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International Electronics Manufacturing Initiative

BGA Availability for High Rel Applications – EMS Perspective

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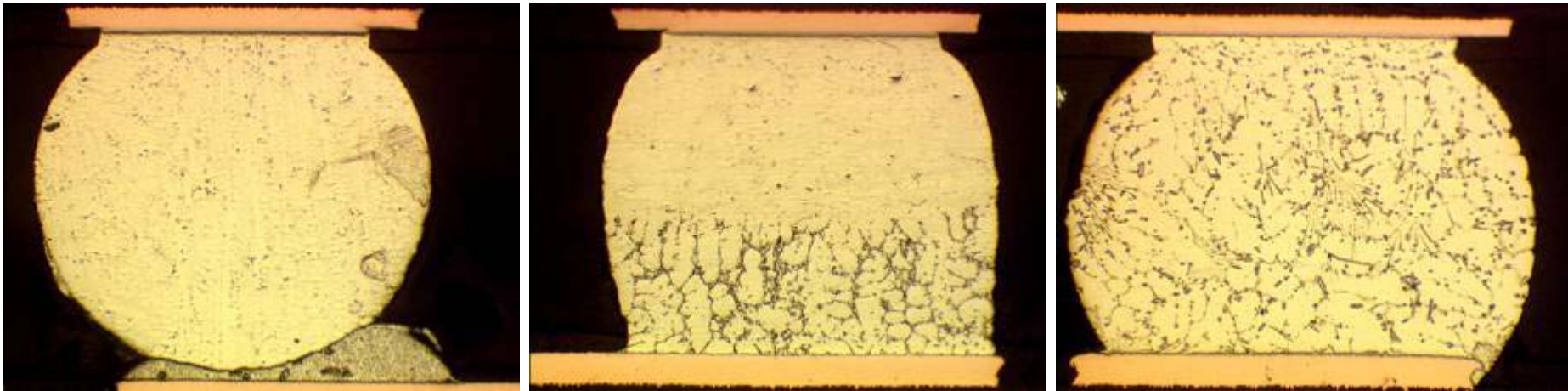
Advancing manufacturing technology

High Reliability Perspective

- **Sn/Pb assembly is well understood and reliable - primary reason for taking the Pb exemption**
- **The component supply chain is rapidly converting to RoHS compliant offerings (Pb-free) with little motivation to continue to produce Sn/Pb product**
- **Taking the Pb exemption will change the risk profile for High Reliability producers**

Backwards Compatibility

- Reflow profile temperatures must increase if Pb-free BGAs are introduced on Sn/Pb soldered board
- Technically minimum temperature on board should be above melting point of SnAgCu solder ball to assure reliability of interconnect
 - May present significant thermal challenges to other components on board not yet converted to Pb-free materials



————— Increasing Soldering Temperature —————>

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Component Survivability

- **Maximum allowable peak temperature a component can experience during reflow dictated by IPC J-STD-20**
 - **Peak allowable temperature a function of amount of moisture absorbing material it contains**

Table 4-1 SnPb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥ 350
<2.5 mm	240 +0/-5 °C	225 +0/-5°C
≥ 2.5 mm	225 +0/-5°C	225 +0/-5°C

Table from IPC J-STD-20C

Available Assembly Process Window

Sn-Pb Soldering

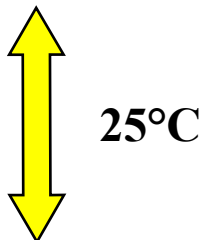


Hybrid Soldering



Max temp for small components = 240°C

Max temp for large components = 225°C



25°C

Typ. min peak temp = 200°C

SnPb mp = 183°C

250°C

230°C

210°C

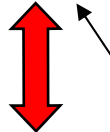
190°C

Max temp for large components = 225°C



8°C

SnAgCu ball mp = 217°C



17°C

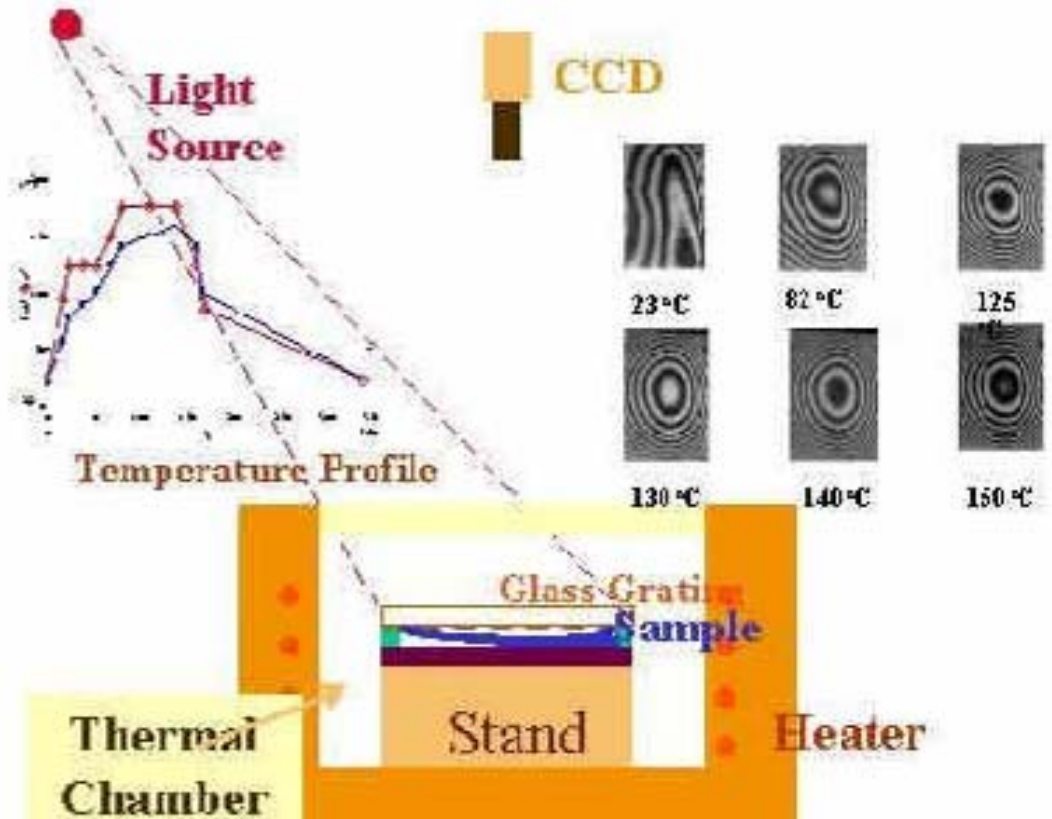
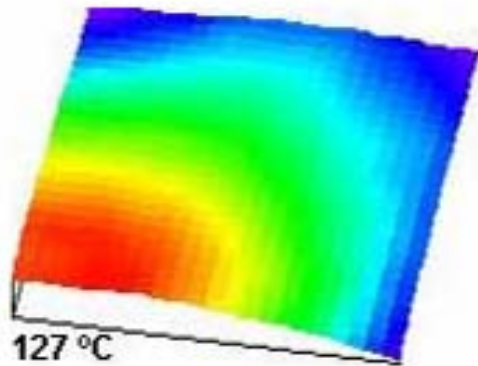
Typical Oven / Profiling Variability = 4-5°C



Challenges for Large Board Assembly

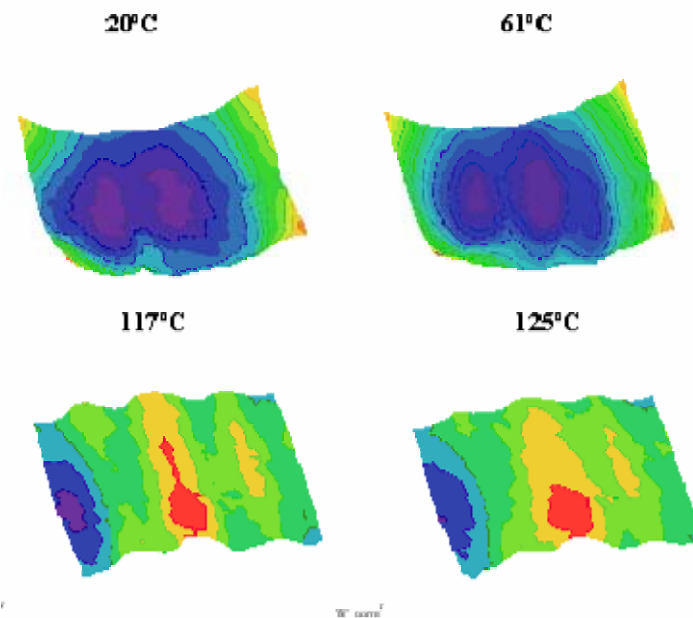
- **Current Pb-free solutions are based on low to medium complexity assemblies**
- **Progress into higher complexity Enterprise and Telecom products will extend soldering profiles, producing larger assembly ΔT due to mix of components used:**
 - **More overheated parts / Higher part warpage**
 - **More barrel failures from z-axis expansion**
 - **More resin Imbrittlement**

Shadow Moiré for Surface Topography

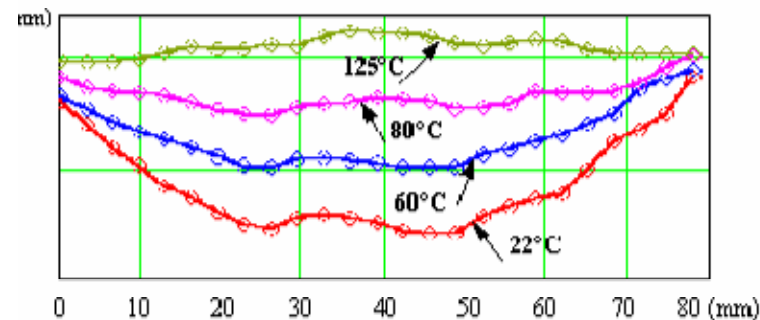


Assessing Package Warpage

- Higher temperatures, have in certain cases based on package construction, resulted in larger package warpage
- Higher warpage has led to unique failure modes not previously seen with Sn/Pb soldering

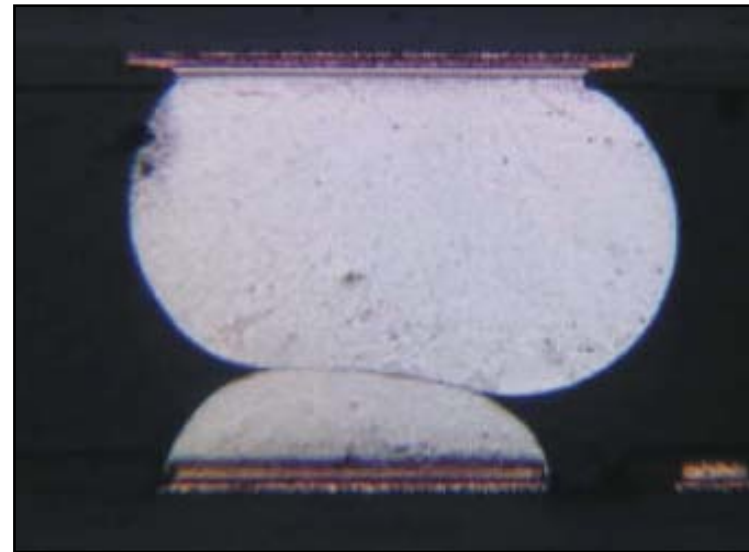
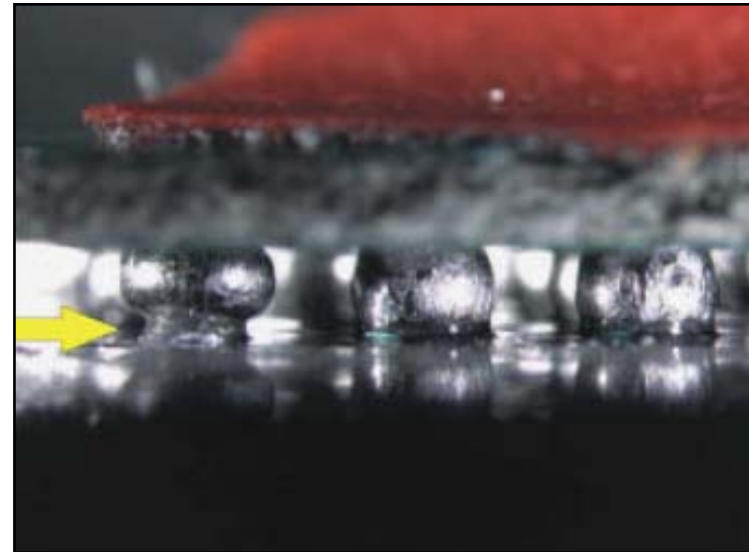


Surface profile obtained by shadow moiré



Head-on-Pillow Defect

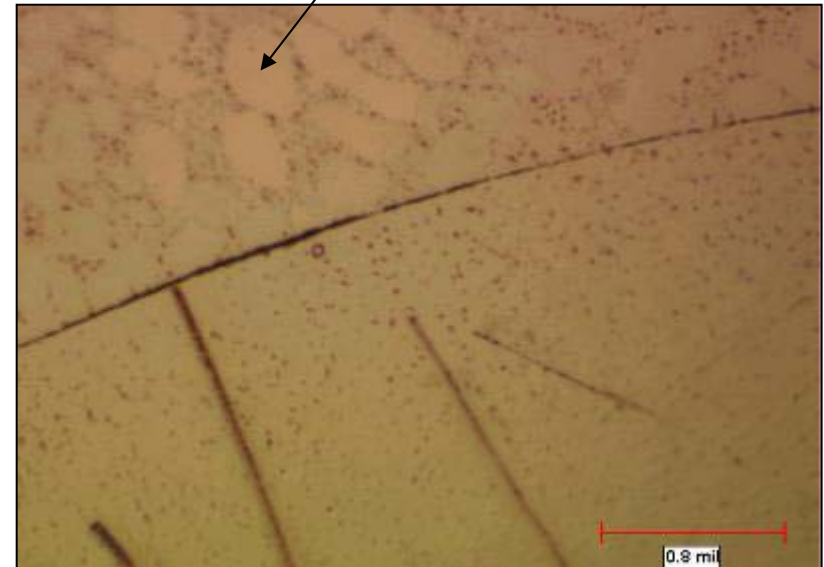
- **Secondary reflow (backside or rework) resulted in the liquification of the previously reflowed connections**
- **Extreme warpage around the BGA package periphery, has extended the now molten solder connections beyond their cohesive limits.**
- **The separation along with the lack of active flux resulted in a skin of oxide on the two surfaces**



Head-on-Pillow Defect

- Upon cooling and subsequent reduction of the warpage and depending upon the exact timing of solidification, two separate solder globules have resulted each with their own distinct microstructures

Large Sn dendrite indicates slower cooling at component side

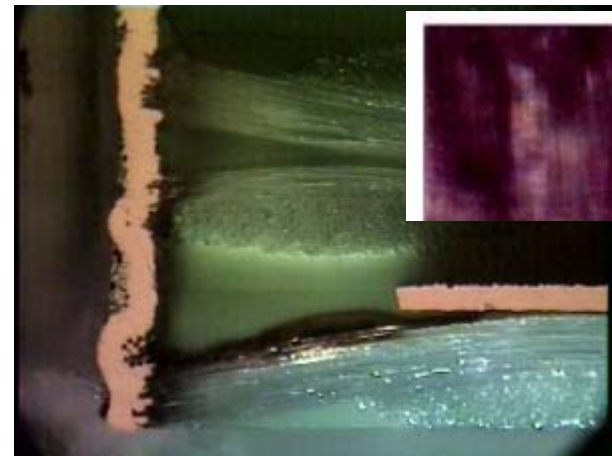


PWB Challenges

- Impact of increased peak temperature on PWB laminate survivability:
 - Z axis expansion characteristics
 - CAF (conductive anodic filament) resistance



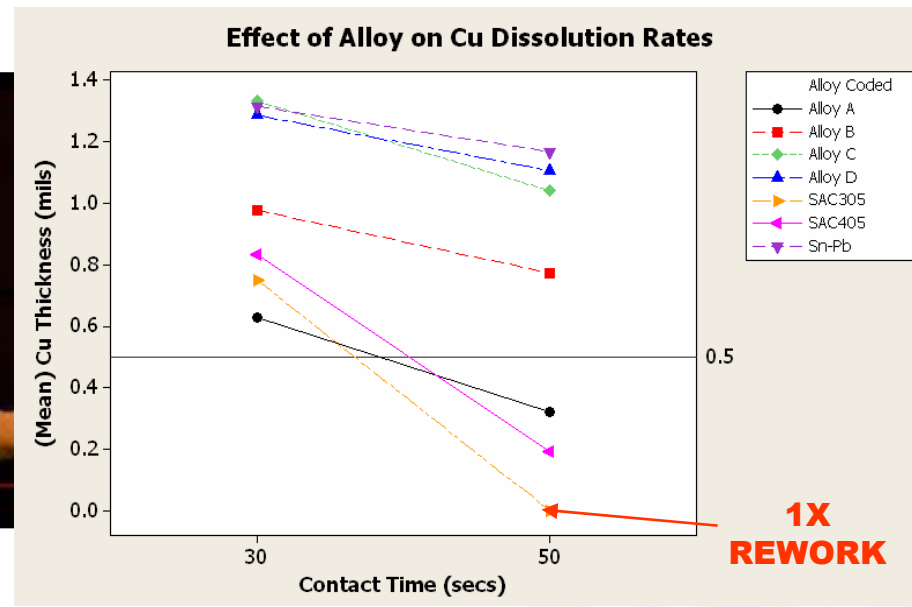
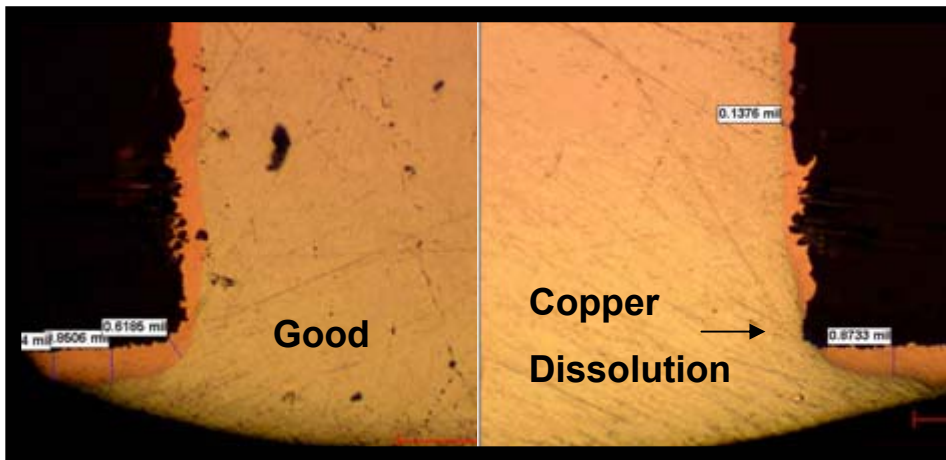
Crack in PWB (Laminate) Barrel



CAF Failures

PTH Rework Issues

- **Cu dissolution is a key issue for Pb-free PTH rework**
- **Was previously only an issue with VERY thick complex boards for Sn/Pb**
- **Now even simpler boards are subject to increased levels of Cu dissolution**
 - **Specifically a concern for high reliability products**



Summary

- **Introduction of Pb-free BGAs in a Sn/Pb process introduces significant process risk**
- **Reliability impacts:**
 - **Mixed alloy solder joints**
 - **Increased assembly temperature overstressing components and board**
- **Significant reduction in available process window for thermally challenging products**

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