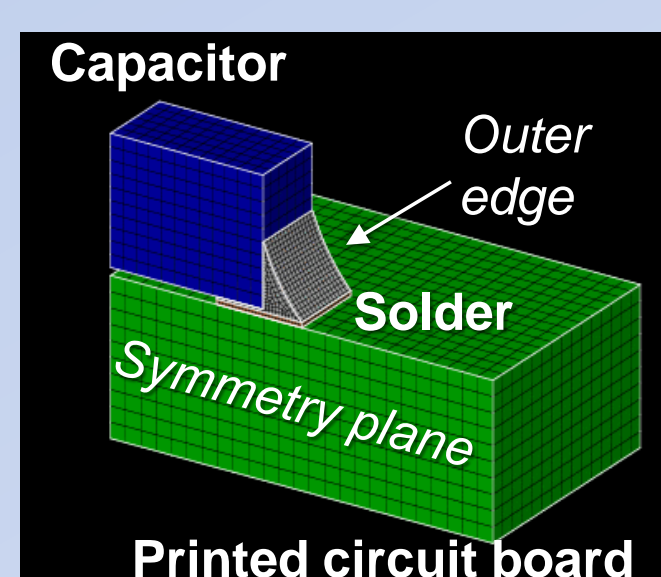
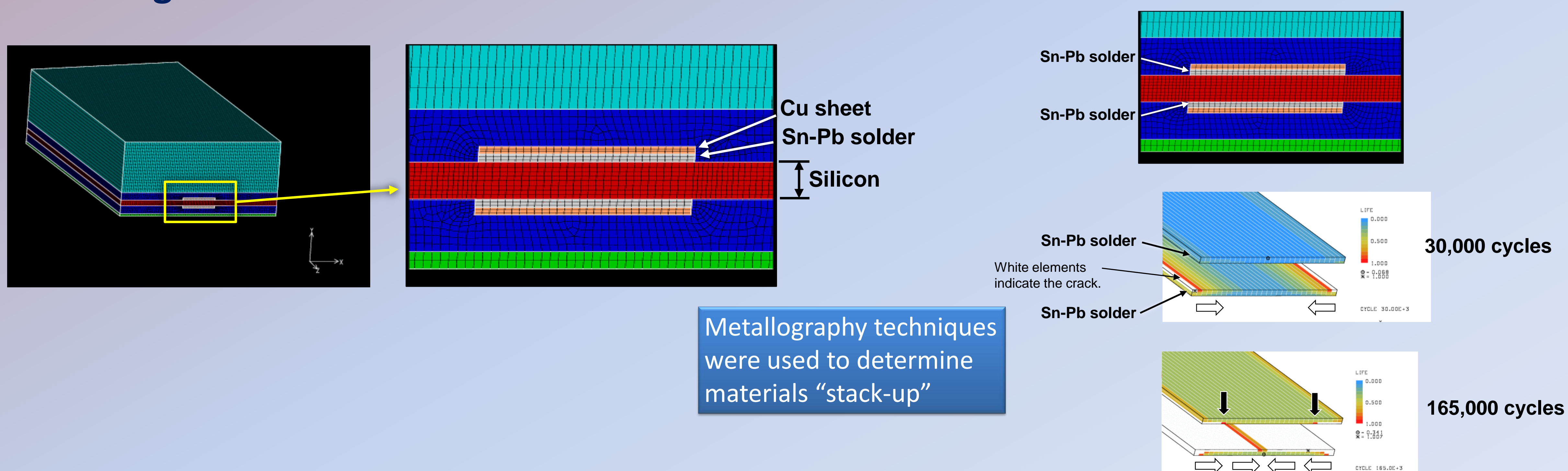
Module Current Trace



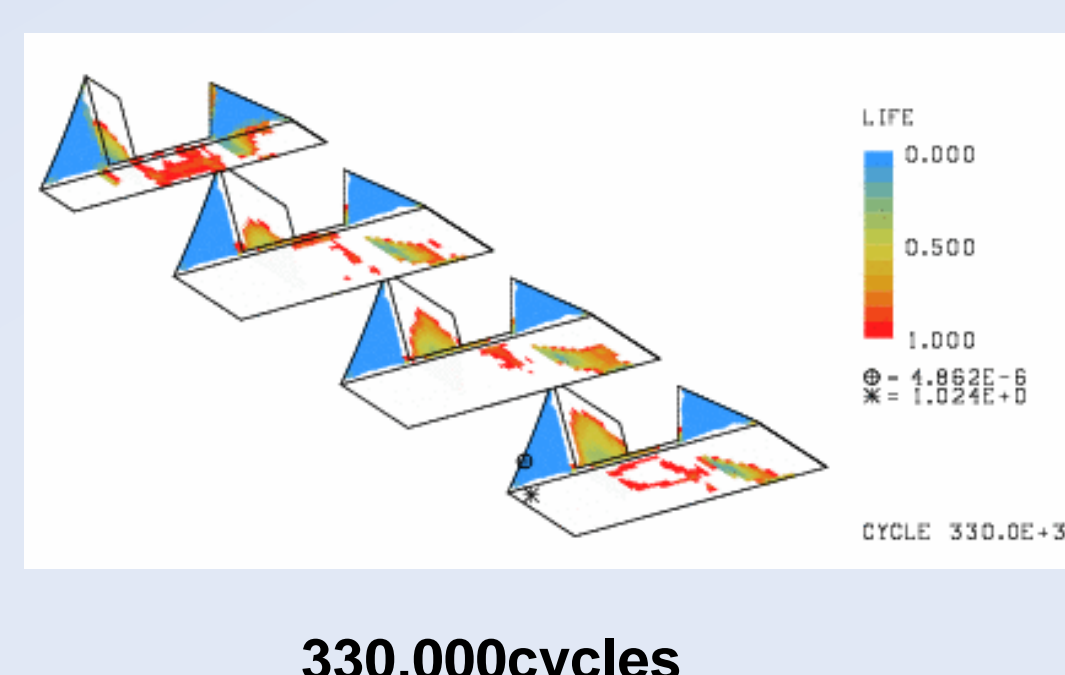
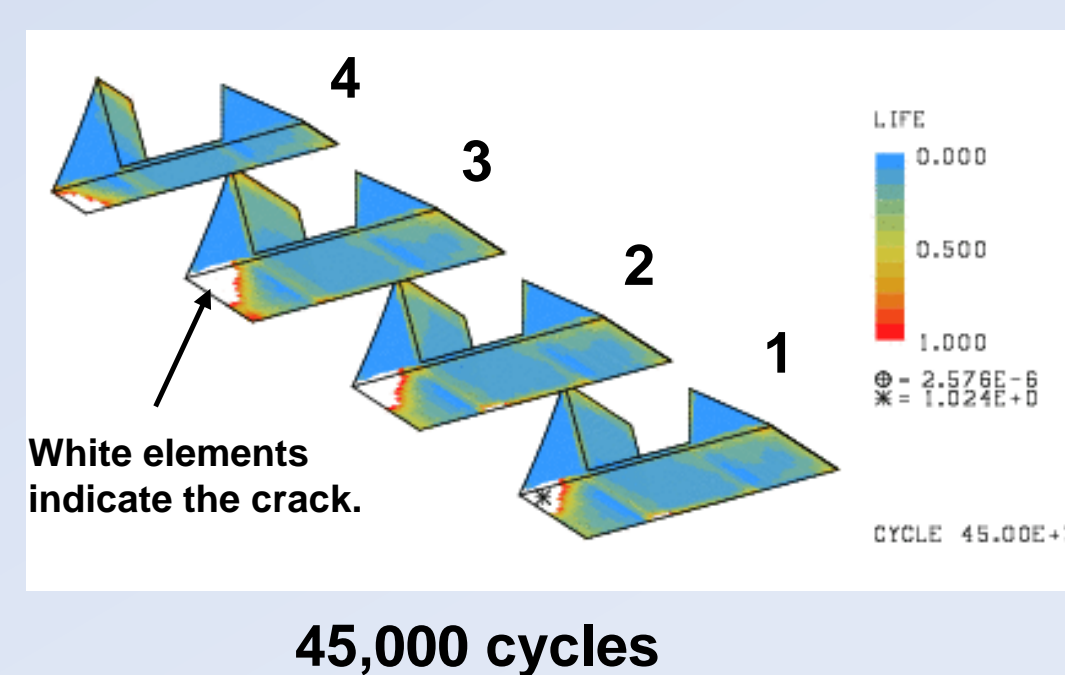
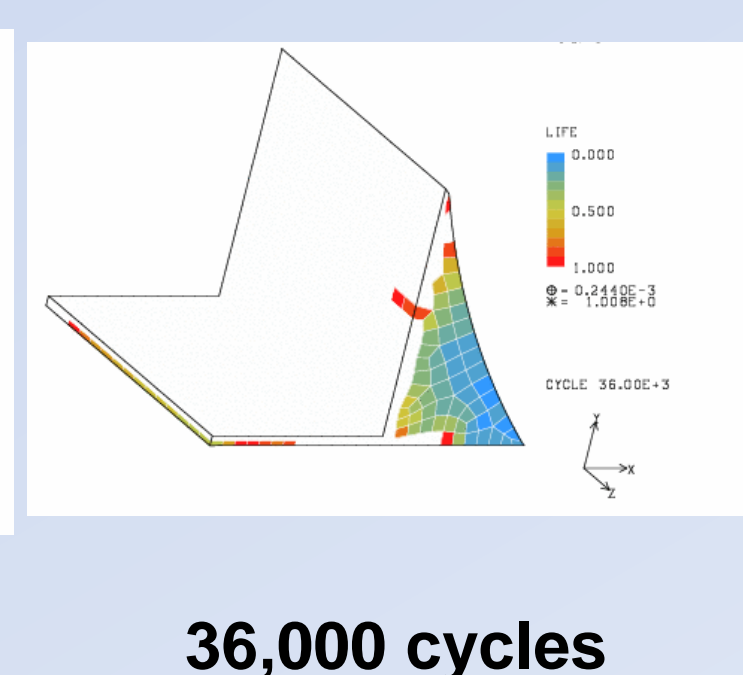
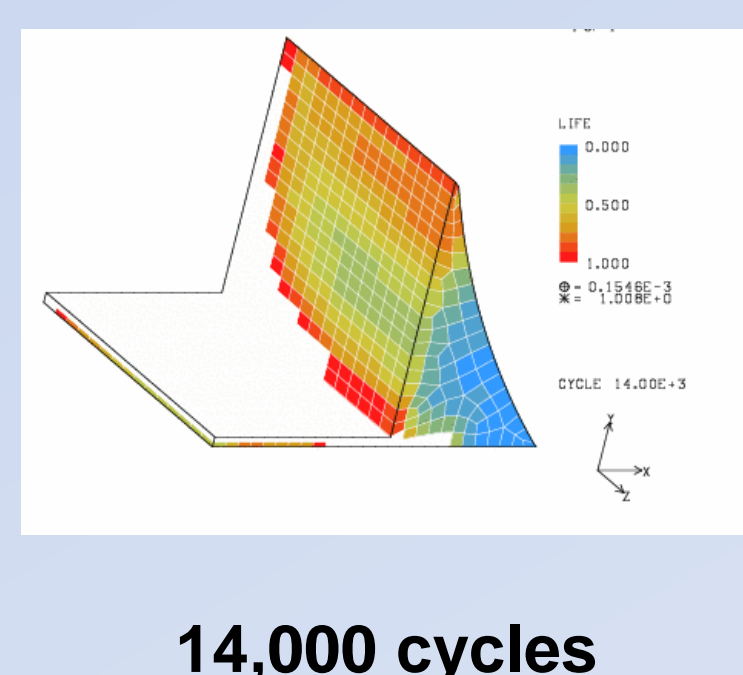
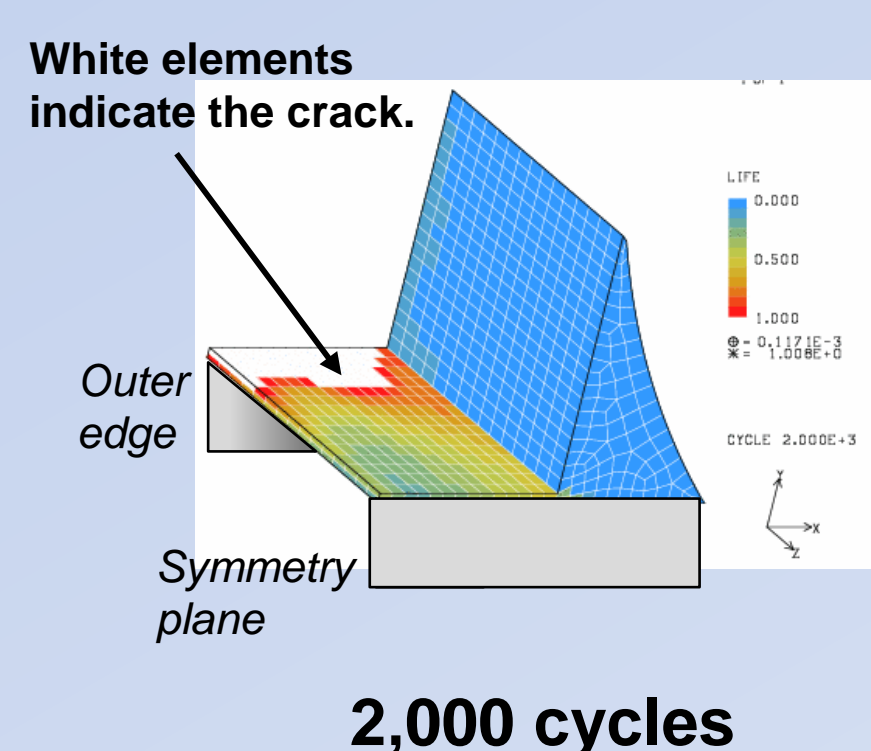
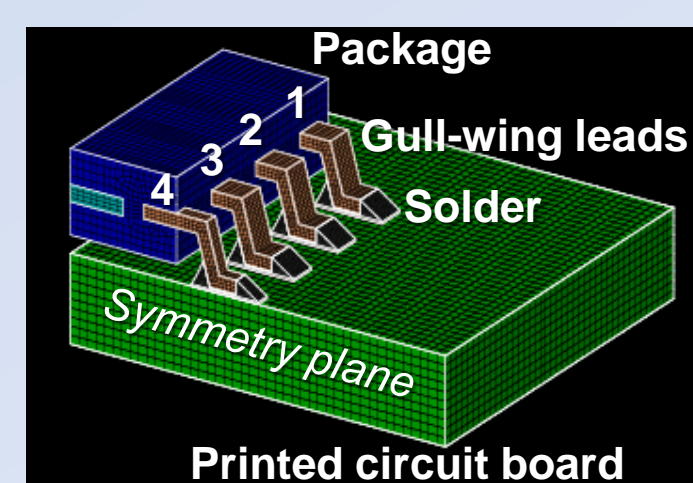
Inverter Electrical Components



Modeling Results



TurboSiP predicts solder joint evolution, including crack initiation and propagation.



Summary

- The TurboSiP[®] software is a tool for predicting the thermal mechanical fatigue (TMF) of commonly used solder joints. The input parameters include package materials, interconnection design, solder alloy (Sn-Pb or Pb-free), and the environment.
- This software was used to predict the TMF lifetimes of collector circuit solder joints used in photovoltaic solar panel systems. The specific cases were the TMF reliability of 1206 chip capacitor and 14 I/O SOIC components soldered to a printed circuit board. All interconnections were made with the eutectic Sn-Pb solder. A service temperature cycle was defined for the TurboSiP[®] software using data logger conditions. Accelerated aging test conditions were also exercised in the software.
- The TurboSiP[®] predictions clearly showed that both the collector circuit as well as the 1206 capacitor and SOIC component solder joints on a printed circuit board possessed more than sufficient service lifetime to meet the customer's operational expectations.

Future Work

- Validate model predictions using solder joints from fielded inverters.
- Apply rainflow counting algorithms to obtain higher fidelity input data (temperature) files.
- Model components from additional modules.
- Model components from commercial / utility scale inverters.