

Effects of Conformal Coating on Solder Spreading Phenomenon

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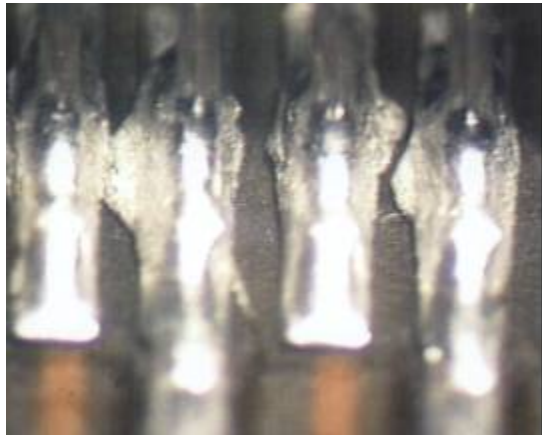
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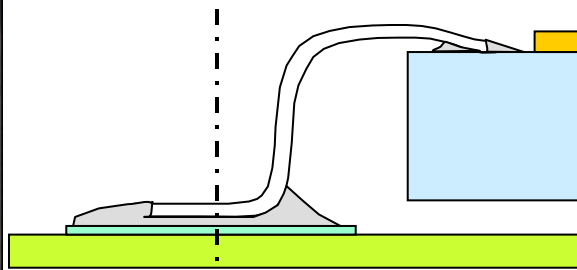
Background

Conformal coatings are used to protect electronic assemblies from moisture, corrosion, dust, and solvents. The possibility of electronics devices being exposed to these environment in automotive, consumer electronics and industrial controls has led to the increased use of conformal coatings. Coatings may also provide additional dielectric resistance between conductors as printed wiring board dimensions continue to decrease.

Motivation

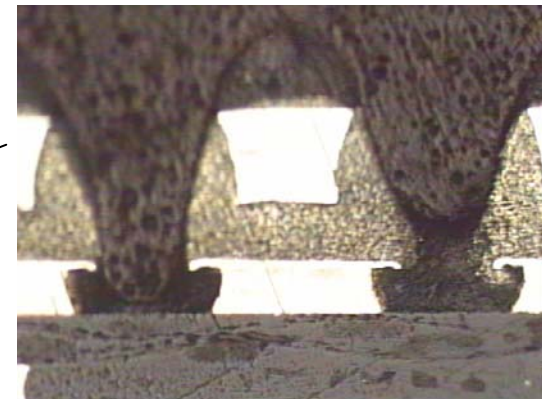
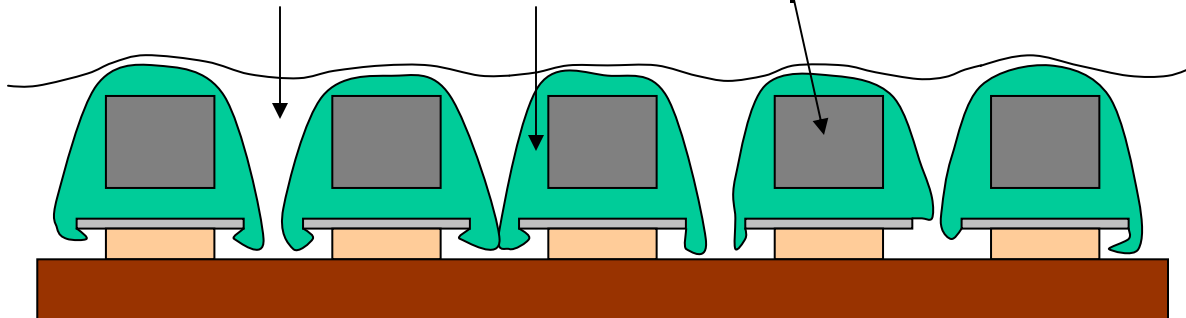


Cross-section cut



During use, excessive solder deformation causes adjacent leads on a ceramic gullwing package to short together. Failures confirmed to only occur when excessive conformal coating is present

Conformal Coating Solder Lead



Field failures could not be duplicated using -55 to 125°C thermal cycling

Material Characterization

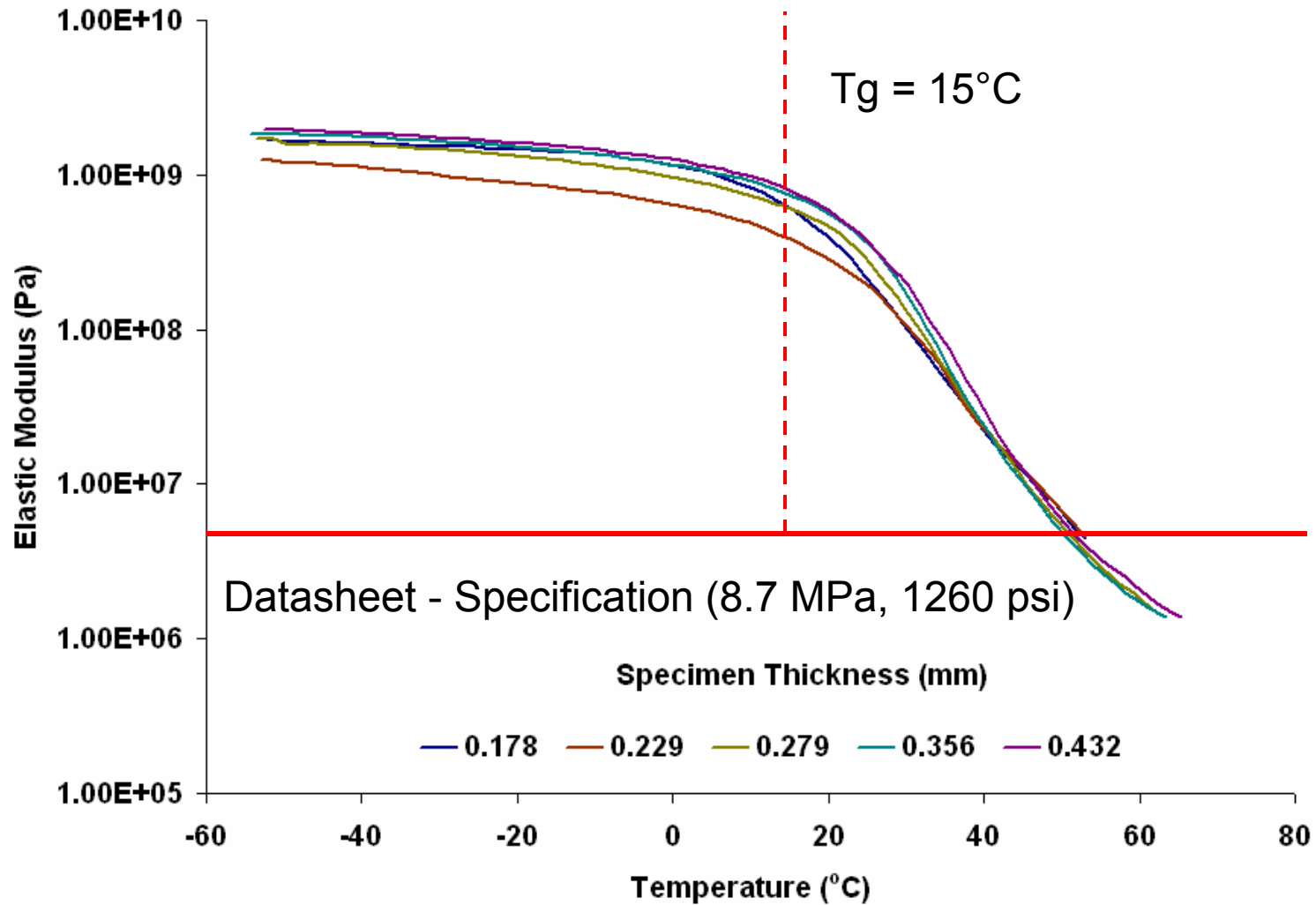
- Acrylic Conformal Coating
- Verification and determination of mechanical properties
 - Elastic Modulus as a function of temperature
 - Glass Transition Temperature
 - Coefficient of Thermal Expansion
 - Effect of Ultraviolet light on properties

Physical	Continuous Use Temp. Range °C	-65 +125
	Thermal Shock Test ⁷	Passes
	Flammability ⁸ (self extinguishing)	Yes
	TCE in/in/°C ⁹	5.5 x 10 ⁻⁶
	Young's Modulus ¹⁰ psi	1260
	Tg °C ¹¹	15
Electrical	Dielectric Constant ¹²	2.5
	Dissipation Factor ¹³	.01
	Dielectric Withstand ¹⁴ (volts)	>1,500
	Insulation Resistance ¹⁵ (teraohms)	800
	Moisture Resistance ¹⁶ (gigaohms)	60

Young's Modulus
Datasheet 1260 psi (8.7 MPa)

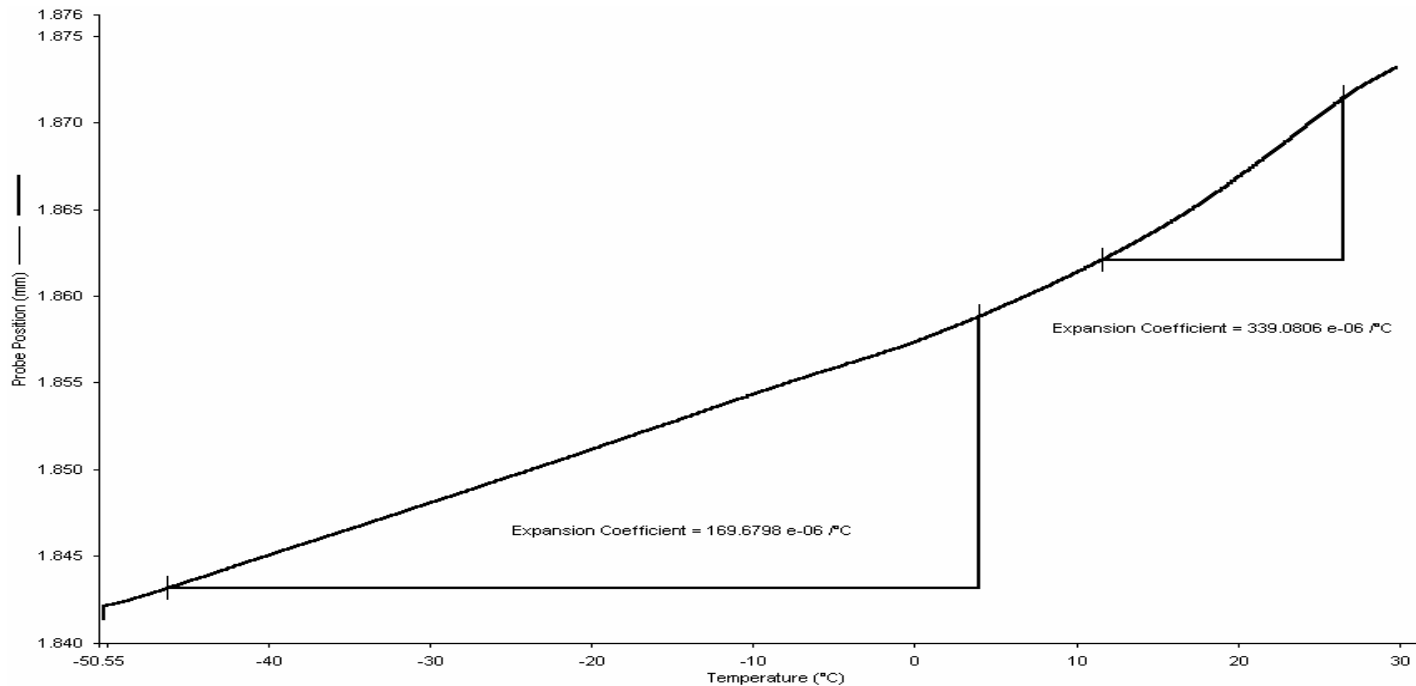
Coefficient of thermal Expansion
Datasheet 55 ppm/°C

Elastic Modulus - DMA



Elastic modulus is not a function of specimen thickness

Coefficient of Thermal Expansion - TMA



Below Tg CTE – 170 ppm/°C
Above Tg : CTE – 340 ppm/°C

Glass Transition Temperature
Tg ≈ 5 to 15°C

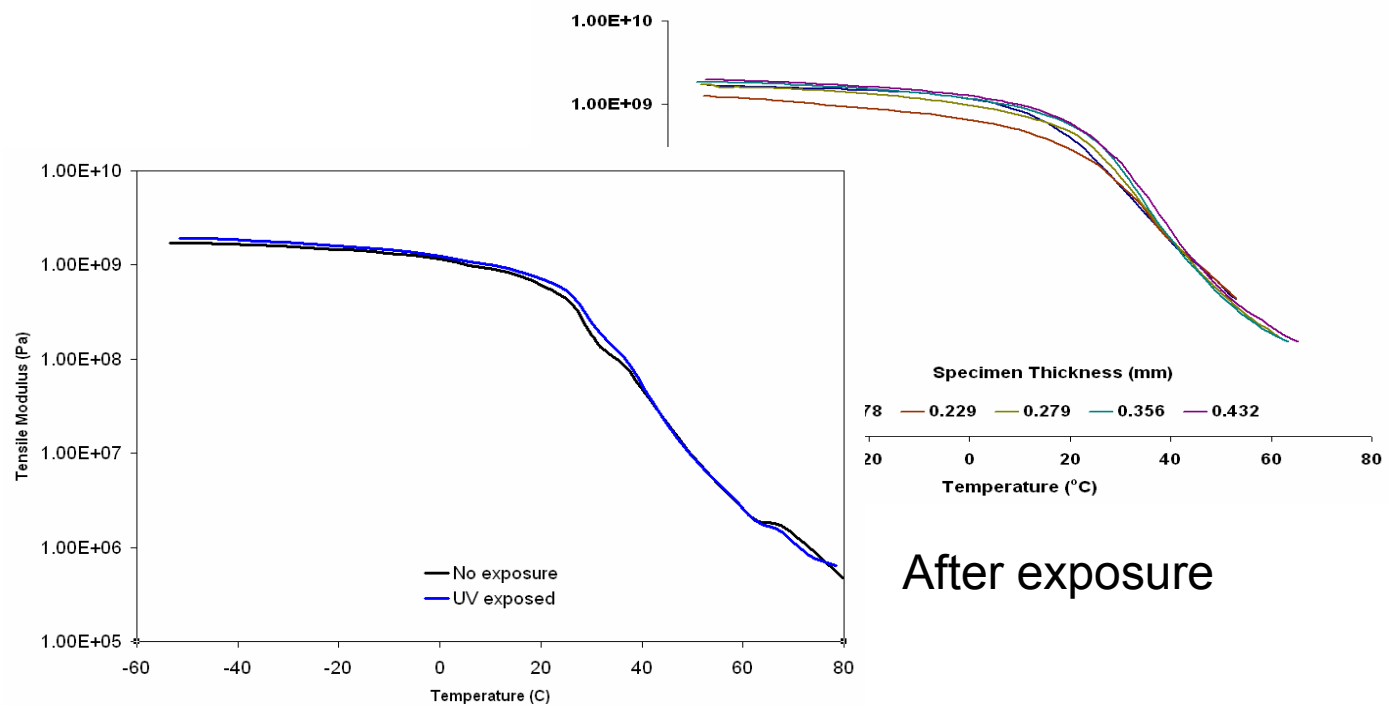
Ultraviolet Aging



- Eight samples placed on a ceramic plate 5 cm from a 253 nm UV light for 12 hours
- Four samples placed on a ceramic plate with no exposure
- Both plates were white at the beginning of exposure

Tensile Modulus Comparison - DMA

Previous test results



No noticeable difference in properties after 12 hour exposure to UV light

2D FEA Modeling

4 - 2D FEA Models

Nominal conformal coating

- Thick solder with bulbous side fillets

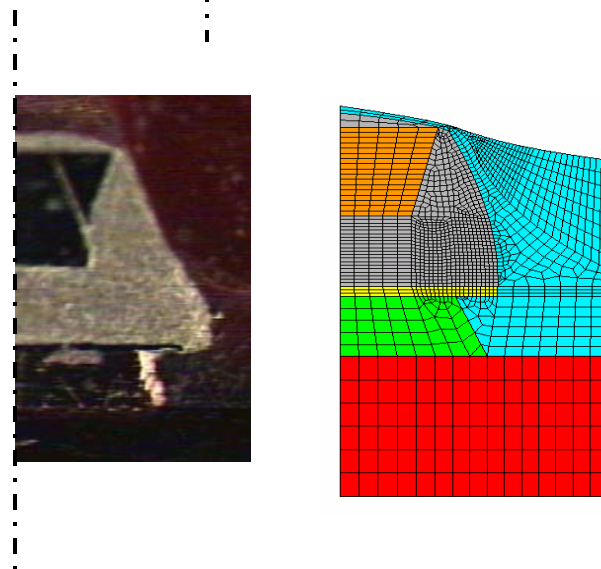
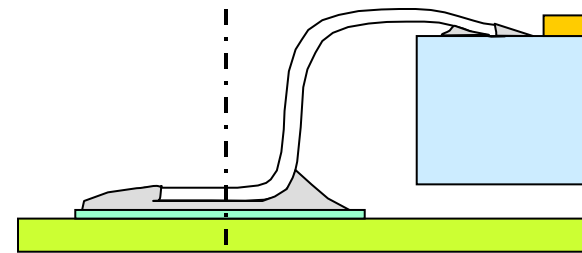
Thick conformal coating

- Thick solder with bulbous side fillets
- Nominal solder with nominal side fillets

Very thick conformal coating

- Thick solder with bulbous side fillets

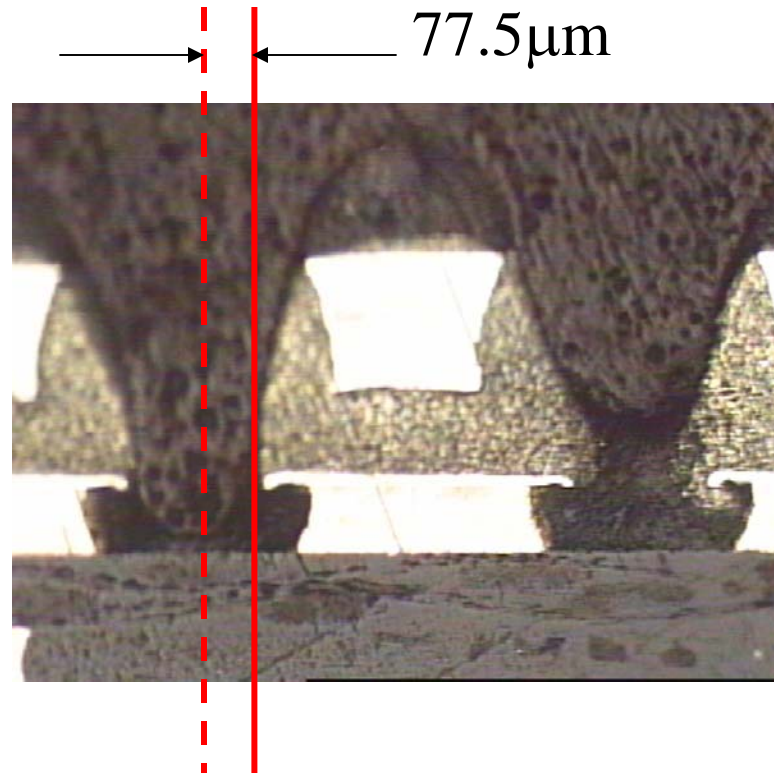
Cross-section cut



Symmetry axis

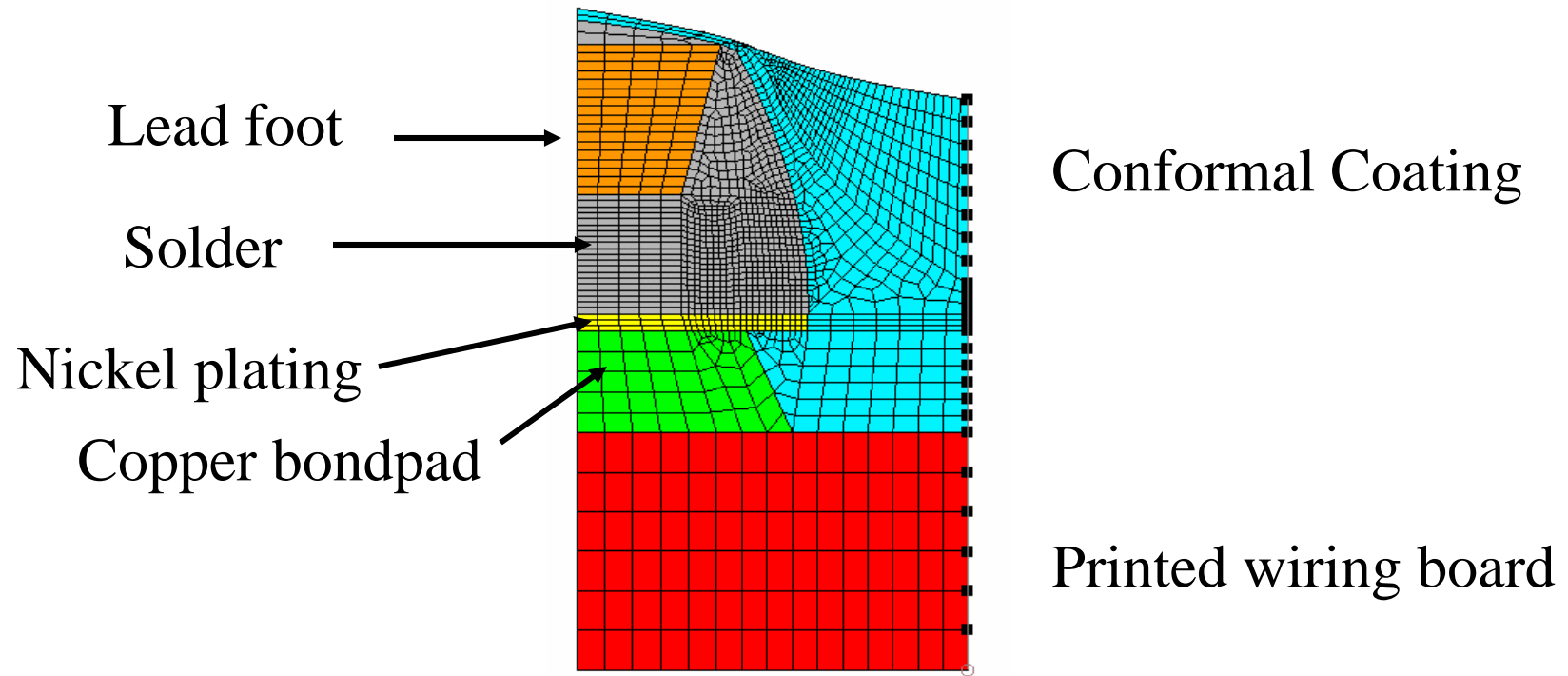
Failure Criteria Definition

The number of cycles to failure is defined to occur at the point when the location of the side of the solder joint is equal to one half the pitch



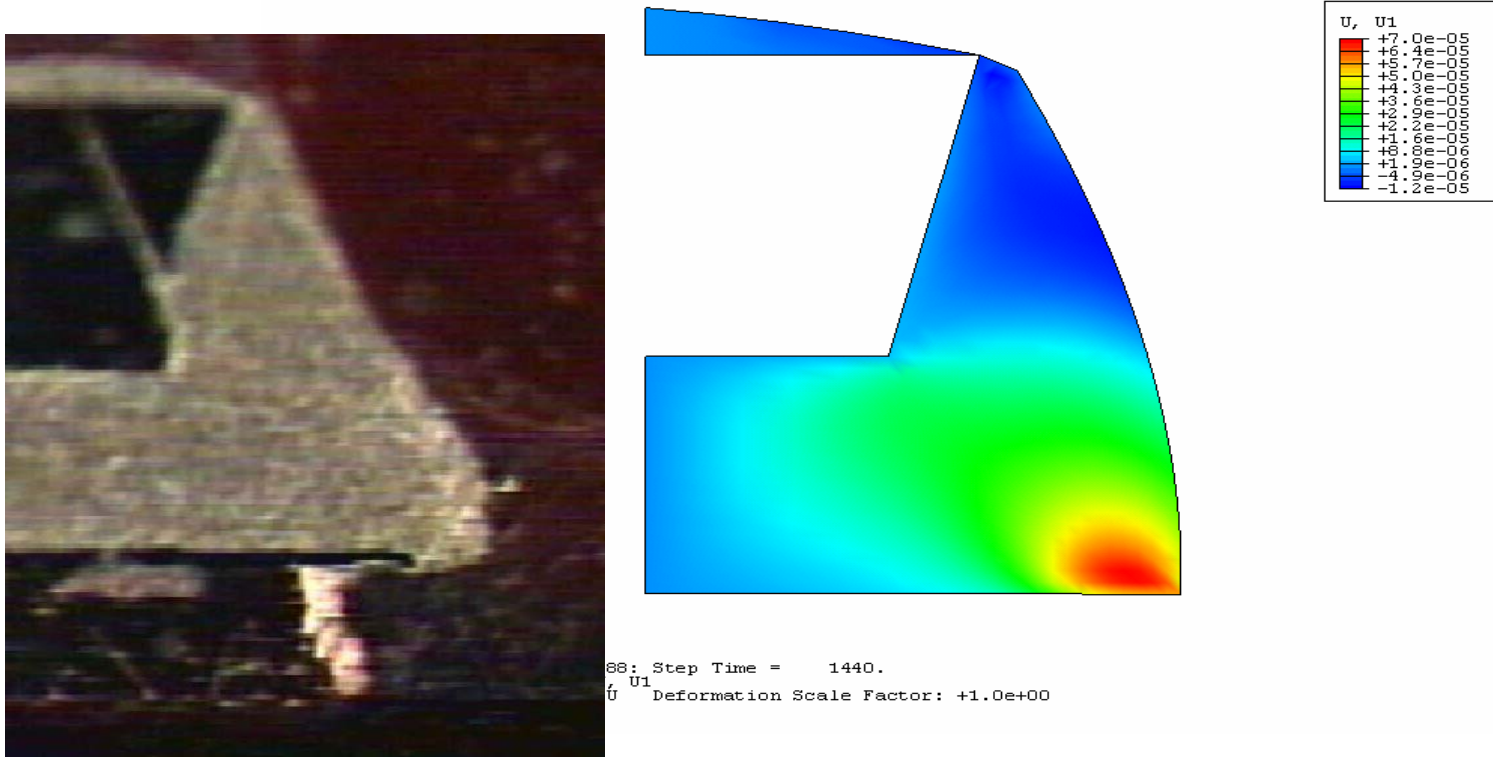
Bulbous Solder Joint

-30 to 40°C Thermal Cycle



Very thick conformal coating

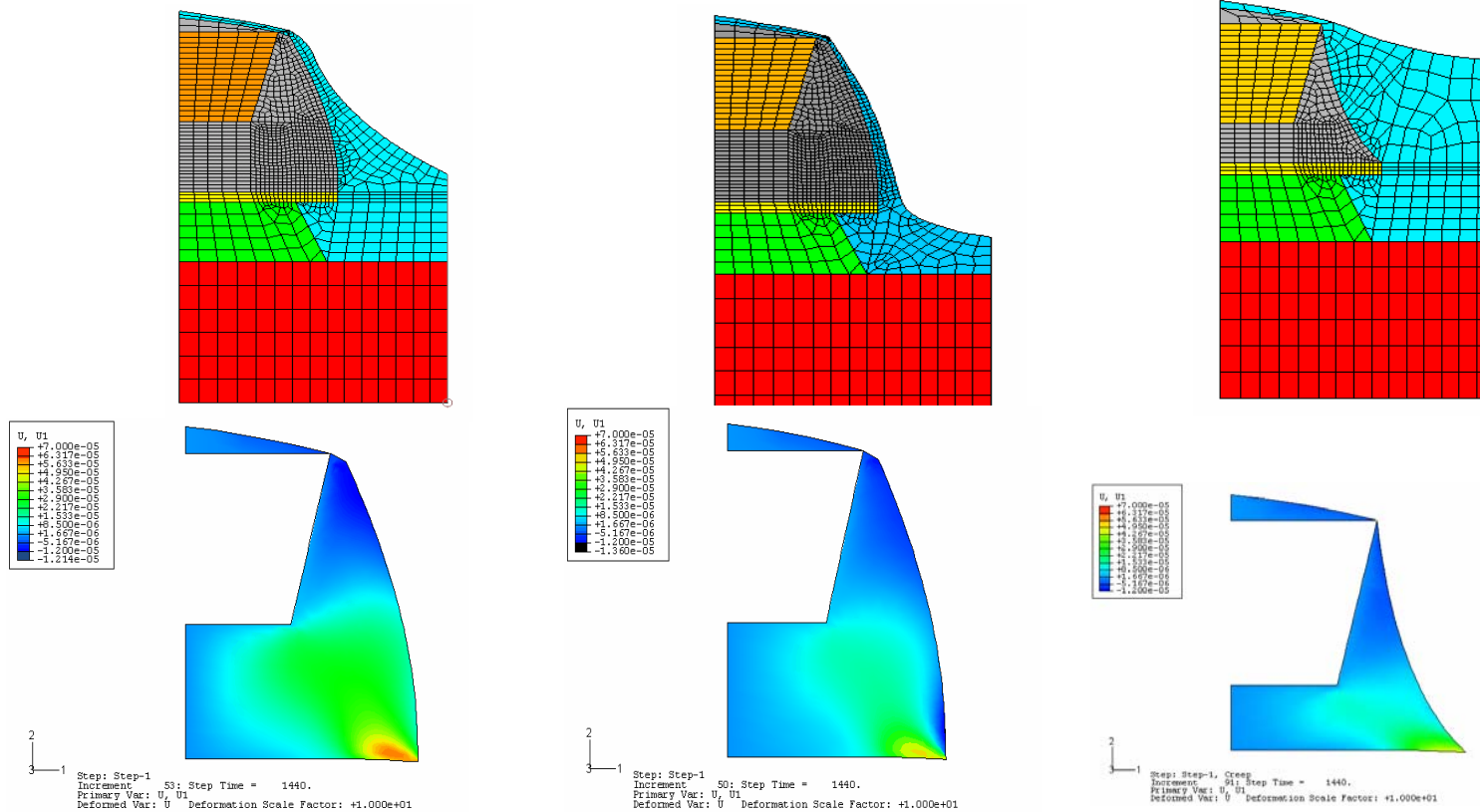
Very Thick Conformal Coating



X – Displacements (0.04 μm) per cycle
1940 Cycles to move 77 μm

2D FEA Modeling Results

Thick and Nominal Conformal Coating



**X – Displacements (0.03 μm)
2600 Cycles to move 77 μm**

**Minimal X displacements (<0.0085 μm) which are
likely due to the bending of the nickel plating**

Summary

- Conformal coating properties significantly different than manufacturer specifications
- UV exposure had no noticeable effect on the material properties
- Manufacture's specified Tg is within the values determined by testing
- The deformation shapes predicted by the FEA agree with those seen in the field return units
- Thermal cycling results reveal that -30 to 40°C is more likely to cause the failures than -55 to 125°C