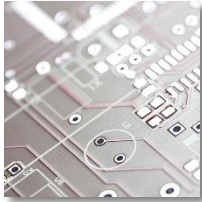
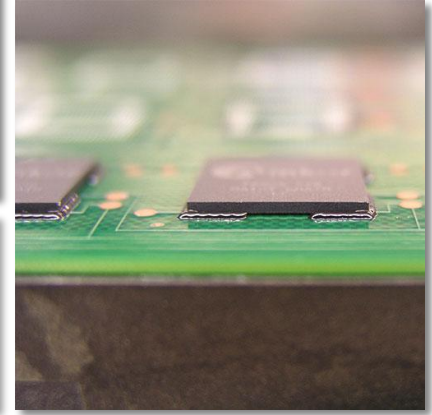


Reliability of Interconnects in LED Lighting Assemblies Utilizing Metal Clad Printed Circuit Boards

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BDM I.M.S.

Henkel Electronic Materials



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Agenda

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1. Introduction
2. Motivation
3. Interconnect Reliability
4. Solder Joint Testing
5. Test Results
6. Conclusions

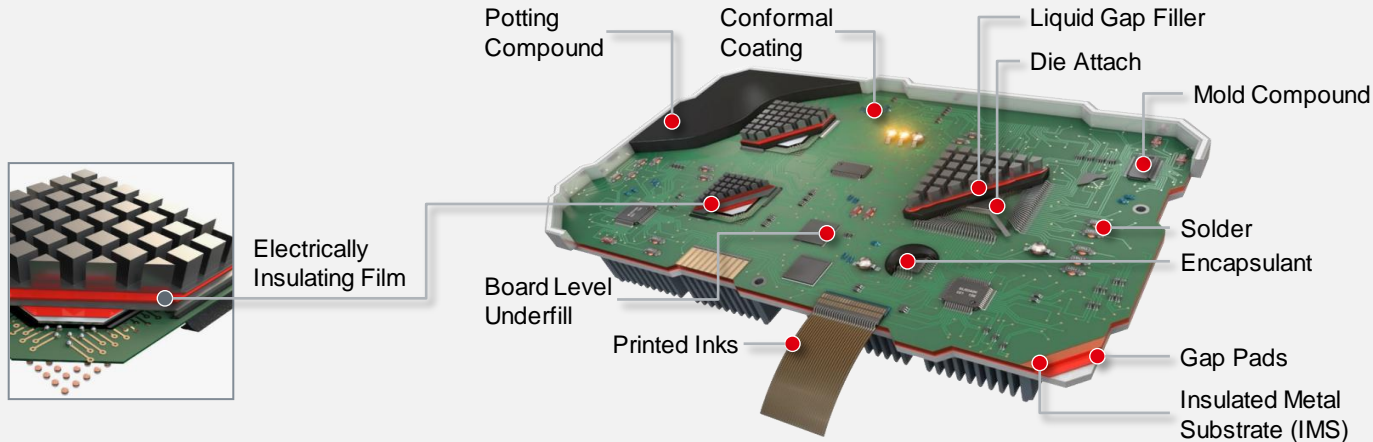


Introduction

Henkel at a glance

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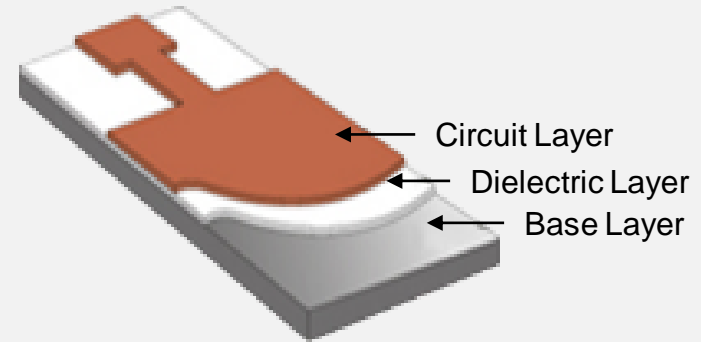
- 140 years old, German based, family owned company
- Close to 50,000 employees, over €18B in sales
- 3 divisions: Laundry & Home Care, Beauty Care and Adhesive Technologies
 - Specific division focused on solutions for Electronics applications



Motivation

Why using MCPCB in a LED assembly?

- LED performance is highly influenced by junction temperature
 - LED lifetime depends on junction temperature of the die
 - LED brightness depends on junction temperature of the die
 - LED Color shift depends on junction temperature of the die
- Various ways to achieve this:
 - FR4 with filled vias
 - FR4 with Cu-inlays
 - Ceramic boards
 - MCPCB



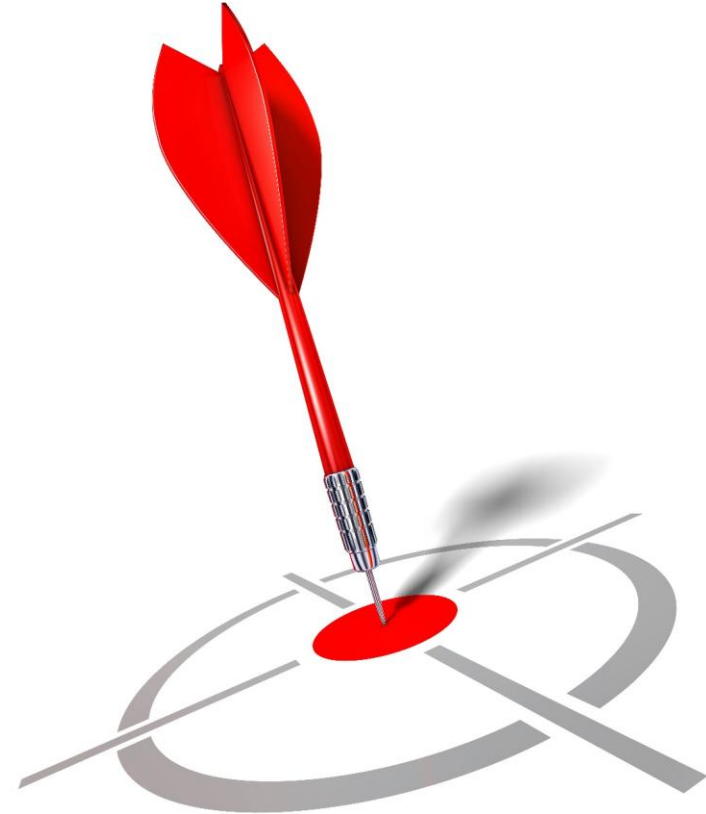
» **Proper thermal management is a must**

Motivation

Interconnect Reliability

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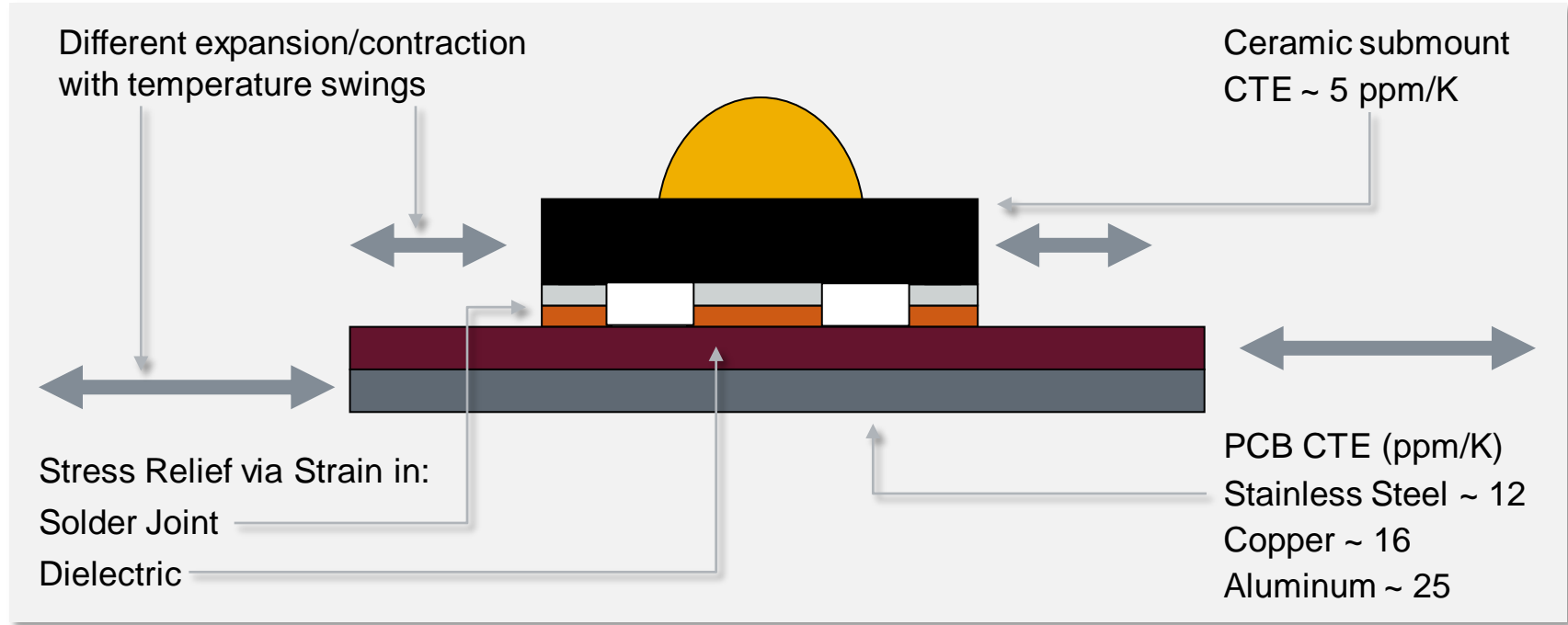
- Interconnect failure is an open circuit, not a short
- This causes all of the lights in series with the failed interconnect to go out.
- More significant than a single point source due to a short
- Warranties of 5 year or more are common in high reliability applications like street lighting, so the interconnect is crucial.



Interconnect Reliability

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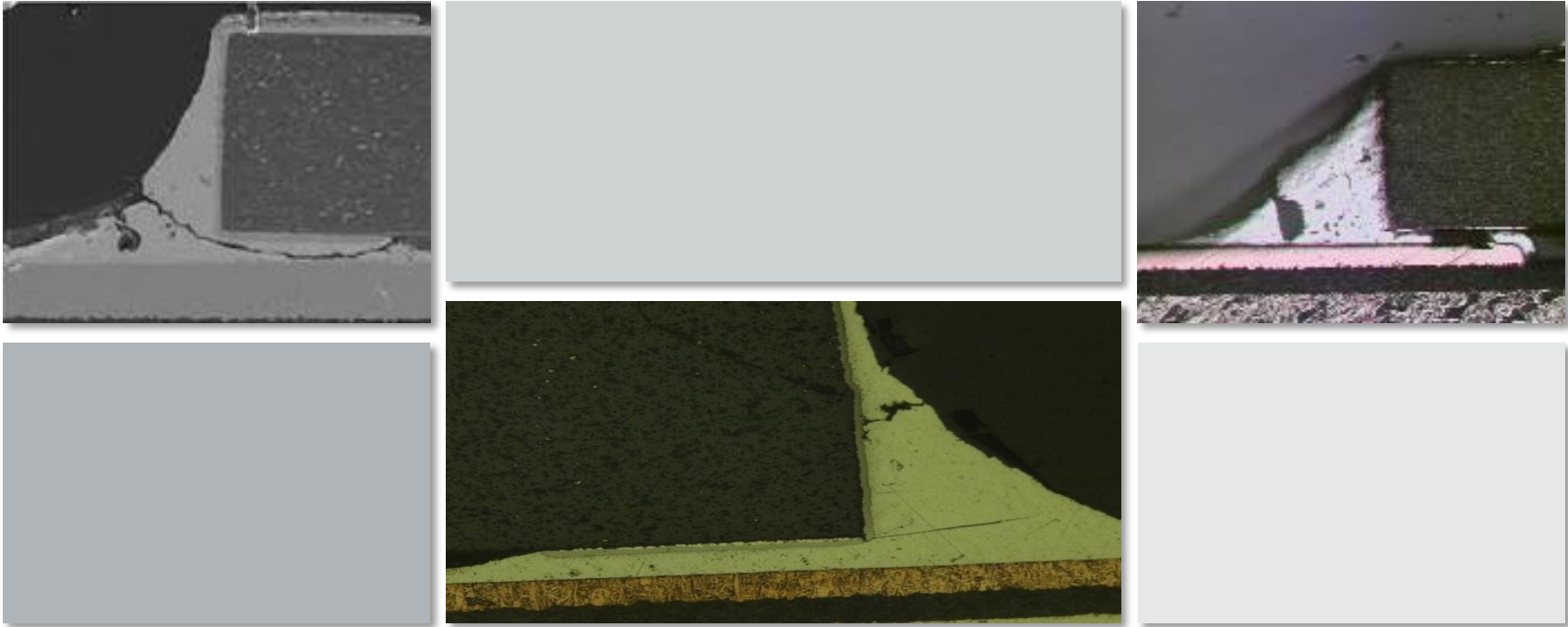
What happens



Interconnect Reliability

The Result

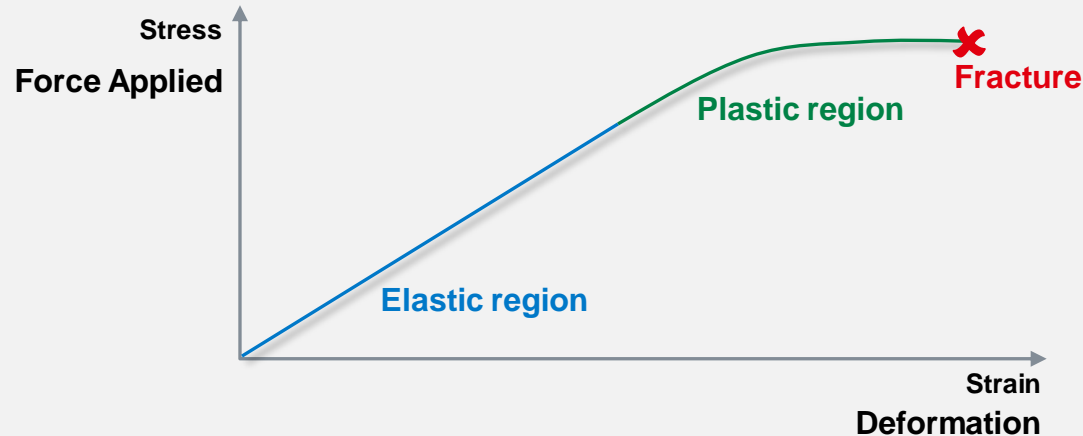
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Interconnect Reliability

What Happens

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- Most interconnect reliability / fatigue failures occur where there is local plastic deformation. They are initiated at a void, discontinuity, or stress concentration and grow through plastic deformation

Source: Wikipedia

- ΔD = the cyclic damage term. Generally: **the lower the better**

$$\Delta D = \frac{F L_D \Delta \alpha \Delta T}{h}$$

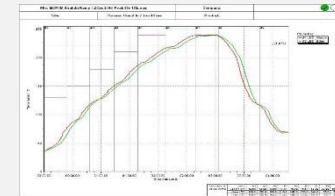
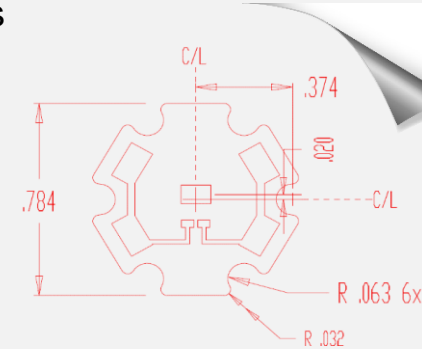
- F: correction factor $0.7 < F < 1.2$, generally
- L_D : distance to centerline or neutral plane
- $\Delta \alpha$: difference in CTE between package and substrate
- ΔT : maximum and minimum temperatures in thermal cycle
- H: solder joint thickness

Source: Engelmaier, Pb-free solder creep-fatigue reliability models updated and extended; Global SMT & Packaging, 9/2009. pg 36-37

Solder Joint Testing

Test parameters

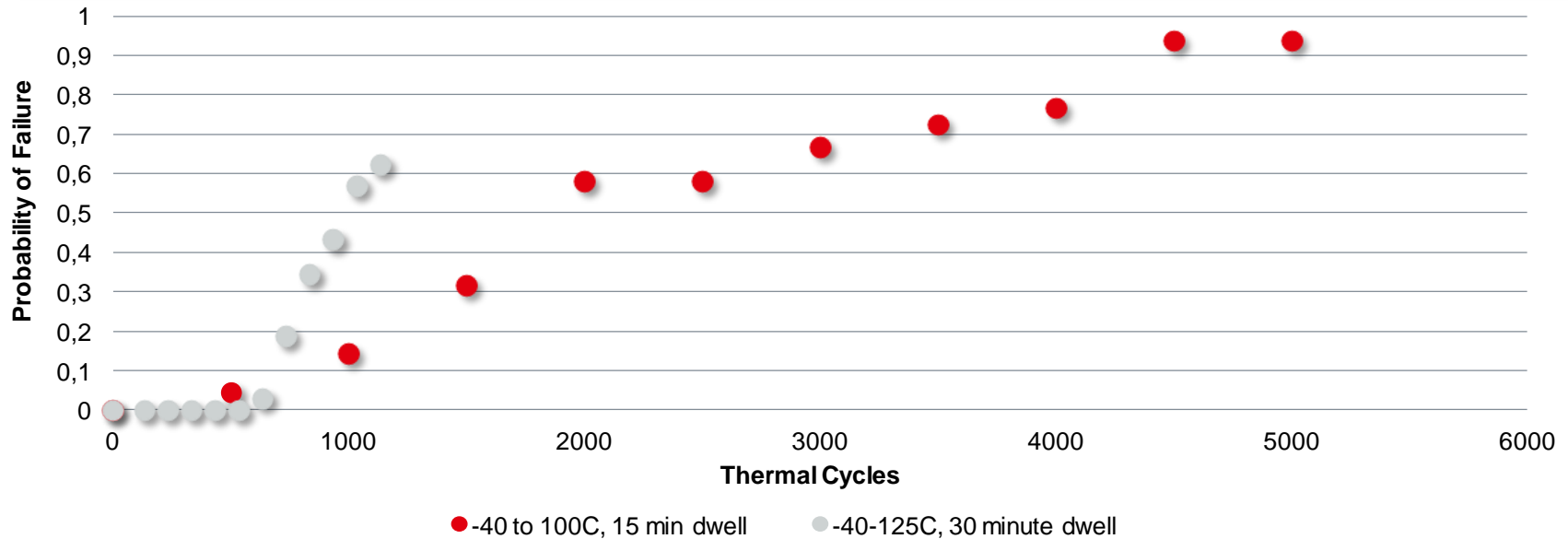
- Copper and Aluminum based boards with different dielectric materials
- Circuit pattern as shown
- Finished with Electroless Nickel Immersion Gold
- 3 solders evaluated
 - Low Creep (Henkels 90iSC)
 - Standard (SAC 305)
 - Low melt (140C)
- Solder was stenciled using a 125 micron laser cut stencil with a 10% reduction in aperture size
- Populated with Luxeon Rebel
- Solder was reflowed as shown in air with standard reflow cycle
- Thermal Cycle the assembly
- Apply 3 V at the pads and look for light at cycling intervals



Solder Joint Testing

Test results

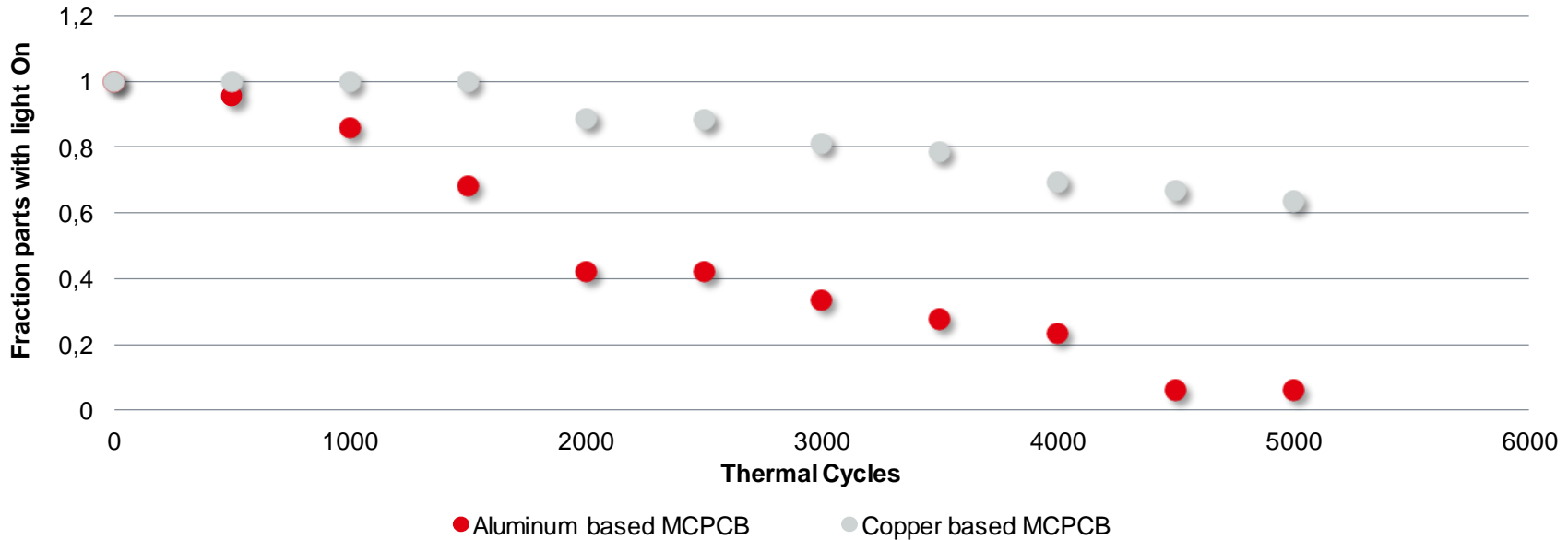
Comparison of Thermal Cycle on Solder Joint Reliability (aluminum)



Solder Joint Testing

Test results

Comparison of MCPCB Substrate on Solder Joint Reliability





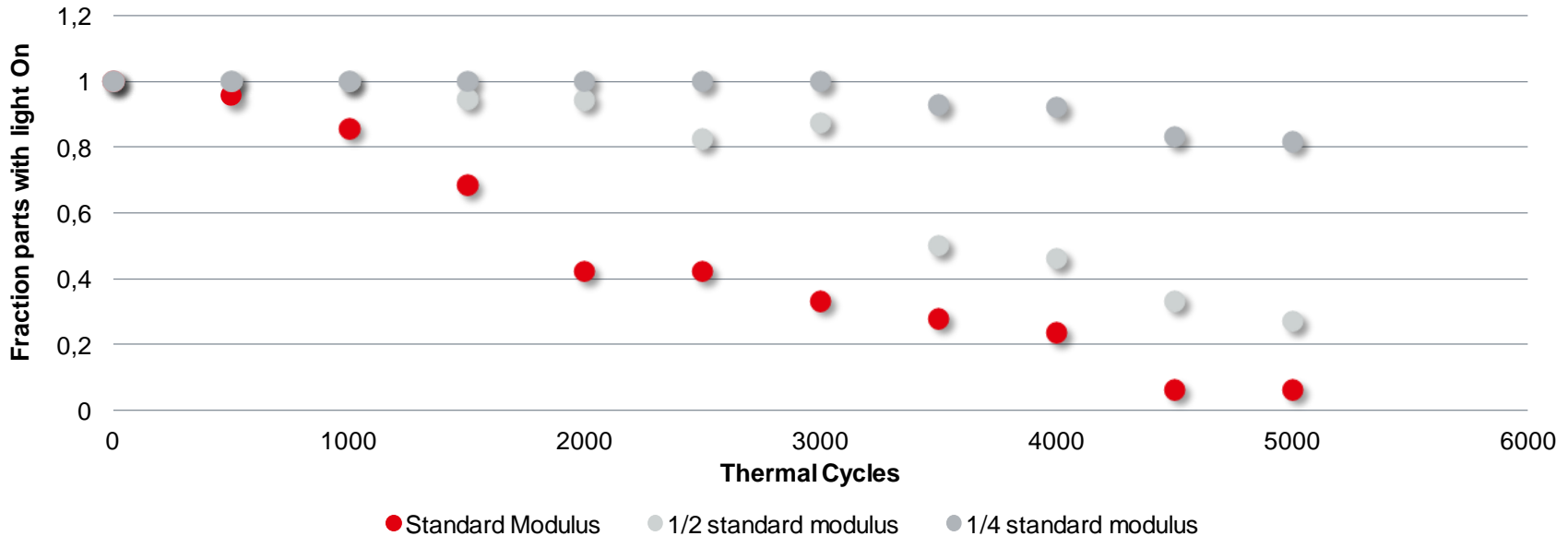
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Solder Joint Testing

Test results

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Comparison of MCPCB Dielectric Modulus on Solder Joint Reliability



Solder Joint Testing

Test results - Conclusions

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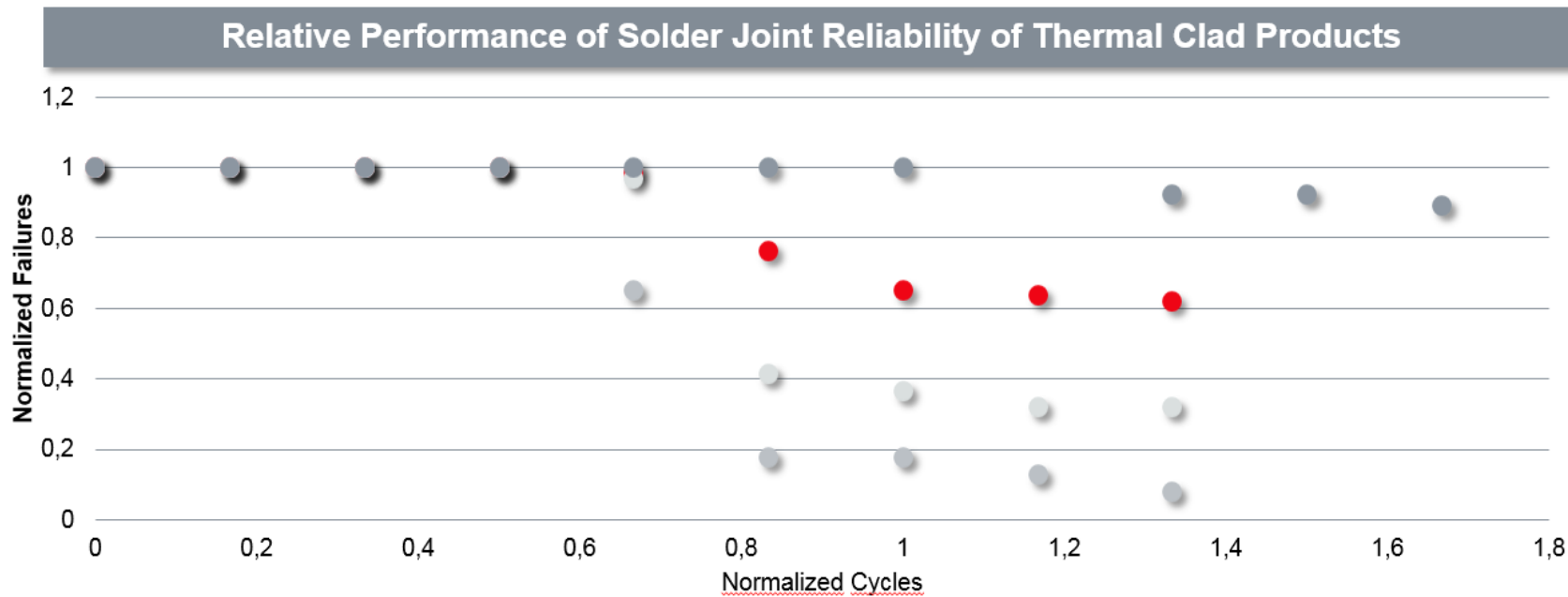
- Solder joint reliability can be improved by:
 - Minimizing the temperature swing
 - Minimizing CTE Mismatch
 - Select Copper base v. Aluminum
 - **Strain absorption of dielectric**
 - **Strain absorption of solder**



Interconnect Reliability

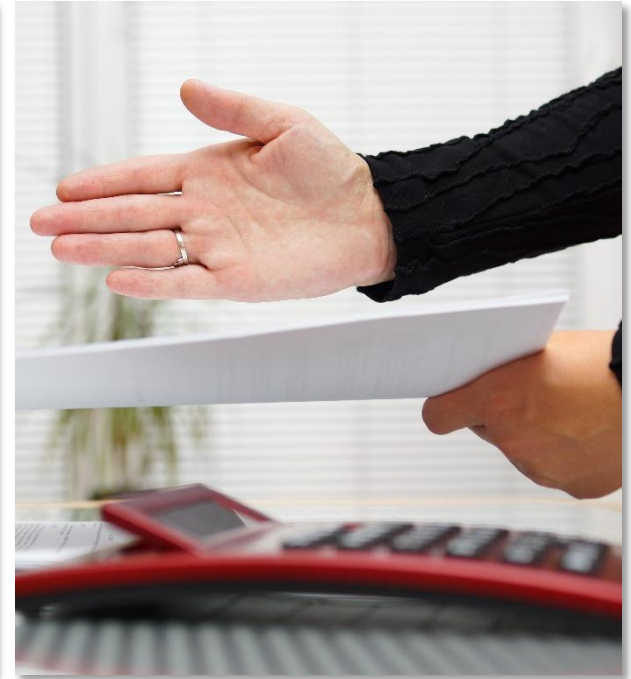
What can Henkel do?

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● ASL-1 SAC 305 aluminum 75 ● IMS 1 90iSC aluminum 75 ● IMS 2 SAC 305 aluminum 75 ● IMS 1 SAC 305 aluminum 75

- Reliability of LED lighting solutions is key to continuing large scale adoption
- Interconnects can play a significant role in the reliability of LED assemblies in applications with thermal cycling requirements
- Solder joint reliability is determined by
 - Quality of solder joints
 - Solder types
 - Substrate materials
 - Part geometry
 - Thermal Cycles

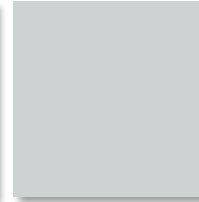
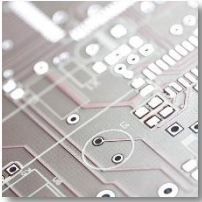
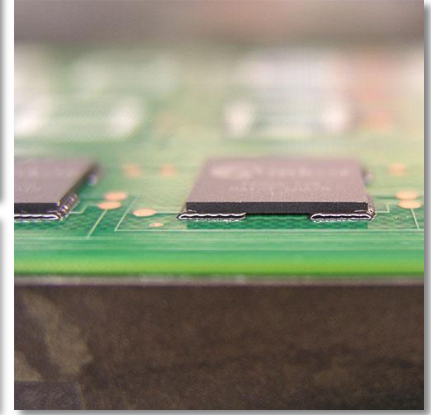
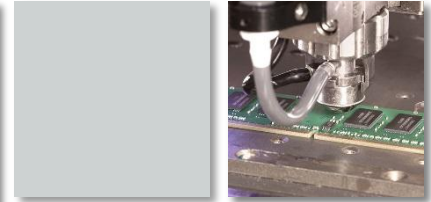


Questions?



Thank you!

www.henkel-adhesives.com/electronics



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This material has been visually improved with the help of our team at the Graphic Design Center in SSC Manila.
To know more about this service, please visit <http://graphics> in the Henkel portal.