DfR Solutions
RELIABILITY DESIGNED & DELIVERED

sherlock
AUTOMATED DESIGN ANALYSIS™

2019
DESIGN FOR RELIABILITY
CONFERENCE

Accurately Capturing System-Level Failure of Solder Joints

...

March 26, 2019 | Maxim Serebreni

9000 Virginia Manor Rd Ste 290, Beltsville MD 20705 | 301-474-0607 | www.dfrsolutions.com

Agenda

2019 DESIGN FOR RELIABILITY CONFERENCE

System Level Reliability

01 Introduction
- Failure modes in electronic systems
- Failure mechanisms in solder joints
- System level solder joint reliability using sherlock

02 Fatigue Models
- Mechanical fatigue models
- Thermal fatigue models

03 Pb-free Solder Alloys
- Low silver and low melt Pb-free solder alloys
- Consortium projects

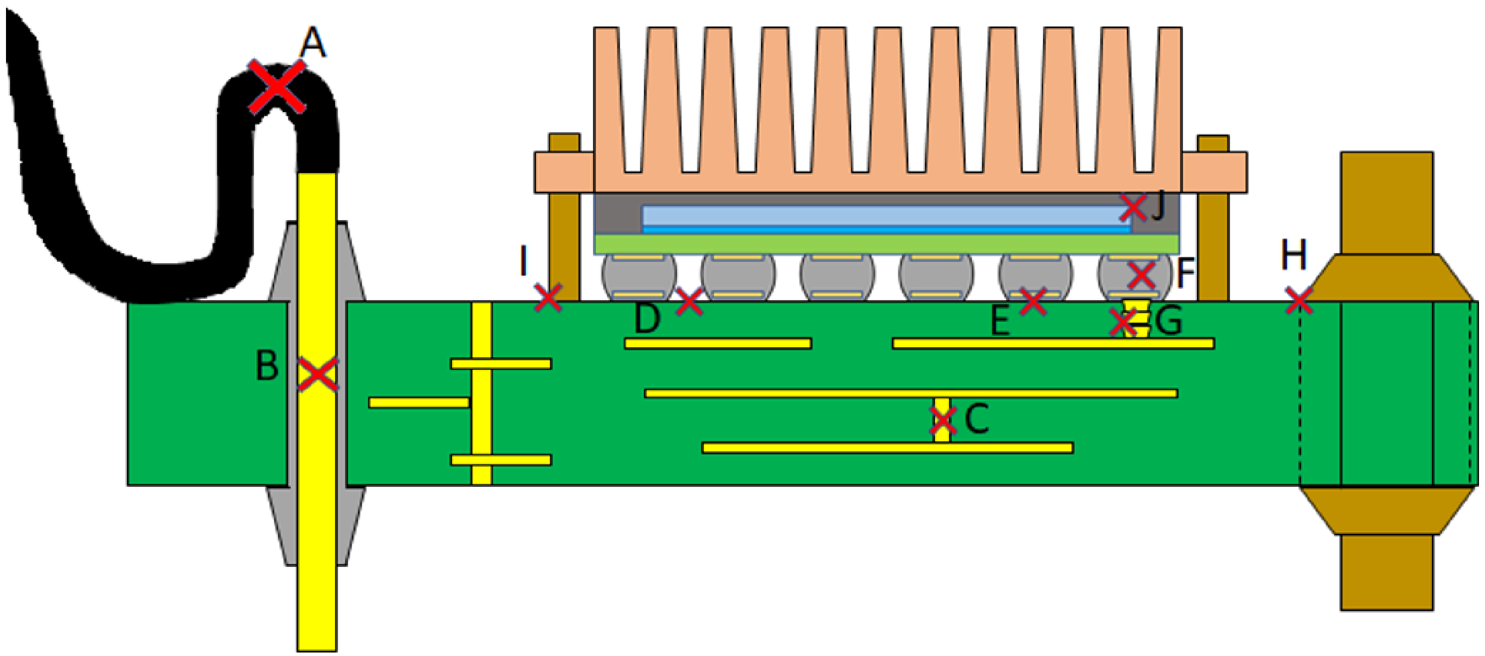
04 Case Study 1: PCB composition

05 Case Study 2: Underfill selection for BGA package

06 Conclusion

Failure Modes in Electronic Systems

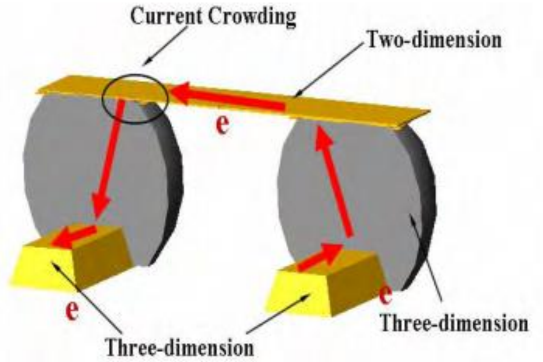
- Solder joints can be found in multiple locations within the electronic system from connectors to components as well as mechanical support points interconnecting PCBs.
- System level reliability should identify the dominant failure mode and then isolate the critical location on the board that is most susceptible to failure.

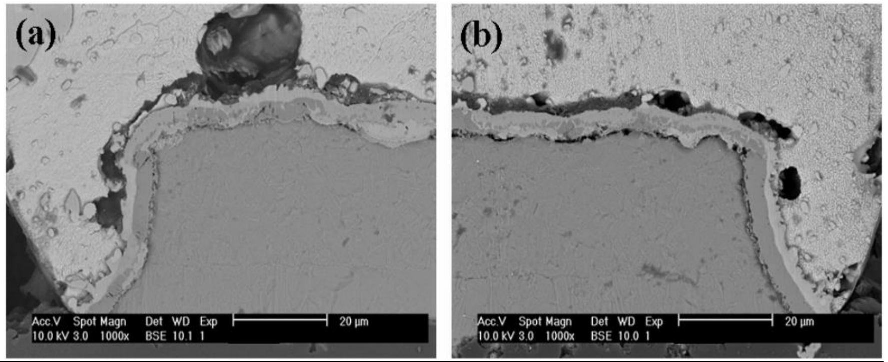


A	Kink in wire
B	Crack in PTH solder due to wire pull
C	Cracking in PTH copper barrels
D	Short between two joints (dendrites..)
E	Pad cratering on PCB or component
F	Cracking in BGA solder due to fatigue
G	Failure in microvia during reflow or thermal cycling
H	Increased board strain due to proximity to mount points
I	Increased board strain from heat sink clamps
J	Die/passivation cracking

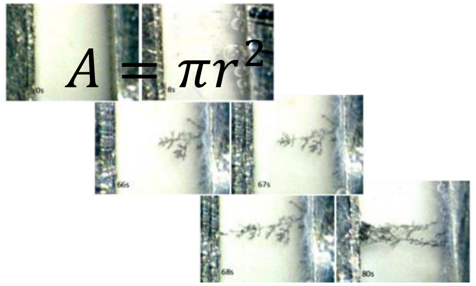
Failure Mechanisms in Solder Joints

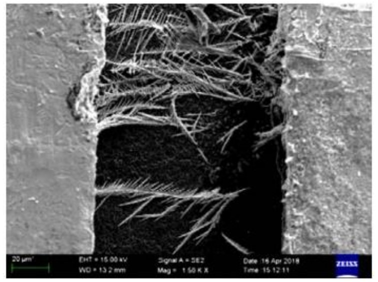
- Electrical
  - Current stressing
    - Void formation in solder
- Chemical
  - Electro-chemical migration
  - Corrosion
- Thermal
  - Thermal fatigue
  - Overheating
- Mechanical
  - Mechanical Fatigue
  - Overstress





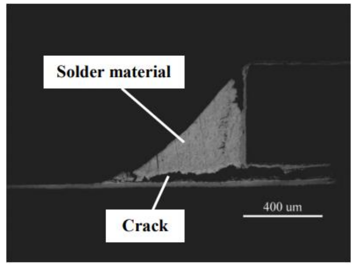
Lu, Yu-Dong, Xiao-Qi He, Yun-Fei En, and Xin Wang. "Failure modes of Sn3. 0Ag0. 5Cu flip-chip solder joints under current stress." In *2009 8th International Conference on Reliability, Maintainability and Safety*, pp. 849-853. IEEE, 2009.

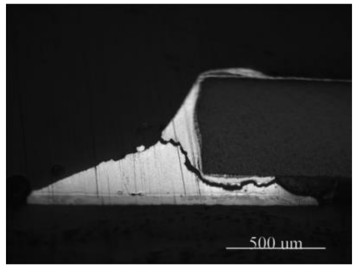




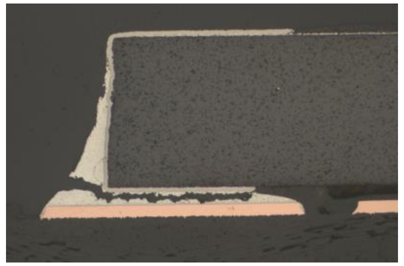
X. Qi *et al.*, "Study on Electrochemical Migration of Sn-0.7Cu," *2018 19th International Conference on Electronic Packaging Technology (ICEPT)*, Shanghai, 2018, pp. 387-390.

Thermal cycling -40 to 125°C





Mechanical loading 5Hz

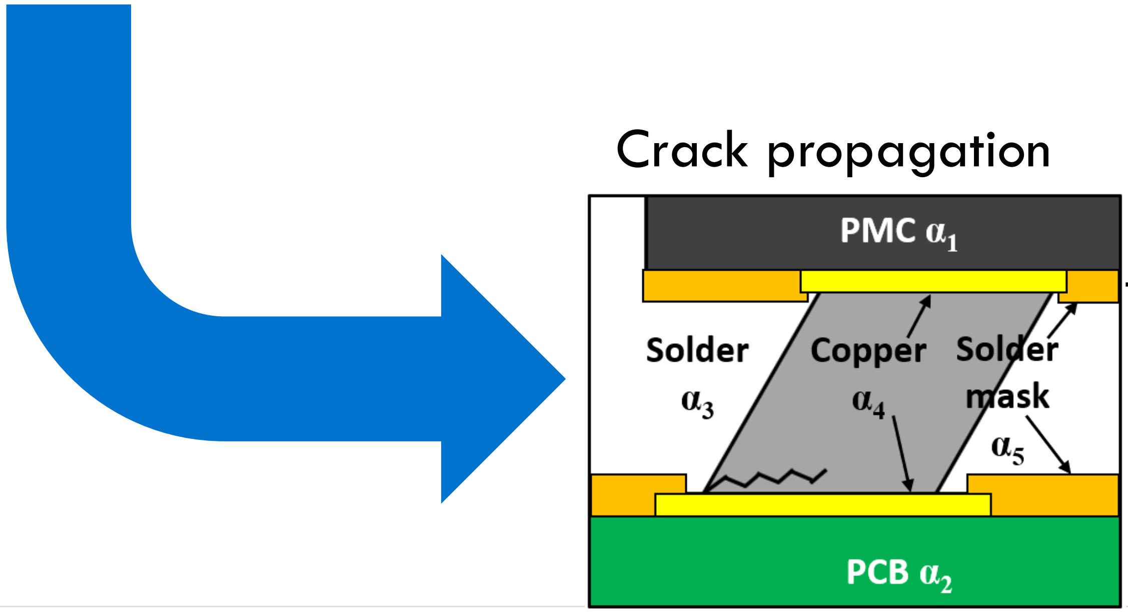


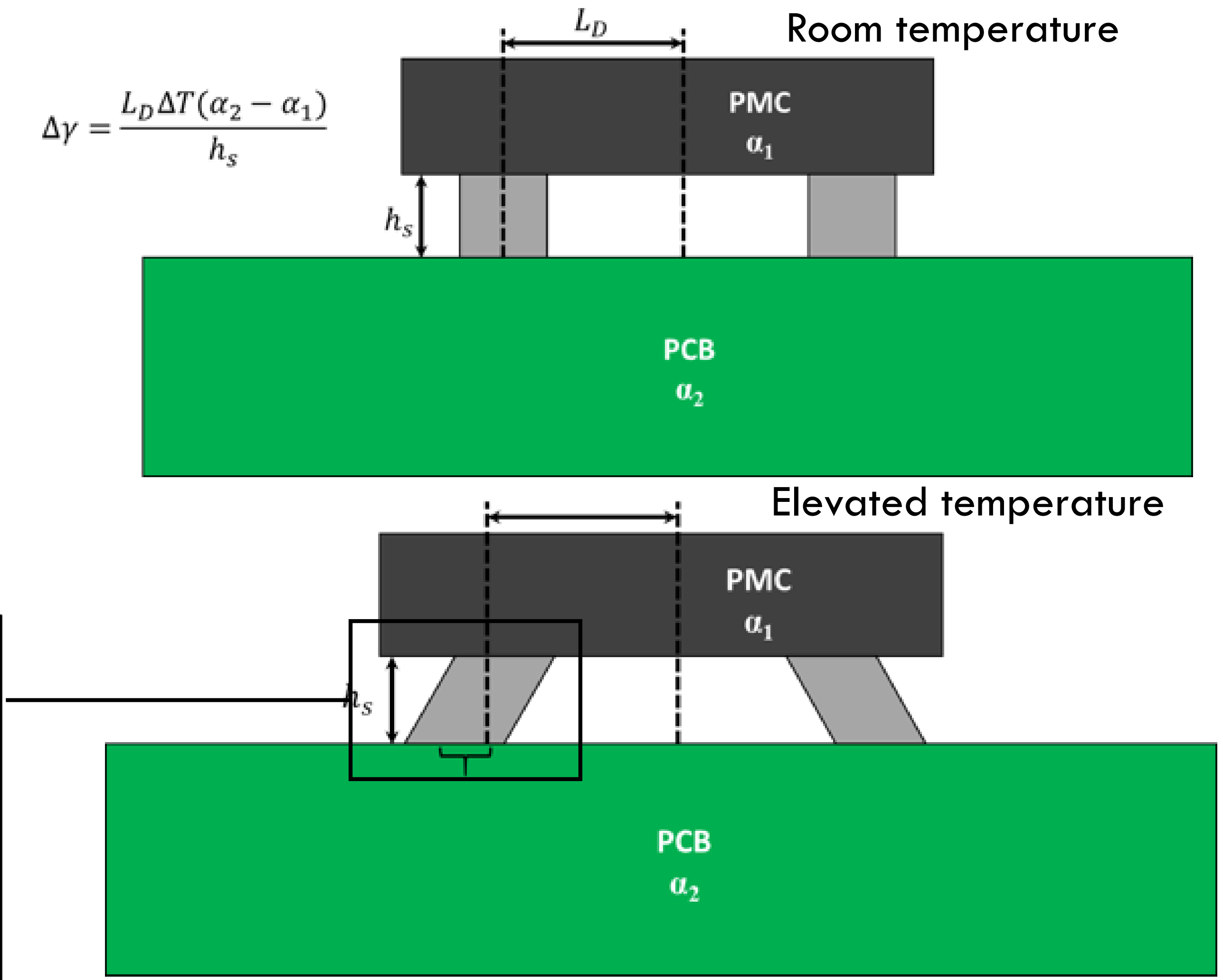
?

Lin, Jian, Yongping Lei, Zhongwei Wu, and LanLi Yin. "Comparison investigation of thermal fatigue and mechanical fatigue behavior of board level solder joint." In *2010 11th International Conference on Electronic Packaging Technology & High Density Packaging*, pp. 1179-1182. IEEE, 2010.

Thermo-Mechanical Fatigue

- Thermo-mechanical fatigue is a synergetic damage process caused by cyclic thermal and mechanical loading.
  - Thermally induced mechanical strains
  - Microstructural changes in solder alloy
- Different solder alloys will have different microstructure with unique response to thermal loading.

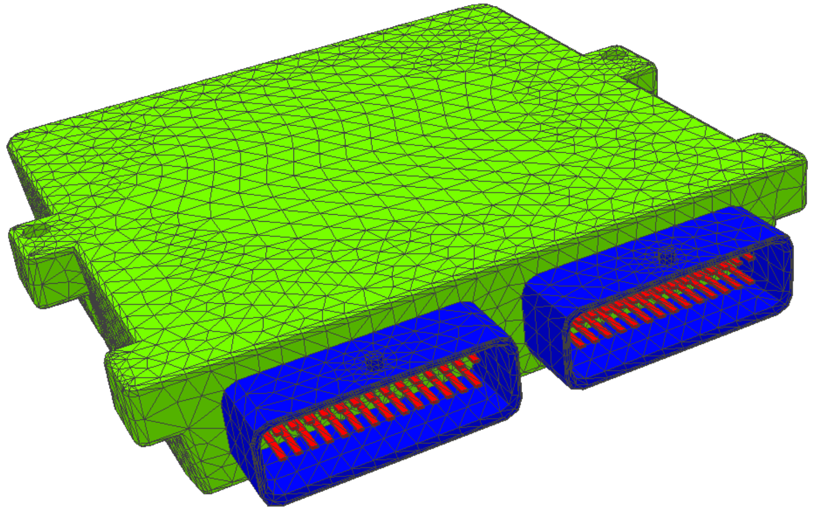




System Level Solder Joint Reliability Using Sherlock

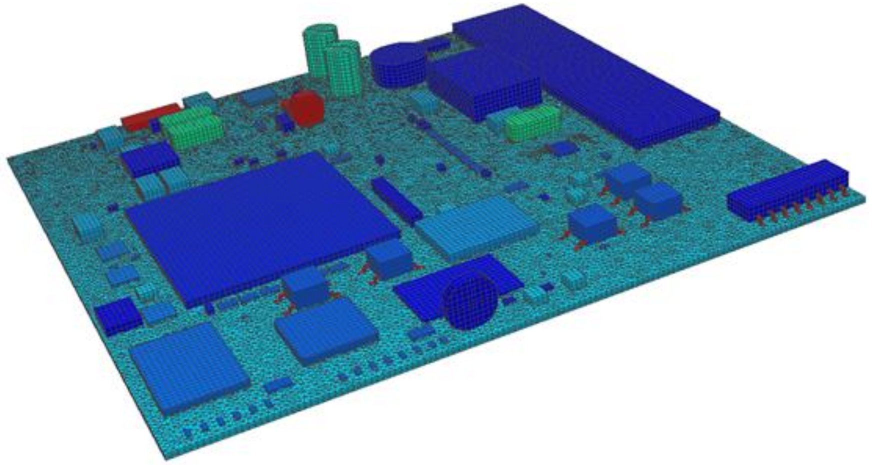
- Interaction of the electronic circuit card with housing under reliability assessment
- Aluminum housing tied to PCB using 1) 3mm corner standoffs 2) Direct bond to housing with adhesive
- Evaluate entire assembly under thermal cycling of -40°C to 125°C (IPC, JEDEC standards…)

Enclosure



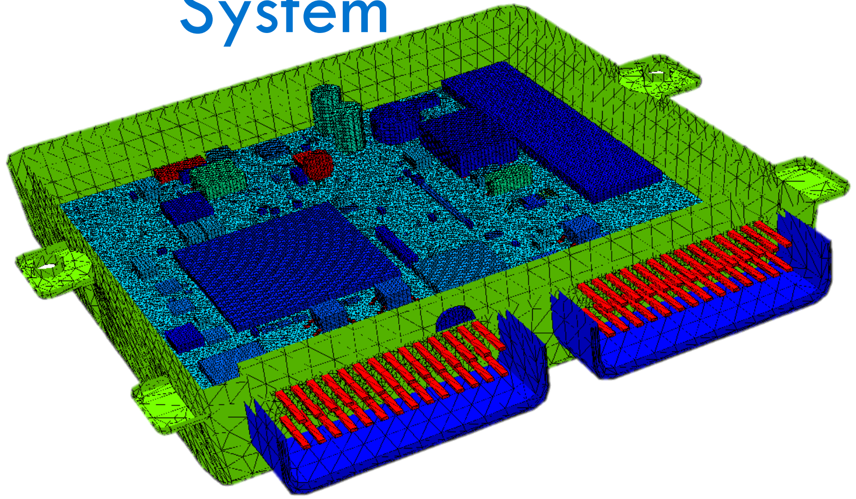
+

PCBA



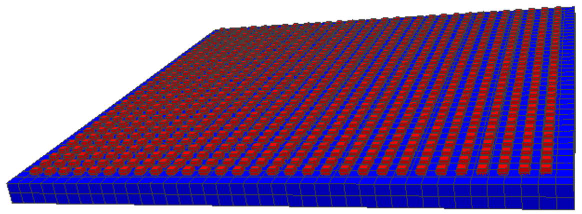
=

System

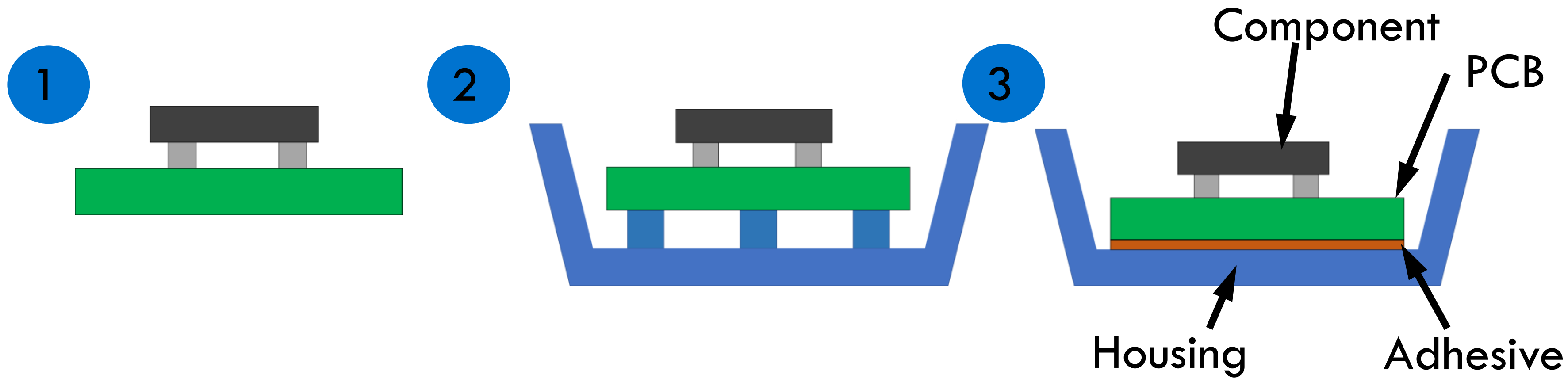


System Level Solder Joint Reliability Using Sherlock

- Package: 40x40mm^2, 1.65 mm thick, 900 IO, 1.27 mm pitch, 27x27mm^2 die
- Material properties: PCB: 17.7 ppm/°C, 38 GPa
  BGA Mold: 13 ppm/°C, 18 GPa
  BGA Laminate: 15 ppm/°C, 24 GPa
  Silicon: 2.6 ppm/°C, 130 Gpa
  Solder: 2900@-40°C =>1297.6@125°C secant modulus
  Aluminum Housing: 24 ppm/°C, 70GPa



- Three boundary conditions representative of accelerated thermal cycling of bare PCB, PCB with housing connected using standoffs, PCB connected to housing using adhesive.

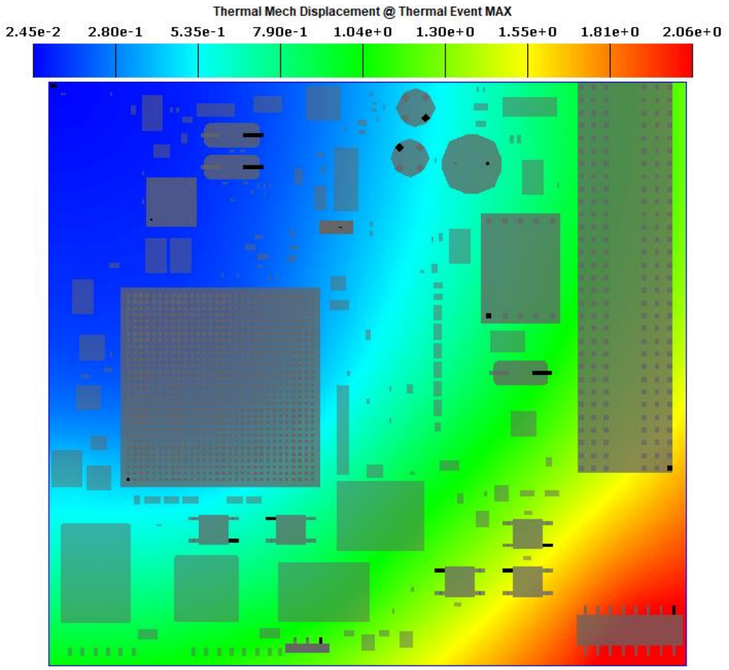


Adhesive: CTE = 40 ppm/°C
E = 1GPa

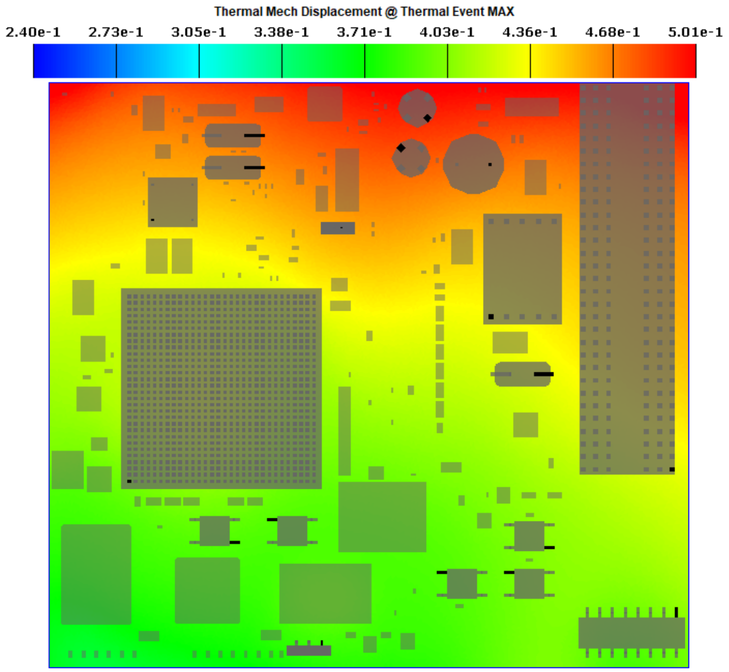
System Level Solder Joint Reliability Using Sherlock

- Location and magnitude board deflection is a function of temperature and board constraints
- Bare board shows a uniform board deflection while the adhesive and standoffs boundary conditions result in different deflection behavior

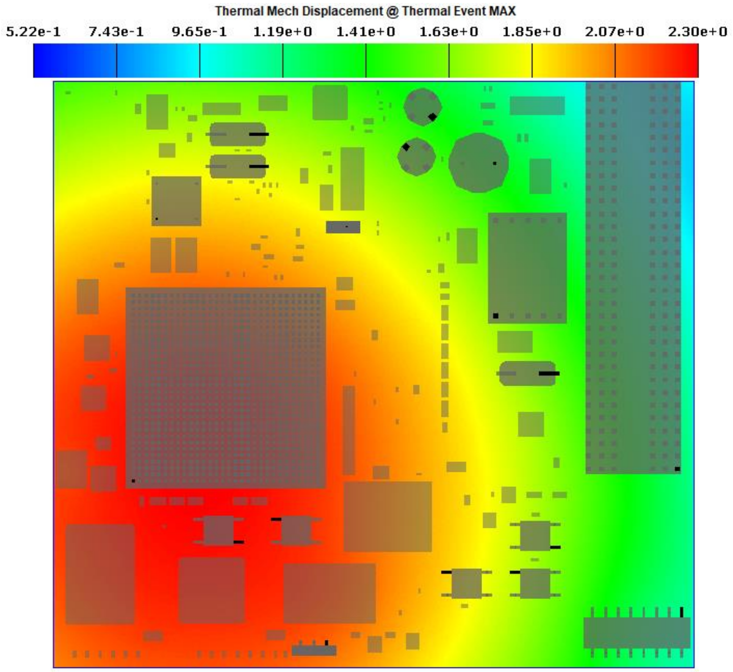
2.06 mm
Bare PCB



0.5 mm
Corner and center standoffs



2.30 mm
Adhesive

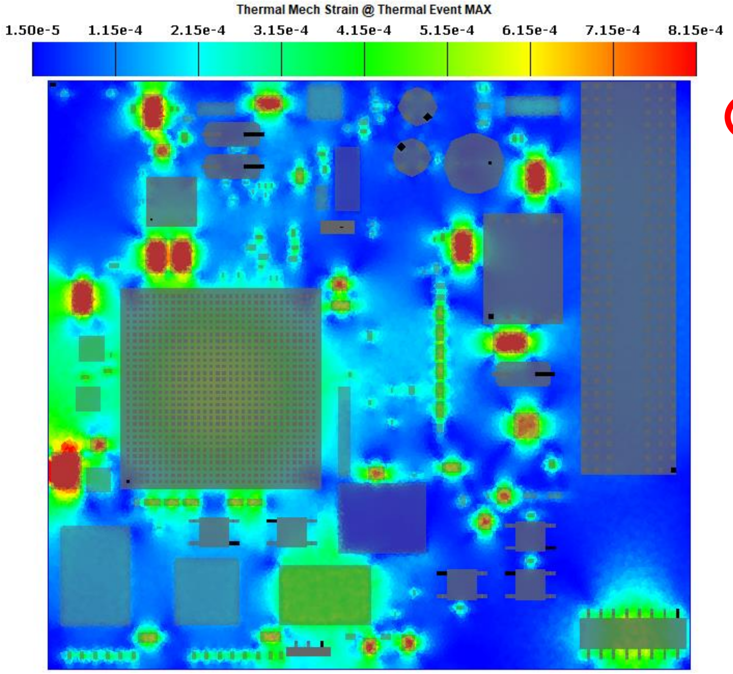


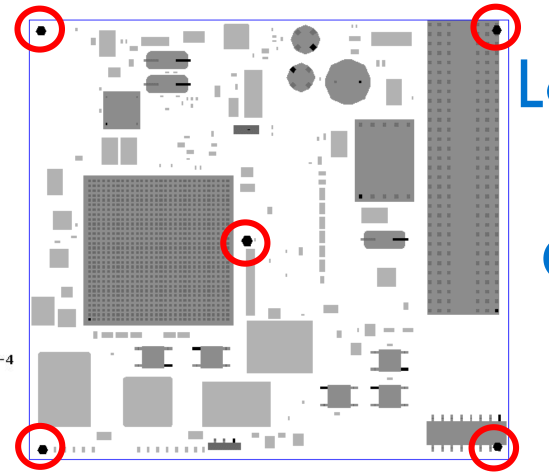
System Level Solder Joint Reliability Using Sherlock

2019 DESIGN FOR RELIABILITY CONFERENCE

- Strains on the board and in BGA solder joints are evaluated for each boundary condition
- Small variation in peak board strain is observed between boundary conditions
- Mount points in proximity of BGA component can significantly increase strain in solder joints

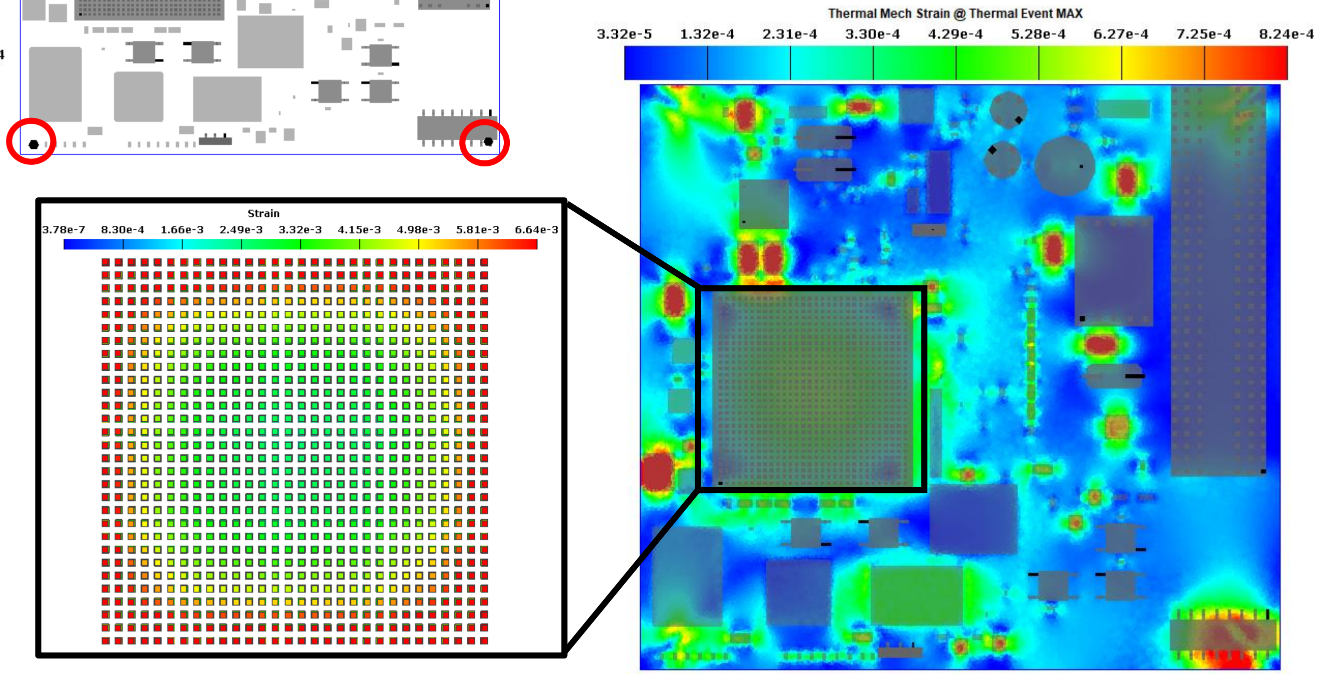
8.15E-4 με
Bare PCB



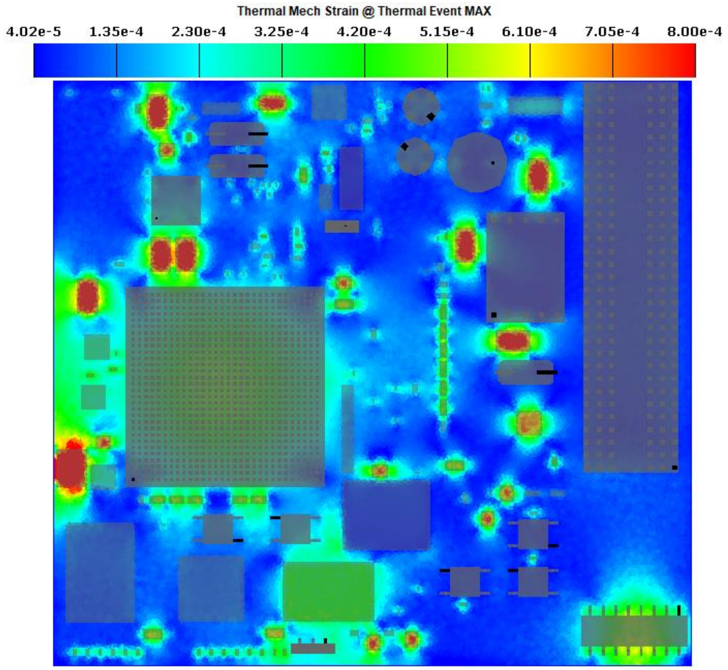


Location of mount points

8.24E-4 με
Corner and center standoffs

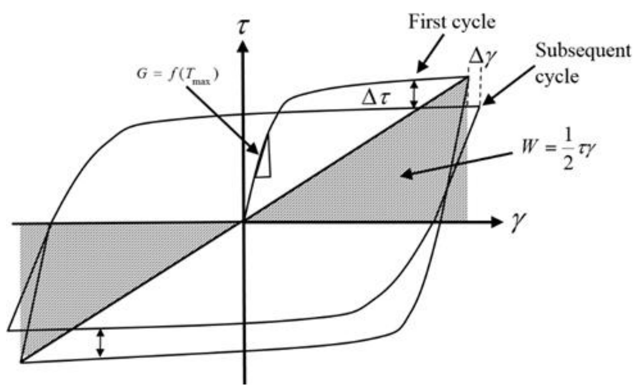


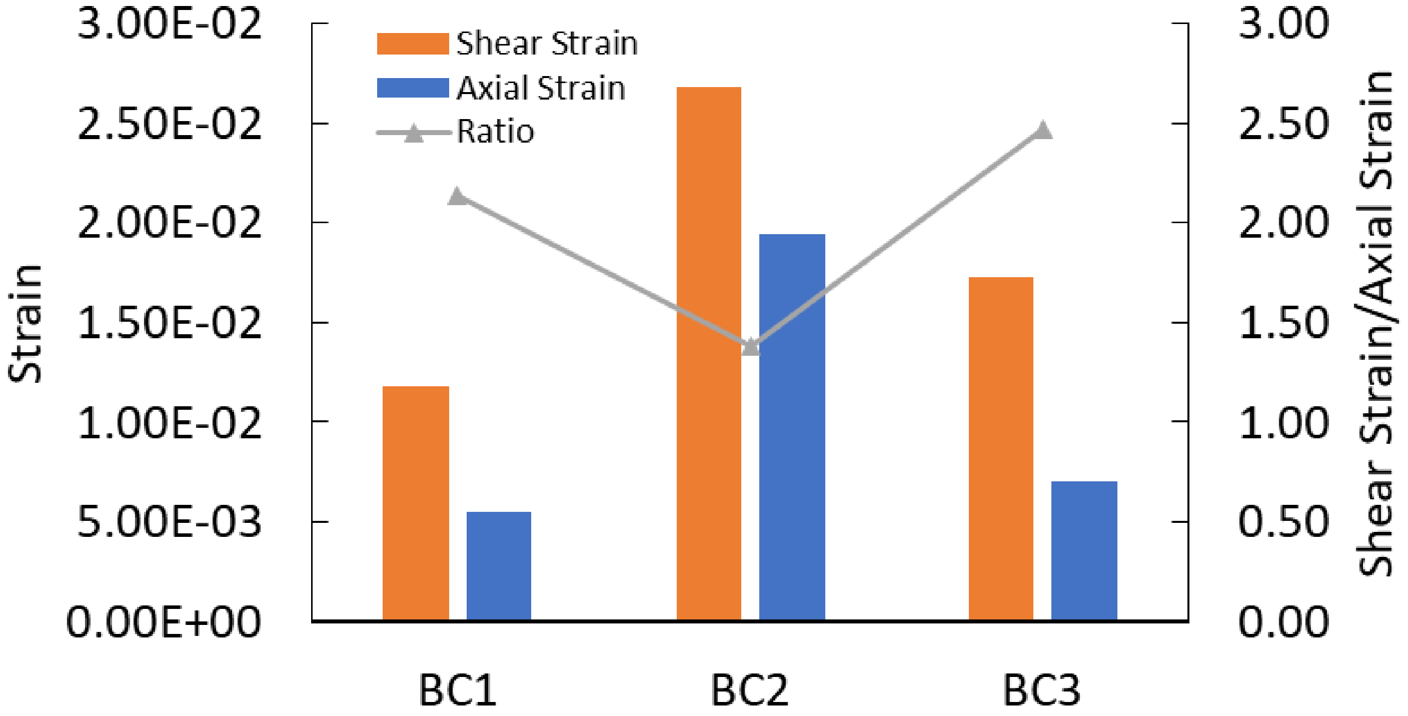
8.0E-4 με
Adhesive

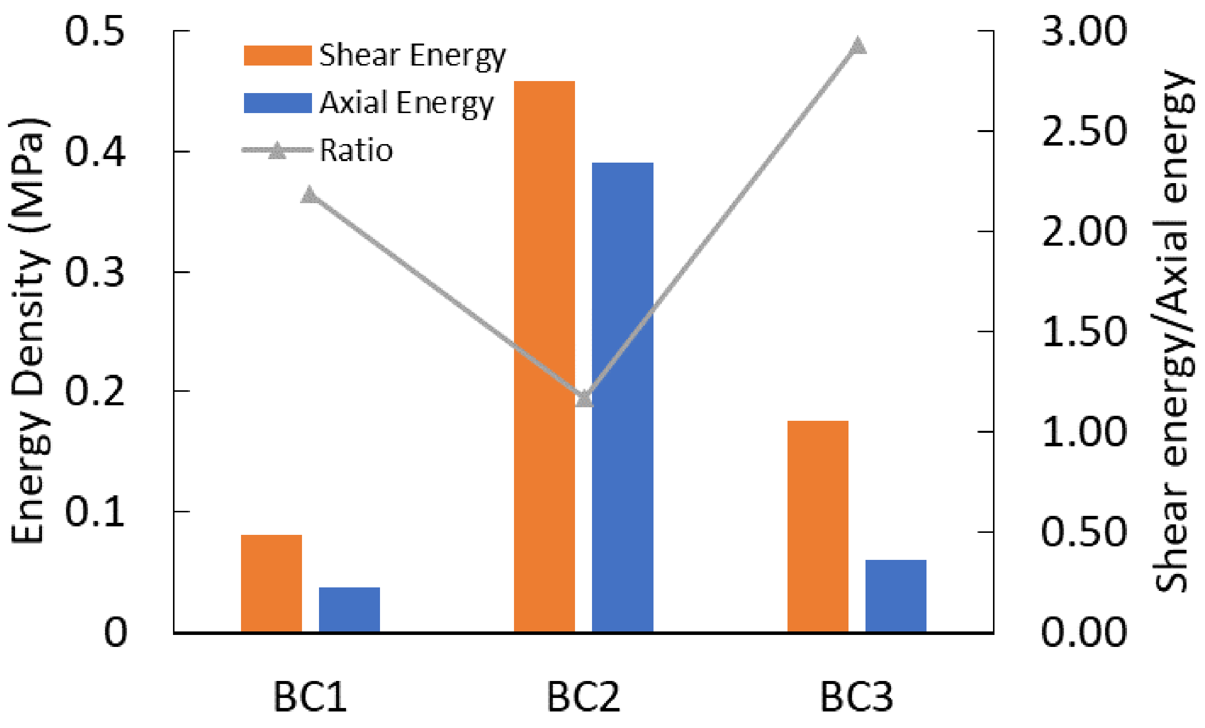


System Level Solder Joint Reliability Using Sherlock

- Strain and energy density in solder joints is evaluated for the three boundary conditions
- Shear strain is proportionally larger than axial strain for all three boundary conditions
- Energy density ratio decrease compared to strain ratio for BC2 and increases for BC3.

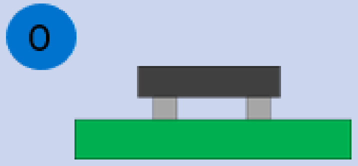
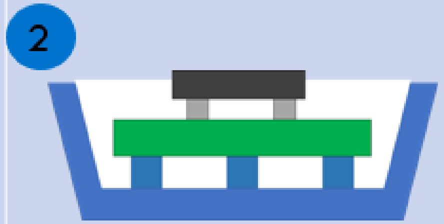
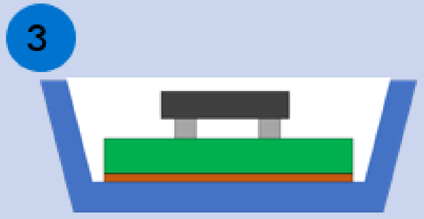






System Level Solder Joint Reliability Using Sherlock

- The addition of central mount point results in detrimental effect on BGA solder fatigue prediction for -40°C to 125°C profile
- The adhesive resulted in 4.69X reduction in characteristic life compared to bare board configuration
- This analysis can accelerate prototyping by changing adhesive material and/or PCB mounting configuration to the housing that will not compromise critical components with respect to the bare board

Characteristic Life	1150	11	245
Boundary Condition			

Agenda

2019 DESIGN FOR RELIABILITY CONFERENCE

System Level Reliability

01 Introduction
- Failure modes in electronic systems
- Failure mechanisms in solder joints
- System level solder joint reliability using sherlock

02 **Fatigue Models**
- **Mechanical fatigue models**
- **Thermal fatigue models**

03 Pb-free Solder Alloys
- Low silver and low melt Pb-free solder alloys
- Consortium projects

04 Case Study 1: PCB composition

05 Case Study 2: Underfill selection for BGA package

06 Conclusion

Fatigue Models

2019 DESIGN FOR RELIABILITY CONFERENCE

- Thermal Fatigue Models:
  - Analytical Models:
    - Strain range approach:
      - Acceleration factor (Norris Landzberg) $AF = \frac{N_1}{N_2} = \left(\frac{f_1}{f_2}\right)^{-m} \left(\frac{\Delta T_1}{\Delta T_2}\right)^{-n} e^{\frac{E_a}{K}\left(\frac{1}{T_{max,1}} - \frac{1}{T_{max,2}}\right)}$
      - Coffin-Manson $\frac{\varepsilon_p}{2} = \varepsilon'_f (2N)^c$
      - Engelmaier Equation $\Delta\gamma = F\frac{D\Delta\alpha\Delta T}{2h}$ $N_f = \frac{1}{2}\left(\frac{\Delta\gamma}{2\varepsilon'_f}\right)^{\frac{1}{c}}$ $c = -0.442 - 6x10^{-4}\bar{T} + 1.74x10^{-2}\ln(1+f)$
    - Energy density approach
      - Blattau Model

$$(\alpha_2 - \alpha_1)\cdot\Delta T\cdot L_D = F\cdot\left(\frac{L_D}{E_1A_1} + \frac{L_D}{E_2A_2} + \frac{h_s}{A_sG_s} + \frac{h_c}{A_cG_c} + \left(\frac{2-\nu}{9\cdot G_b a}\right)\right) \quad \Delta W = 0.5\cdot\Delta\gamma\cdot\frac{F}{A_s}$$

$$N_f = (0.001)^{-1}$$

  - Each model improves on the previous approach by incorporating additional physical parameters such as package and PCB geometry and material properties.

Fatigue Models

- Thermal Fatigue Models:
  - Finite element based models:
    - Darveaux's model
      - Constants k1 through K4 depend on FEA simulation methodology, package type and solder constitutive model
    - Syed's Model
      - Accumulated energy density per cycle inversely proportional to characteristic life
      - Sensitive to solder constitutive model
      - Calibrated for chip scale packages
    - Sherlock (Thermo-mech)
      - Creep equivalent approach
      - Energy partitioning method of shear and axial components
  - First two methods require highly experienced FEA users to build, execute and post process simulation.

Crack initiation

$$N_0 = k_1 \Delta W_{ave}^{k_2}$$

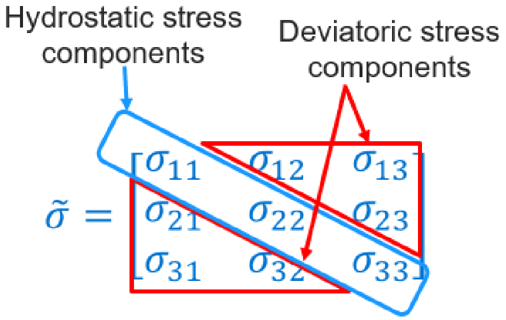
Crack propagation

$$\frac{da}{dN} = k_3 \Delta W_{ave}^{k_4}$$

Characteristic life

$$\eta_w = N_0 + \frac{a}{da/dN}$$

$$N_f = (0.0019\, w_{acc})^{-1}$$



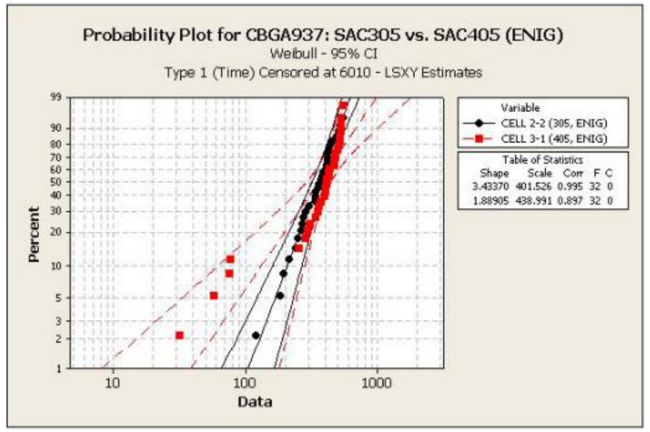
$$N_f = C_1(\Delta W)_{shear}{}^{n_1} + C_2(\Delta W)_{Axial}{}^{n_2}$$

Agenda

System Level Reliability

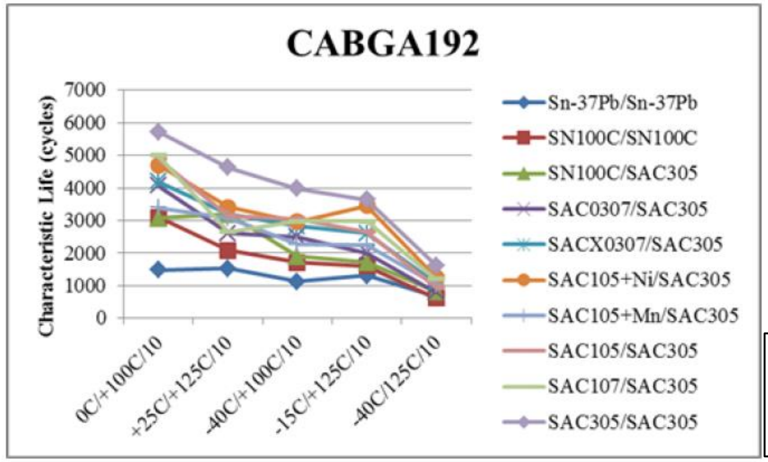
Pb-free Solder Alloys

- SnAgCu solder alloys comprise one of the most widely used alloy groups in board level reflow applications. SAC305 being the most commonly used.
- Effect of Ag content in SAC105 has been shown to benefit shock/vibration durability and thermal cycling performance in SAC405, respectively.
  - Implementation of SAC105 and SAC405 should be comparatively assessed to SAC305 rather than each other.
  - At low temperature range there is no statistically significant difference between SAC305 and SC405 for 1% failure probability. While for more aggressive temperature cycles SAC405 offers marginal increase.



McCormick, Heather, Polina Snugovsky, Craig Hamilton, Zohreh Bagheri, and Simin Bagheri. "The great SAC debate: comparing the reliability of SAC305 and SAC405 solders in a variety of applications." In *SMTA 2007 Pan Pacific Microelectronics Symposium, January 29-31, 2007*. 2007.

- BGA components assembled with mixed solder experience different behavior. SAC305 outperforms SAC105 at almost every thermal profile.

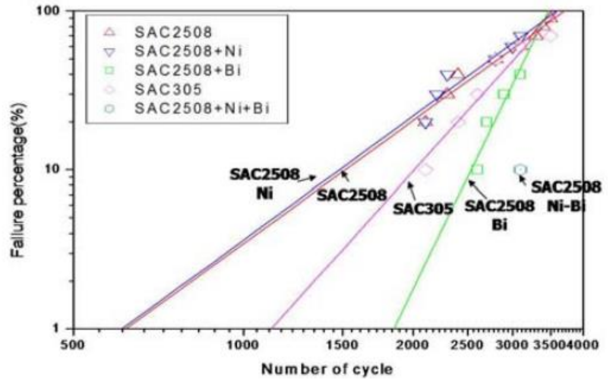


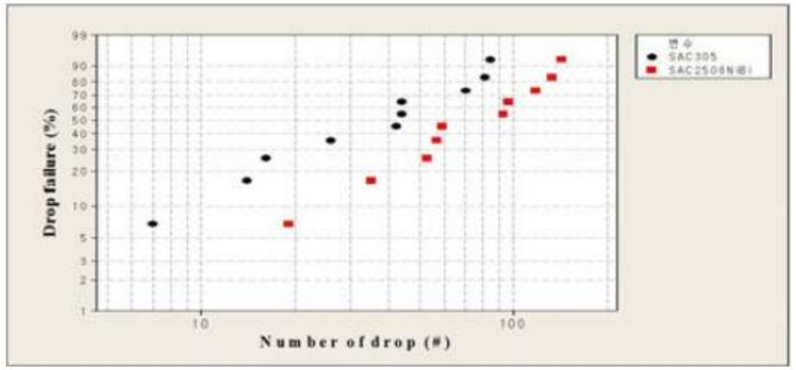
Sweatman, Keith, Keith Howell, Richard Coyle, Richard Parker, Gregory Henshall, Joseph Smetana, Elizabeth Benedetto et al. "iNEMI Pb-free alloy characterization project report: Part III–thermal fatigue results for low Ag alloys." *Proceeding of SMTAi* (2012).

Low Silver and Low Melt Pb-free Alloys

2019 DESIGN FOR RELIABILITY CONFERENCE

- Low silver solders have shown to be more robust to drop
  - Cheaper than SAC305. Can be doped with Ni and Bi to improve ductility.
  - Can be tailored to improve both thermal cycling and drop reliability.





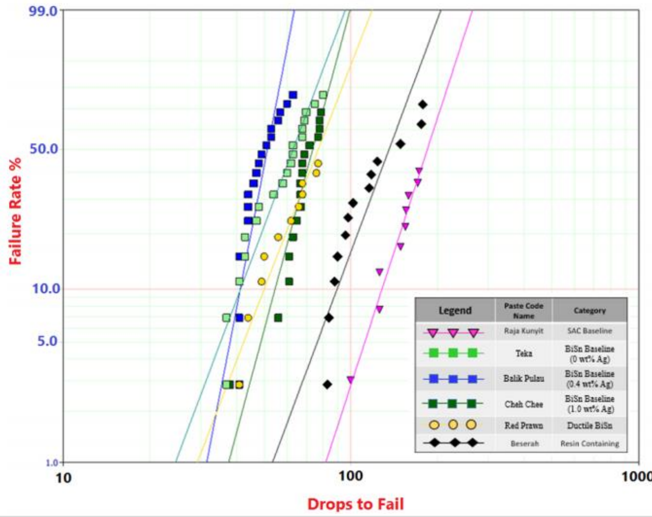
Lee, Jae Hong, Santosh Kumar, Hui Joong Kim, Young Woo Lee, and Jeong Tak Moon. "High thermo-mechanical fatigue and drop impact resistant Ni-Bi doped lead free solder." In *2014 IEEE 64th Electronic Components and Technology Conference (ECTC)*, pp. 712-716. IEEE, 2014.

  - Relative improvement over SAC305 can be application specific. Vary with surface finish, component type and board structure.
- Bismuth containing solder alloys
  - Reduce warpage during reflow <200°C
  - Does not offer improvement over SAC305

    In Package-on-Package devices

Fu, Haley, Raiyo Aspandiar, Jimmy Chen, Shunfeng Cheng, Qin Chen, Richard Coyle, Sophia Feng et al. "iNEMI Project on Process Development of BiSn-Based Low Temperature Solder Pastes." In *Proceedings of the 2017 SMTA International Conference*, pp. 207-220. 2017.

Code Name	Category	Bi wt %	Ag wt %	Initial Melting Temp, C	Liquidus Temp, C
Raja Kunyit	SAC Baseline	0	3.0	217	220
Cheh Chee	BiSn Baseline	57	1	139	139
Teka		58	0	139	139
Balik Pulau		57	0.4	139	143
Red Flesh	Ductile Bi-Sn	40	0	139	179
Black Thorn		15	0	125	191
Kan You		40	0	139	174
Sultan		50	0	138	151
Red Prawn		57	0.4	139	142
Beserah	Resin containing Bi-Sn based	58	0	139	139
Golden Pillow		58	0	139	141
HorLor		58	0	139	139
Chanee		57	1	139	140

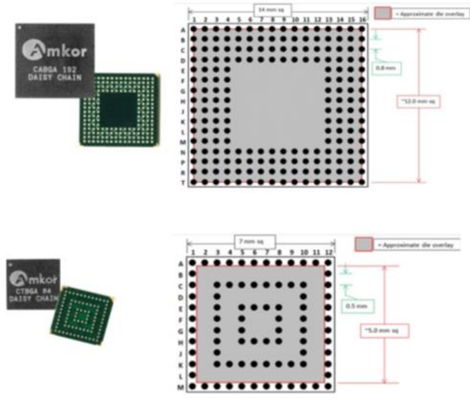


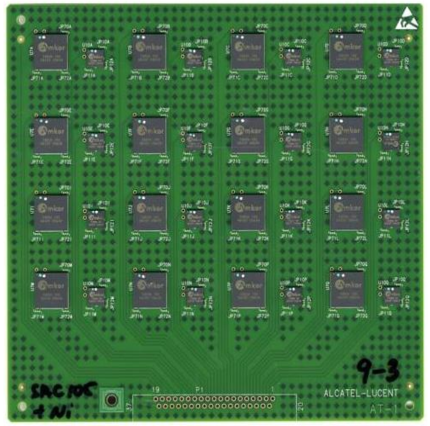
Consortium Projects – Thermal Cycling Reliability

- Consortium projects allow for joint research to investigate the reliability of multiple solder alloys under a variety of environmental stress conditions.
- Project jointly sponsored by iNEMI and HDP User Group and including CALCE and Universal consortium currently assessing 15 third-generation solder alloys.

Alloy	Thermal Cycling Profiles					BASELINE	BASELINE	Components / PCB's Required			
	0/100 °C (OSP)	-40/125 °C (OSP)	-55/125 °C (OSP)	-55/125 °C (ENiG)	-40/150 °C (OSP)	(OSP) (8x / pcb)	(ENiG) (8x / pcb)	CABGA 192 (16x / pcb)	CTBGA 84 (16x / pcb)	PCB OSP	PCB ENiG
SAC305	2	2	2	2	2	1	1	176	176	9	3
Innolot	2	2	2	2	2	1	1	176	176	9	3
HT	2	2	2	2	2	1	1	176	176	9	3
MaxRel Plus	2	2	2	2	2	1	1	176	176	9	3
794	2	2	2	-	2	1	-	136	136	9	-
758	2	2	2	-	2	1	-	136	136	9	-
SB6NX	2	2	2	2	2	1	1	176	176	9	3
Violet	2	2	2	2	2	1	1	176	176	9	3
Indalloy 272	2	2	2	-	2	1	-	136	136	9	-
Indalloy 276	2	2	2	2	2	1	1	176	176	9	3
Indalloy 277	2	2	2	2	2	1	1	176	176	9	3
405Y	2	2	2	2	2	1	1	176	176	9	3
SAC105	2	2	-	-	-	1	-	72	72	5	-
SACm	2	2	-	-	-	1	-	72	72	5	-
SAC1205+Ni (w/SnBi)	2	2	-	-	-	1	-	72	72	5	-
SAC1205+Ni (w/1205)	2	2	-	-	-	1	-	72	72	5	-
LF-C2	2	2	-	-	-	1	-	72	72	5	-
SN100CV	2	2	-	-	-	1	-	72	72	5	-
							Total Components / Boards	2424	2424	138	27

Alloy	Nominal Composition (wt. %)							Melting Range, °C
	Sn	Ag	Cu	Bi	Sb	In	other	
SAC305	96.5	3.0	0.5					217-221
Innolot	91.3	3.5	0.7	3.0	1.5		0.12 Ni	206-218
HT	95.0	2.5	0.5			2.0	Nd	206-218
MaxRel Plus	91.9	4.0	0.6	3.5				212-220
M794	89.7	3.4	0.7	3.2	3.0		Ni	210-221
M758	93.2	3.0	0.8	3.0			Ni	205-215
SB6NX	89.2	3.5	0.8	0.5		6.0		202-206
Violet	91.25	2.25	0.5	6.0				205-215
Indalloy 272	90.0	3.8	1.2	1.5	3.5			216-226
Indalloy 277	89.0	3.8	0.7	0.5	3.5	2.5		214-223
Indalloy 279	89.3	3.8	0.9		5.5	0.5		221-228
LF-C2	92.5	3.5	1.0	3.0				208-213
SN100CV	97.8		0.7	1.5			0.05Ni	221-225
405Y	95.5	4.0	0.5				0.05 Ni; Zn	217-221
SAC105	98.5	1.0	0.5					215-227
SACm	99.0	0.5	1.0				50 ppm Mn	217-227
SAC1205+Ni	98.3	1.2	0.5				Ni	218-227





iNEMI
International Electronics Manufacturing Initiative

HDP USER GROUP INTERNATIONAL, INC.

Agenda

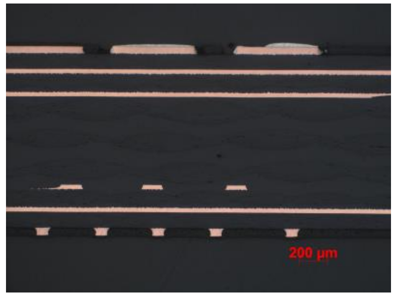
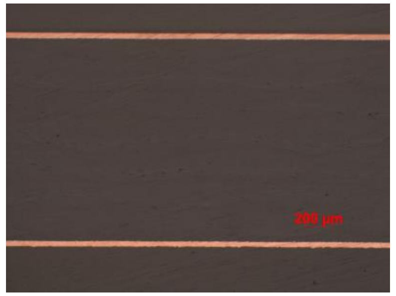
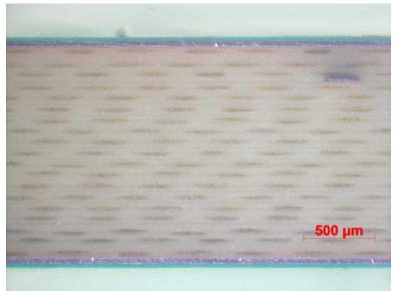
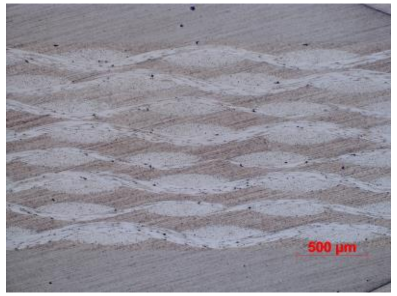
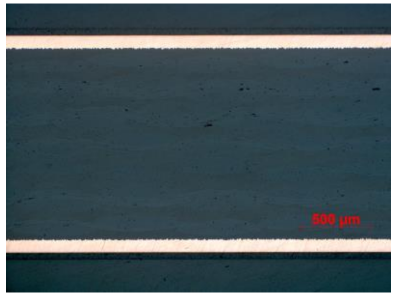
2019 DESIGN FOR RELIABILITY CONFERENCE

System Level Reliability

Case Study 1: PCB Composition

2019 DESIGN FOR RELIABILITY CONFERENCE

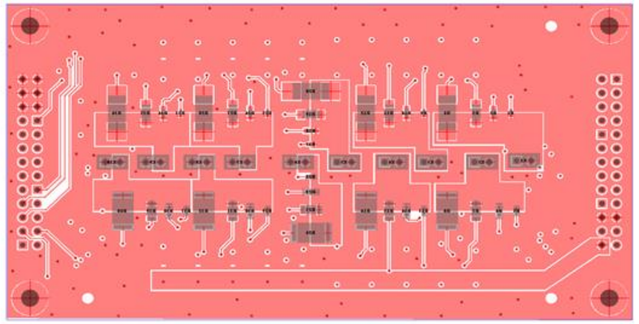
- Printed circuit boards are the backbone of an electronic system.
- Variation in glass style, resin, copper layers change board response to thermal and mechanical loadings.
- For mechanical behavior the elastic modulus is critical!
- For thermal behavior the CTE is critical!
  - Both CTE and E are orthotropic. Different CTE and modulus in different orientations.

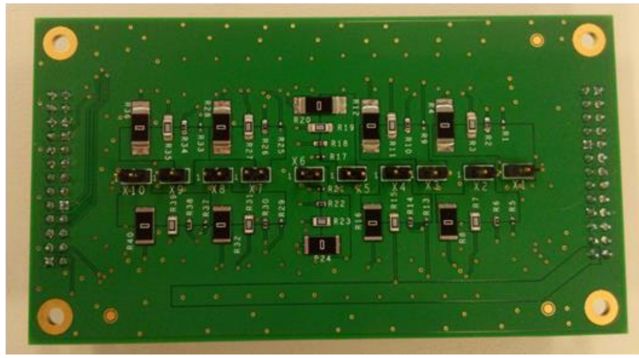
26.1 GPa	34.4 GPa	28.29 GPa	21.86 GPa	27.2 GPa	31.21 GPa	21.5 GPa
						
PCB-A	PCB-B	PCB-C	PCB-D	PCB-E	PCB-F	PCB-G

Case Study 1: PCB Composition

- Effect of glass style on board level reliability
- PCBs assembled with two glass style: 1080 and 7628.
- Both PCBs consisted of four resistors sizes: 2512, 1206, 0603, 0402
- Both PCBs with 62 mil thickness

Gerber file of test vehicle



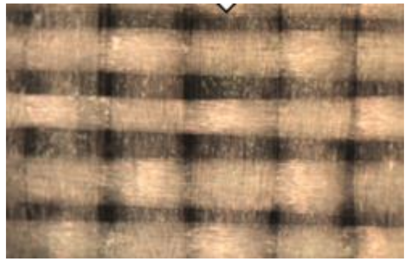


Maxim Serebrini and Greg Caswell (2018) The Impact of Glass Style and Orientation on the Reliability of SMT Components. international Symposium on Microelectronics: Fall 2018, Vol. 2018, No. 1, pp. 000699-000706

CTE Measurements:

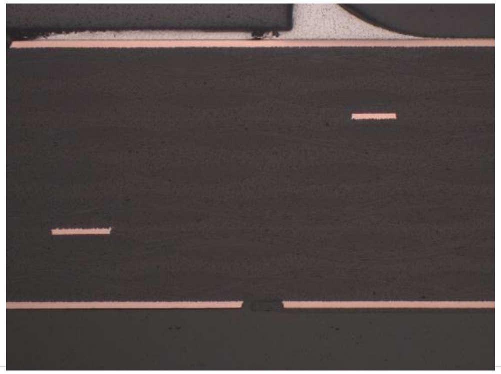
1080 Glass style – 19 layers

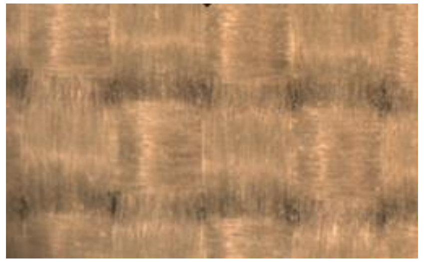
CTE_x= 19 ppm/°C
CTE_y= 18 ppm/°C
CTE_z= 61 ppm/°C



7628 Glass style – 7 layers

CTE_x= 15 ppm/°C
CTE_y= 14 ppm/°C
CTE_z= 42 ppm/°C

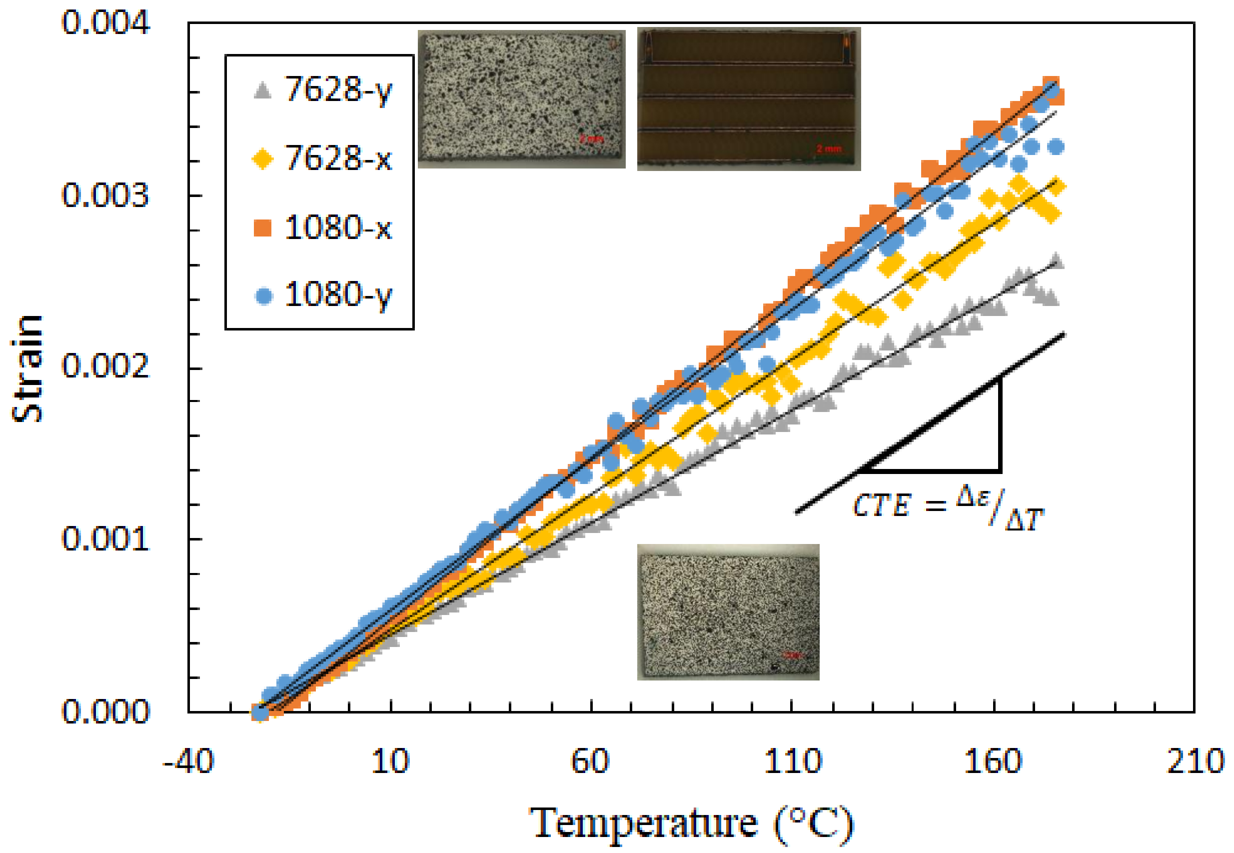




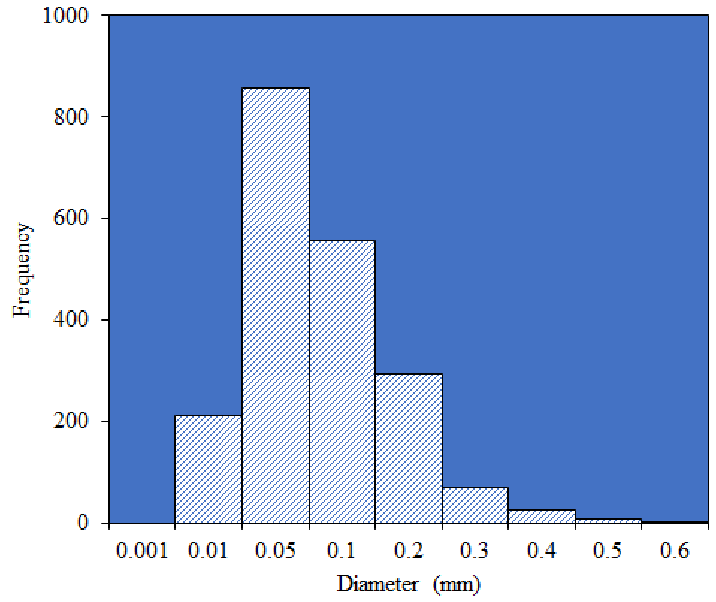
Case Study 1: PCB Composition

Thermal chamber with cameras

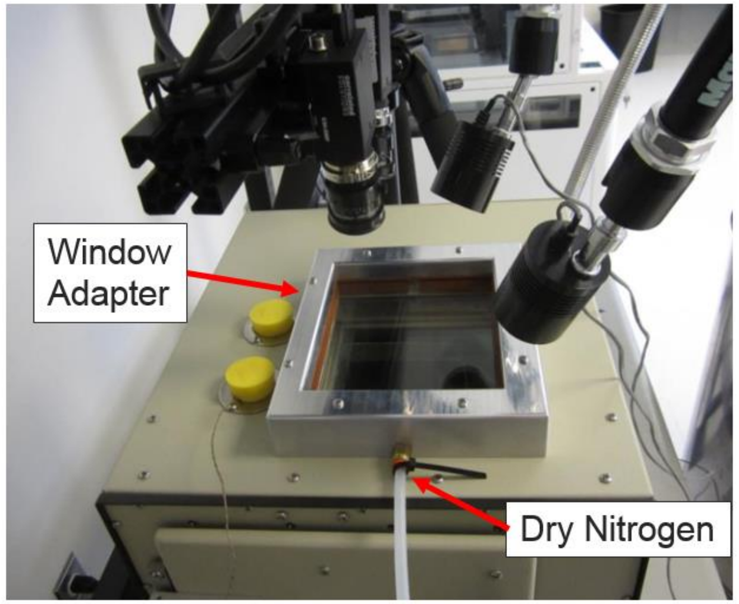
- CTE of PCBs measured using 3D digital image correlation (DIC) technique.
- Samples placed inside thermal chamber and heated at 3°C/minute.



Speckled sample for DIC

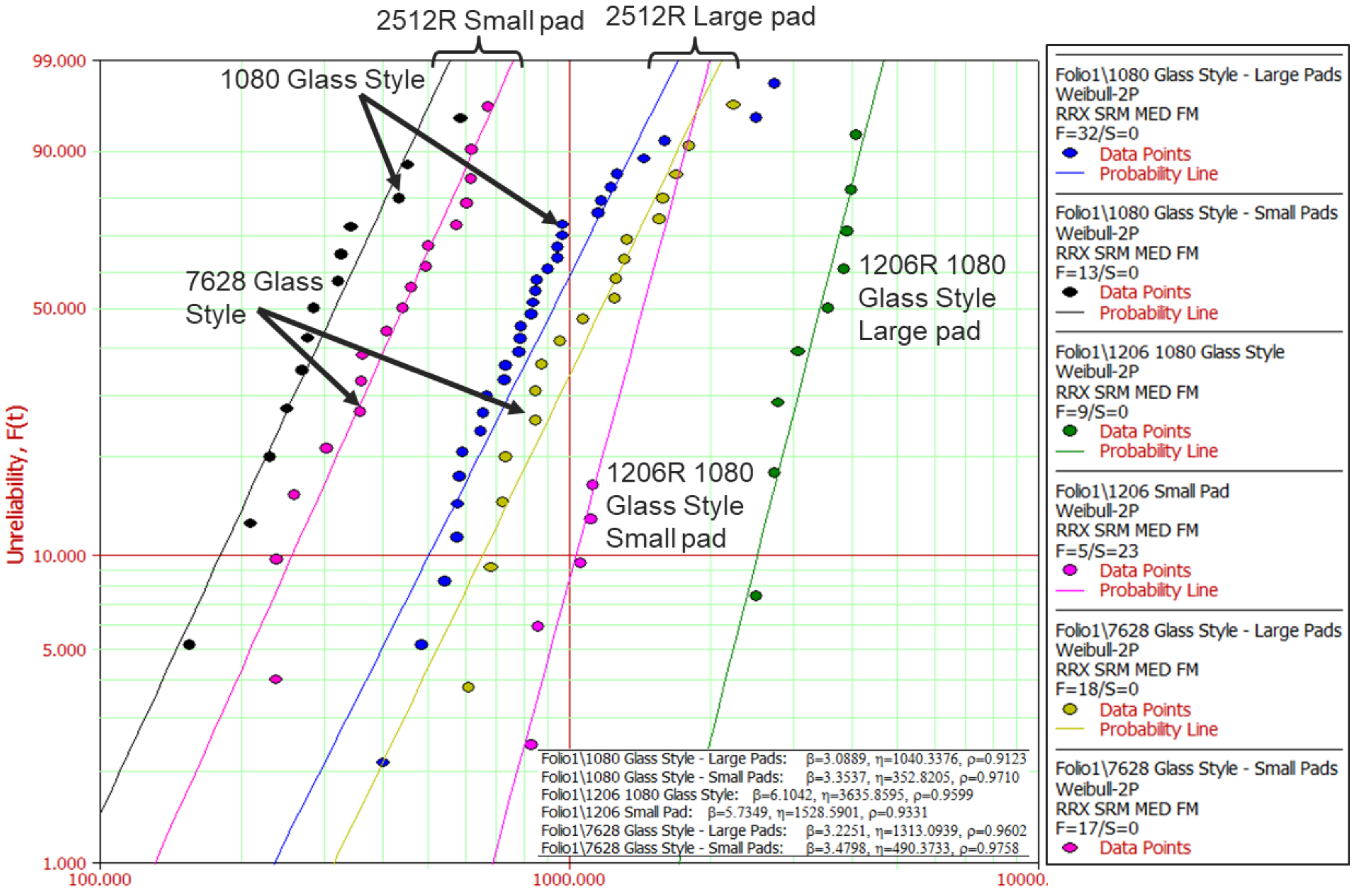


Thermal chamber with cameras



Case Study 1: PCB Composition

- Failure rate fitted to 2 parameter Weibull distribution
- Characteristic life was found to be influenced more by pad size rather than glass style.
- Smaller components were found to be more sensitive to the 1080 glass style boards than the 7628.



Case Study 1: PCB Composition

- Failure analysis before and after thermal cycling

Small Solder pads

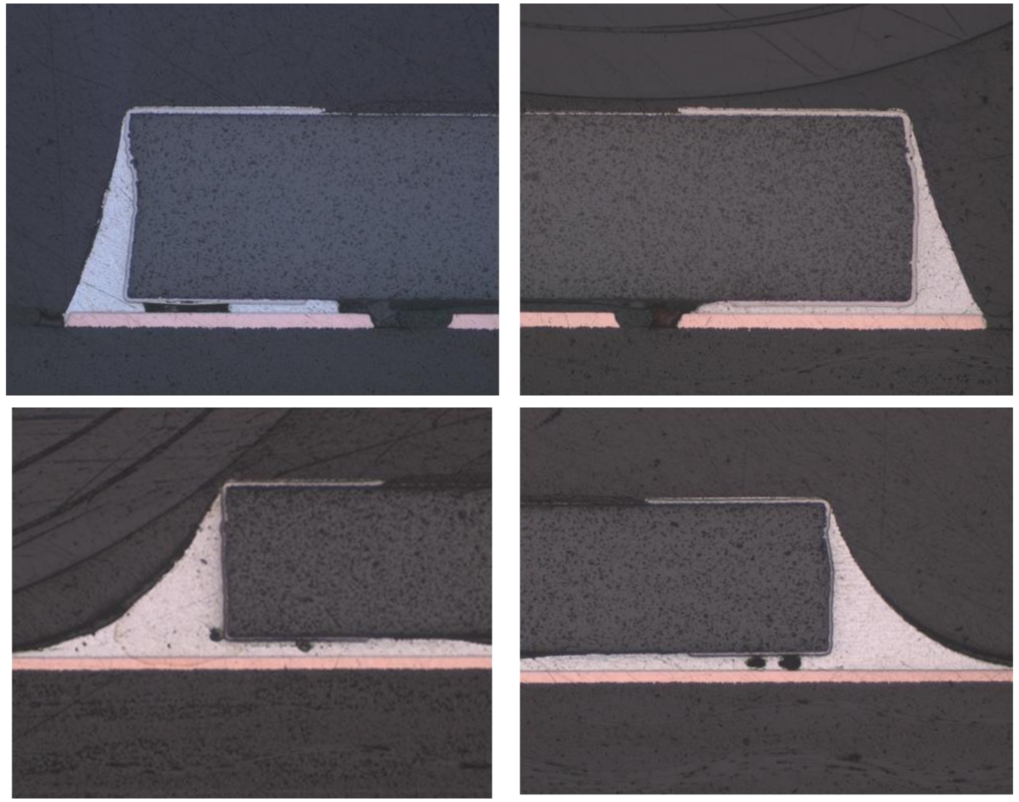
Pad size: 3.2x0.847mm

Solder height: 22-41µm

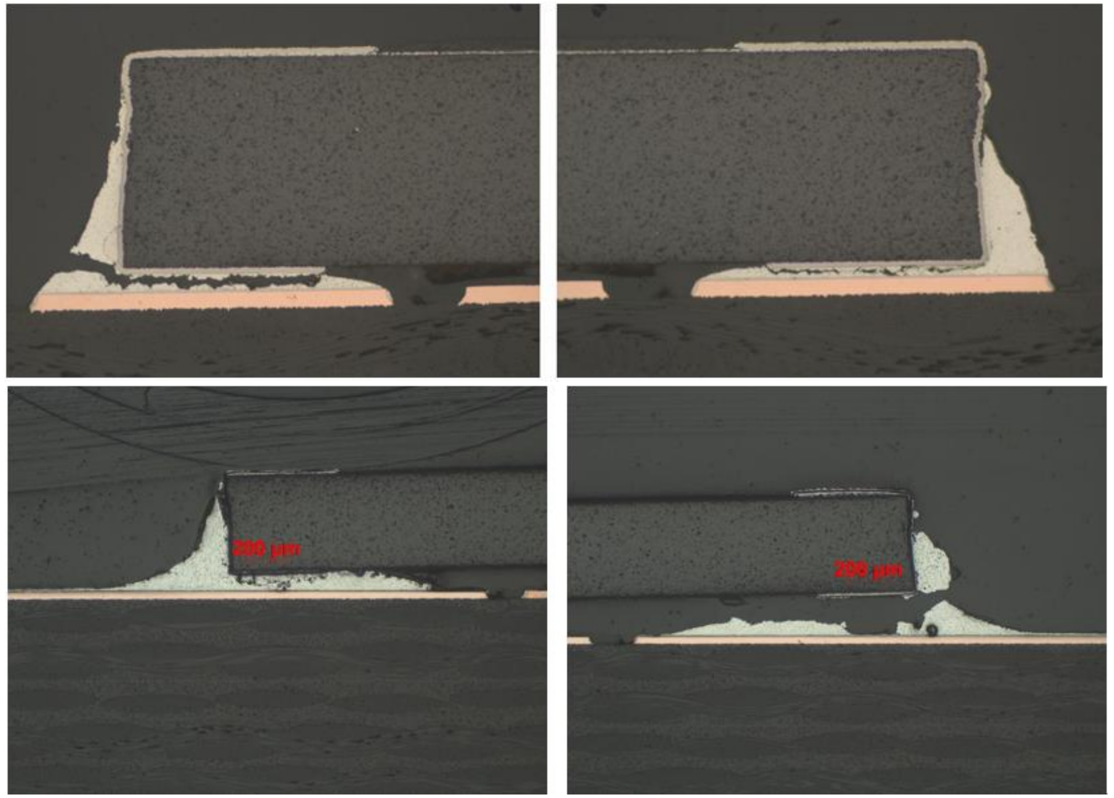
Large Solder pads

Pad size: 3.2x3.2 mm

Solder height: 42-46µm



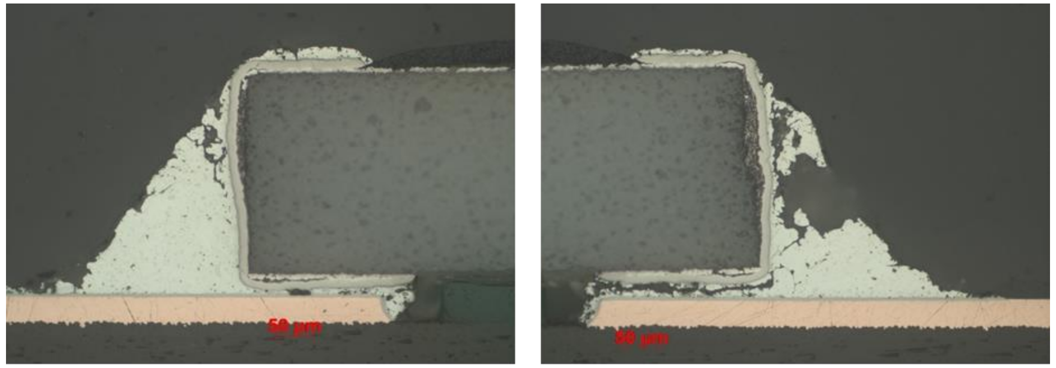
2512 on 7628 Glass style



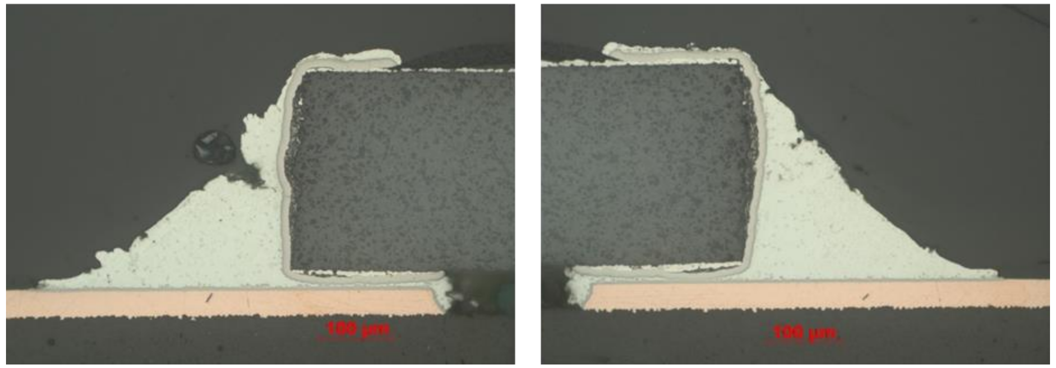
Case Study 1: PCB Composition

- Failure analysis of 0402 components after thermal cycling.
- No electrical open signals were recorded for the smaller 0402 or 0603 resistors on either glass styles.
- Solder joint size and height found to vary between resistors due to pick and place process.
- Solder joints in smaller chip resistors remained electrically connected even after crack propagated through 90% of the joint on 1080 glass style
- Chips on 7628 glass style were found undamaged.

0402 on 1080 Glass style



0402 on 7628 Glass style



Case Study 1: PCB Composition

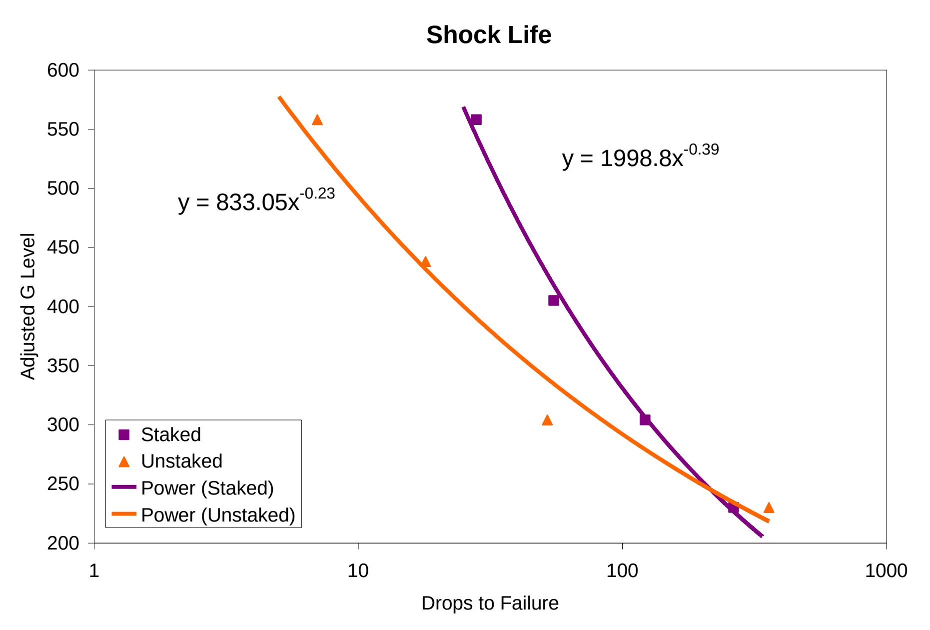
- Understanding PCB stackup is crucial for accurate reliability assessment of solder joints in electronics undergoing accelerated thermal cycling.
- The difference between 1080 and 7628 glass styles is found to change by 4 ppm/°C in-plane and by 20ppm/°C out of plane.
- Solder joint size is found to control characteristic life more so than the difference in CTE between the two glass styles.
- Smaller resistors were found with extensive cracking with the high CTE boards (1080 glass style).
- Analytical and FEA models can be used to predict thermal fatigue life of surface mount components with equal degree of accuracy.

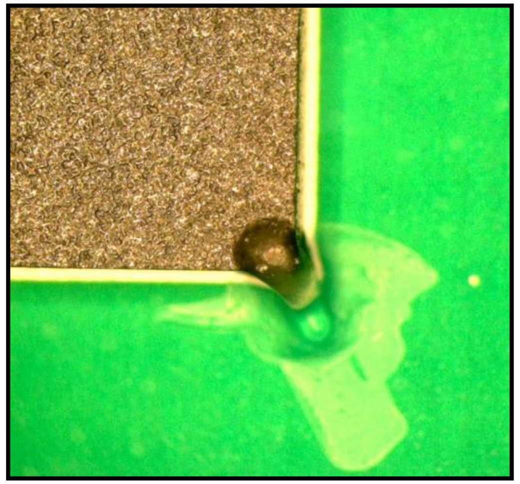
Agenda

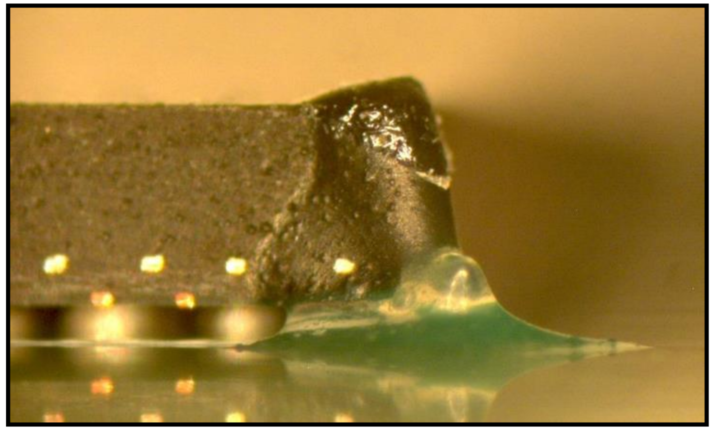
System Level Reliability

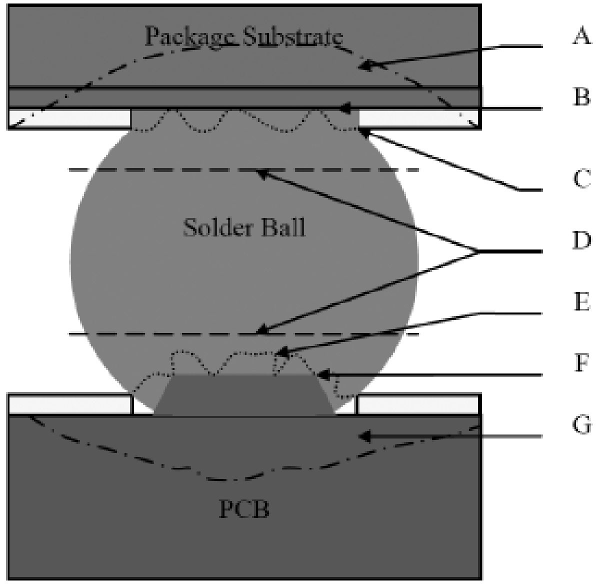
Case Study 2: Underfill Selection for BGA Package

- Underfills, edge bonding, and corner staking are often used to mitigate failure under drop and shock.
- Sherlock implements shock based on critical board level strain.
- FEA simulations utilize implicit transient dynamic simulation.
- Shock transmitted through mounting points into the board.
- Most underfills (soft and hard) improve board level drop to failure.









Legend
A Package Pad Lift/Crater
B Pkg Base Metal/IMC Interface Fracture
C Pkg IMC/Solder Interface Fracture
D Bulk Solder Fracture
E PCB IMC/Solder Interface Fracture
F PCB Solder pad/IMC Interface Fracture
G PCB Pad Lift/Crater

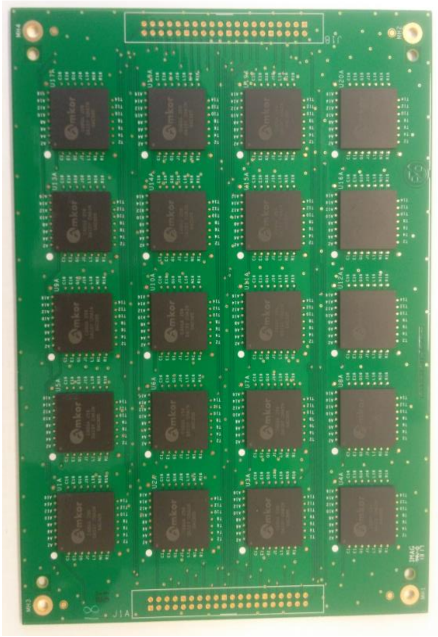
Case Study 2: Underfill Selection for BGA Package

- Underfill selection for thermo-mechanical loading is a bit more challenging
  - CTE is and modulus are a function of temperature.
  - Glass transition temperature is critical value
- Finite element simulations are often the most efficient and accurate method to assess the impact of underfill materials on board level reliability
  - Require temperature dependent CTE and modulus of underfill, package and PCB
  - Creep model of solder alloy
  - Plastic or creep behavior of underfill as function of temperature if going through glass transition
- Modeling underfill interaction with the package and solder requires deeper understanding of material behavior and appropriate assumptions
- Which underfill material model is optimal for obtaining accurate reliability prediction?
- What damage model fits my FEA prediction better?

Case Study 2: Underfill Selection for BGA Package

- Accelerated thermal cycling of reworkable underfills
  - Reworkable underfills are required for electronic assemblies with certain maintenance schedules and costs
  - Material properties of reworkable underfills vary with material chemistry and filler content
  - Thermal cycling from -55°C to 125°C.

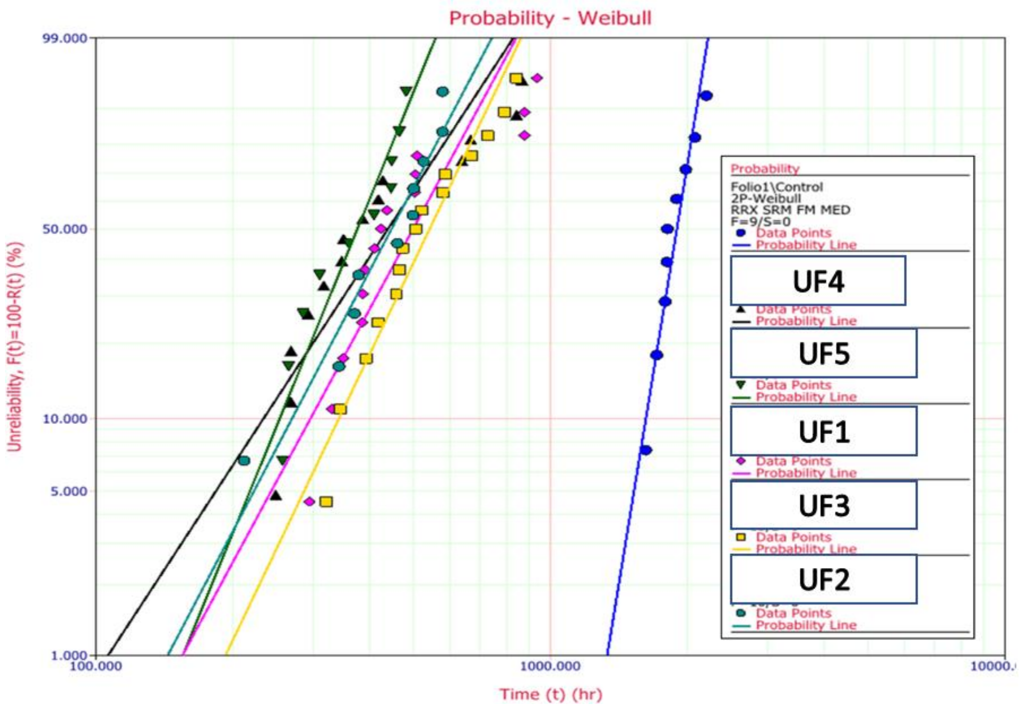
Test vehicle



Reworkable underfills used in the study

		UF1	UF2	UF3	UF4	UF5
Filler	Content (Wt%)	30	35	50	0	0
	Size (mean)	0.6	2	2	0	0
	Size (max)	3	10	10	0	0
Curing Condition	Temperature/Time	130°C/15 minutes				
Viscosity	@25°C Pa.s	3.5	0.6	2.0	4.0	3.6
Density	g/cm³	1.4	1.4	1.5	1.4	1.4

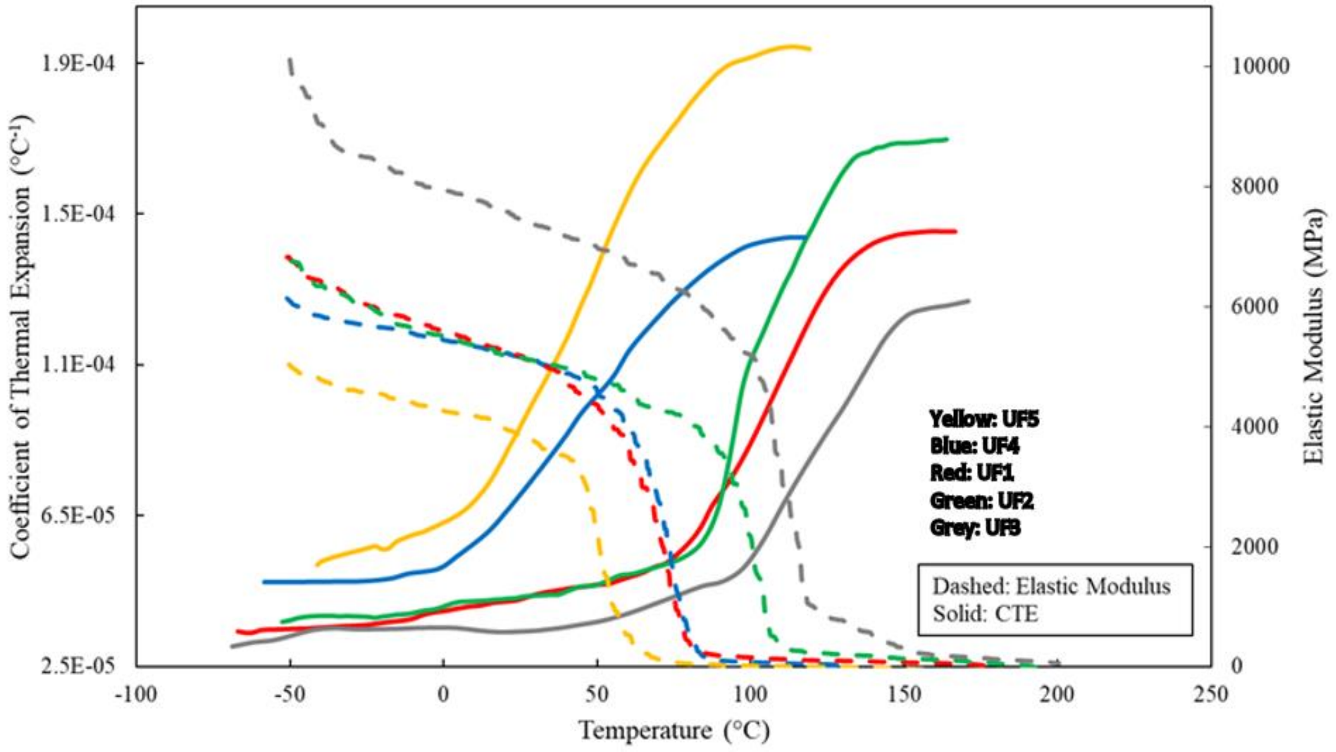
Failure rate

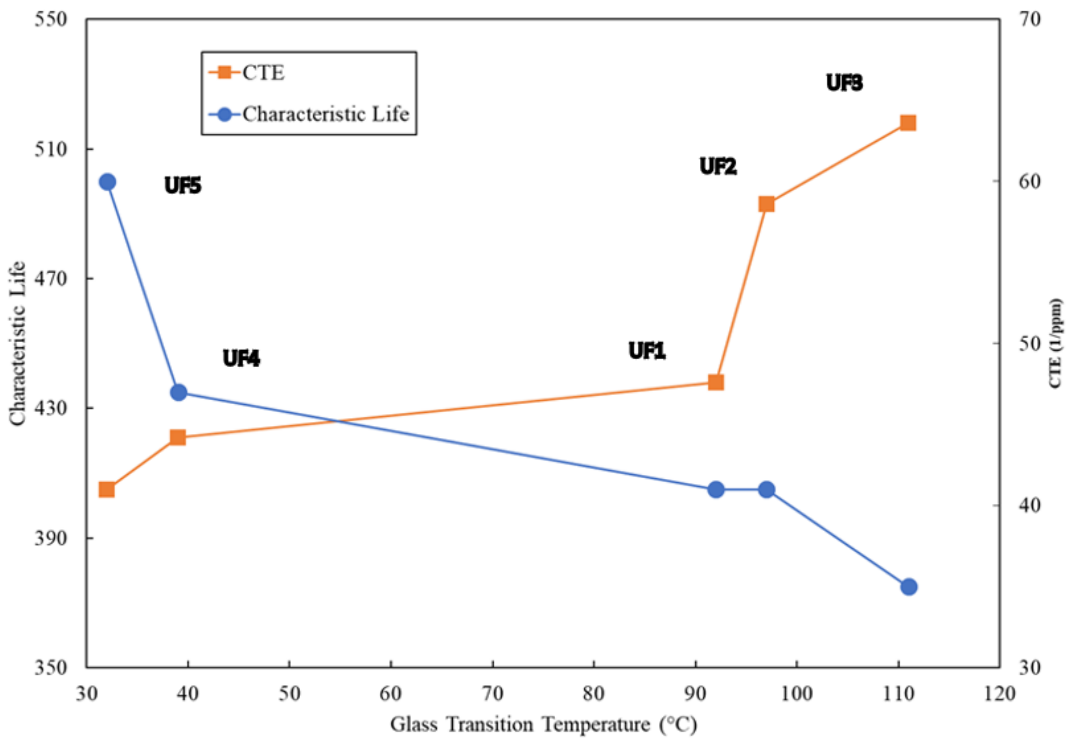


Case Study 2: Underfill Selection for BGA Package

- Failure rate of reworkable underfills follow glass transition point and CTE.
- Reworkable underfills with no filler generally posses higher CTE. The Tg is dependent on resin chemistry and cure profile.

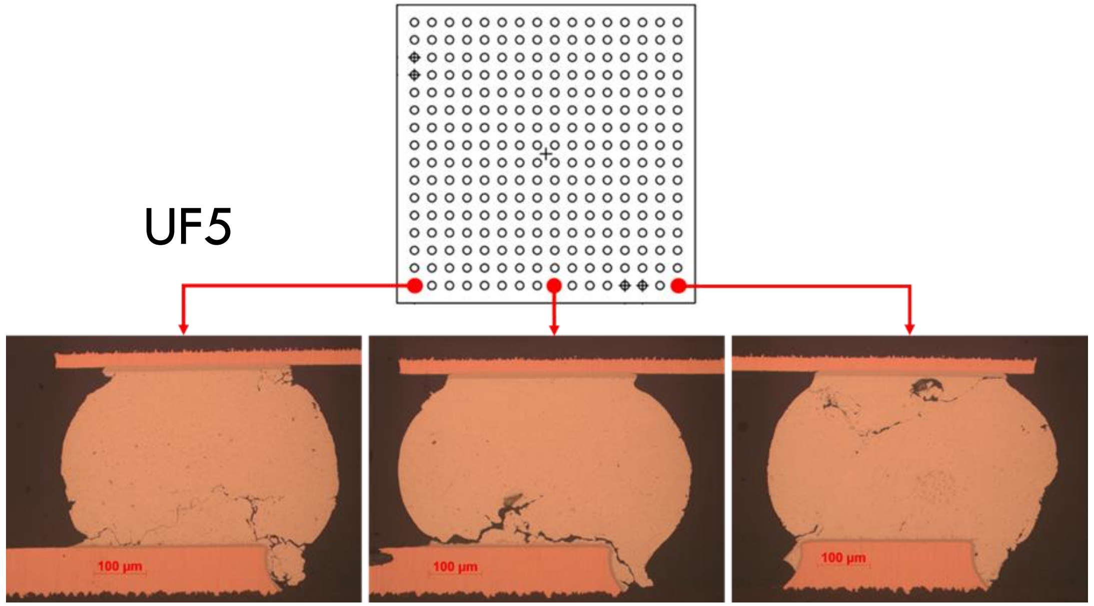
Underfill	η	β	1st Failure	CTE ($\alpha1/\alpha2$)	Tg (TMA/DMA)
Control	1955	11.99	1624	NA	NA
UF5	405	4.78	258	60/189	32/51
UF4	421	3.90	249	47/138	39/71
UF1	438	6.74	295	41/140	92/71
UF2	493	3.73	212	41/164	97/102
UF3	518	5.28	322	35/120	111/114

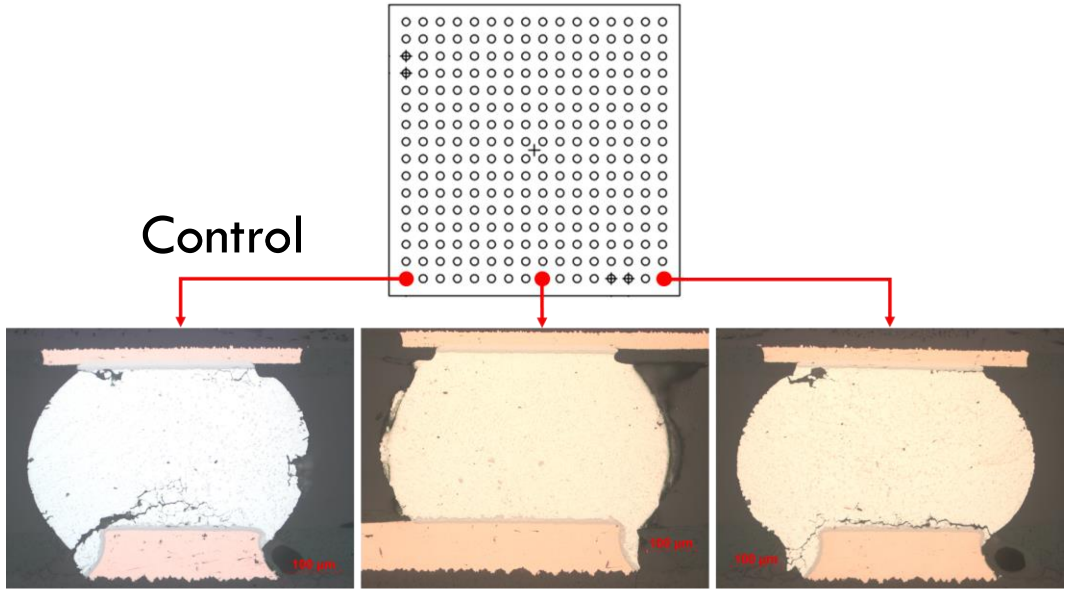


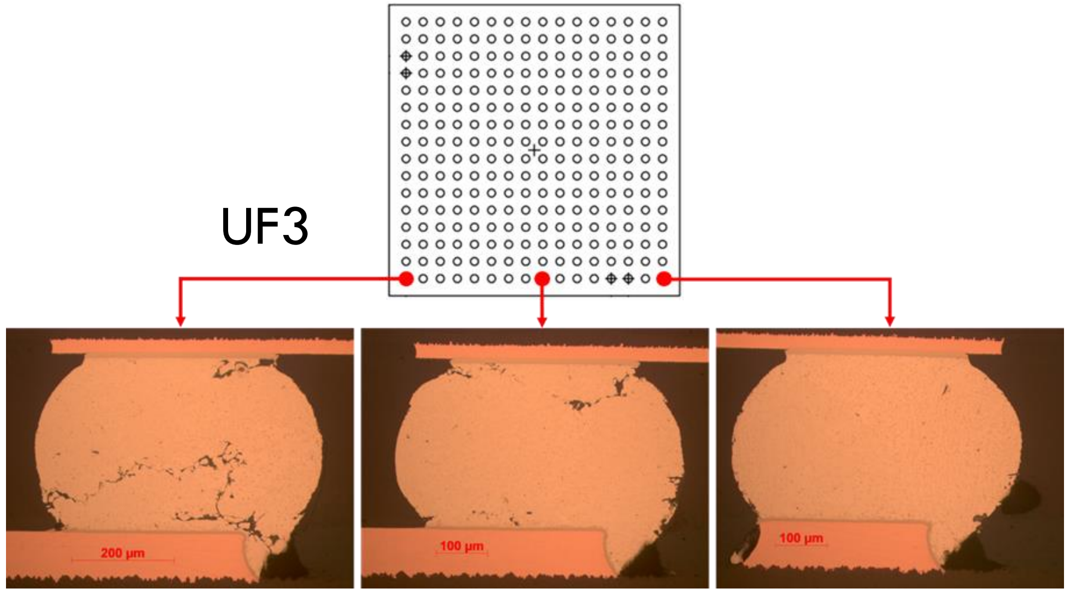


Case Study 2: Underfill Selection for BGA Package

- Failure analysis of BGA shows that control BGA demonstrates classic distance to neutral effect
- Underfilled BGAs with reworkable underfills show cracking that changes between board and package interface
- All underfills have glass transition below the maximum profile temperature







Case Study 2: Underfill Selection for BGA Package

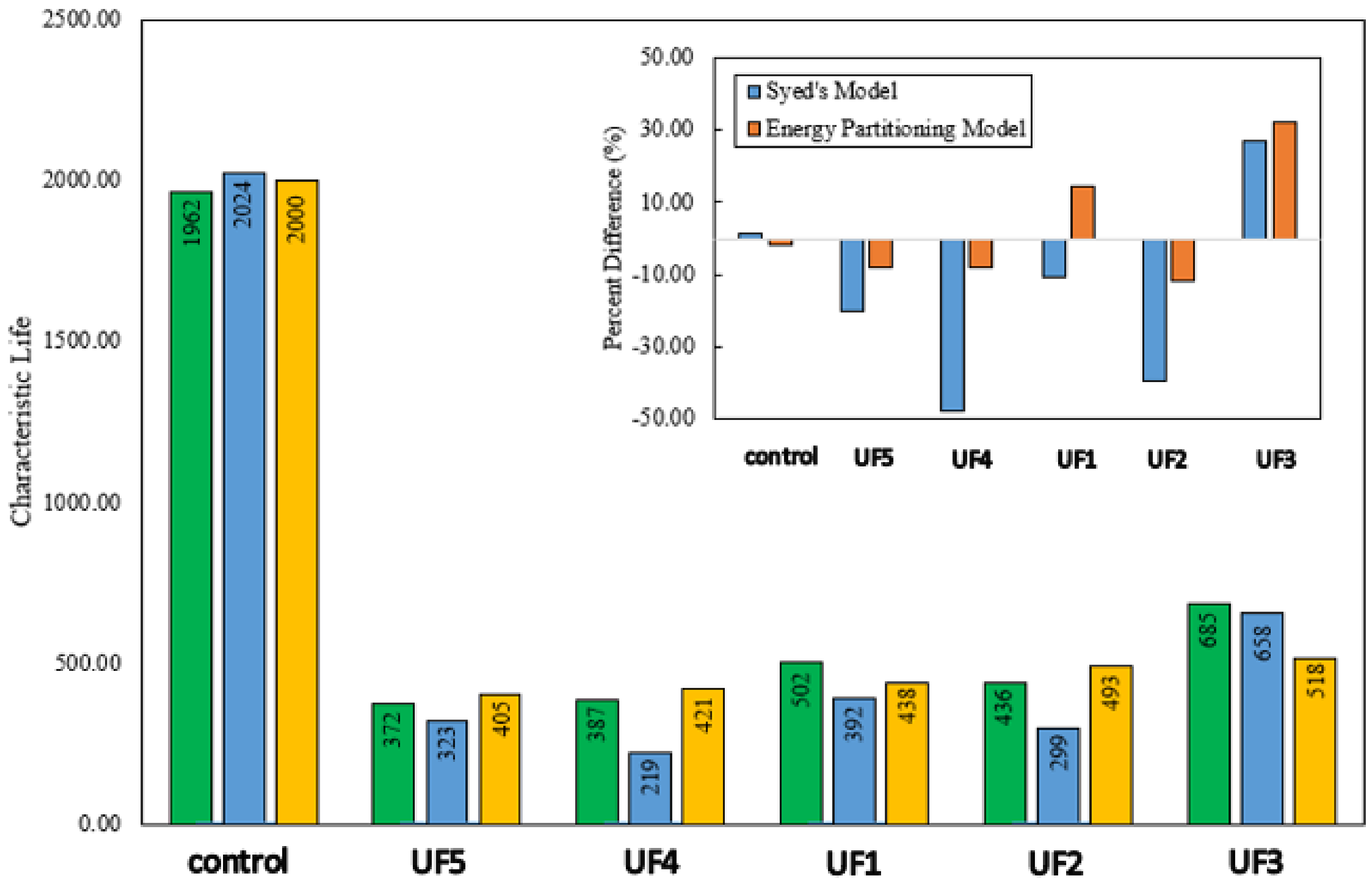
2019 DESIGN FOR RELIABILITY CONFERENCE

- Comparison of predicted characteristic life between energy partitioning model vs. Syed's model for underfilled BGAs

$$N_f = (0.0019\, w_{acc})^{-1}$$

$$N_f = C_1(\Delta W)_{shear}{}^{n_1} + C_2(\Delta W)_{Axial}{}^{n_2}$$

- Partitioning energy density allows for additional fitting constants
- Overall, the energy density partitioning provides better fit to experimental results compared to single energy density value



Conclusions

- Reliability assessment of any electronic system should start with consideration of the PCB, electronic components and environment (Thermal range, vibration load…)
- Thermal cycling of an electronic system considering the interaction of the PCB and housing can be performed using Sherlock to demine the effect on solder joints
  - Avoid placement of mounting point near components, especially large ICs
  - Adhesive selection should be assessed with respect to desired adhesive stiffness and thickness
- Solder alloy selection should be considered based on the intended application and durability requirement for the most critical component on the PCB
- Prevent failures of passive devices by recommending larger solder pads when possible
- Underfill selection should avoid crossing the glass transition both in test and field
  - Always test your underfill CTE and E as a function of temperature
  - Never trust manufacturer's data sheets!

Speaker Bio

Maxim Serebreni, Research Engineer at DfR Solutions

Maxim Serebreni is a Research Engineer at DfR Solutions. He has a background in experimental mechanics, material characterization and numerical modeling. His current research involves integration of Pb-free solder alloys in harsh use environments. He has consulted in the fields of electronics reliability, electronic packaging design and solder alloy metallurgy. He is currently completing his PhD in Mechanical Engineering at the University of Maryland, College Park under the supervision of Dr. Patrick McCluskey.

Contact

mserebreni@dfrsolutions.com

301-640-5831

https://www.linkedin.com/in/maxim-serebreni-88b72b46/