IPC Get Interconnected.™ MIDWEST CONFERENCE & EXHIBITION

An OEM's View of Lead Free Assembly Reliability

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Background

EU RoHS Compliant Assembled Boards

Eliminating the use of Lead(Pb)

Phase 1: Lead Free Solder Paste/Alloy & Board Finish

* Increased Reflow Temperatures
* Moisture-Driven Failure (laminate, components)

Phase 2: Package Terminals

Phase 3: Complete Package (including C4)

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I. Background: EU RoHS Impacts Assembly (Lead Free) & Reliability of Large, Complex Boards

II. Consortia Efforts: iNEMI, Unovis, IPC, HDPUG

III. OEM Lead Free Board Reliability Concerns

- Mechanical Stress [iNEMI, Unovis, HDPUG]
  Ex: 305 vs 405, Multiple ATC Failure Mechanisms
- Board Finishes [iNEMI, HDPUG]
  Surface Contamination, Compatibility / SJ Microvoids

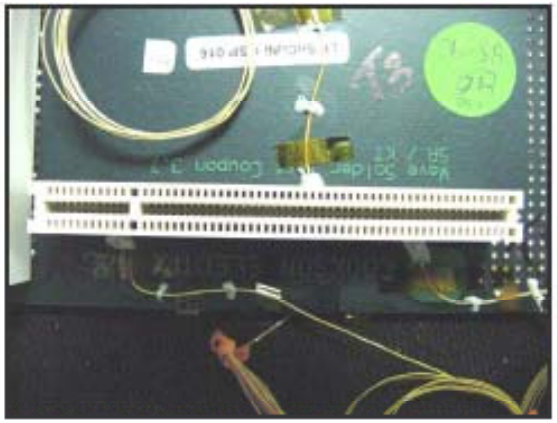
Contents, Cont.

III. OEM LF Board Reliability Concerns, Cont.

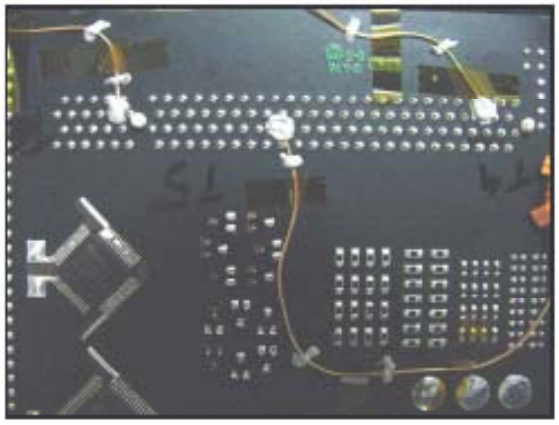
- Laminate Materials [iNEMI, Unovis, IPC] Selection, Lead Free Assembly & Rework Time & Temperature Requirements, Delamination
- PTH Rework and Cu Dissolution [iNEMI]
- Soldered-In Component Pin Hole Fill [iNEMI]
- Filled & Capped Via-In-Pad Reliability
- Lead Free Alloy Proliferation (including impact on thermal fatigue reliability testing requirements)

iNEMI

High Reliability Conversion Concerns

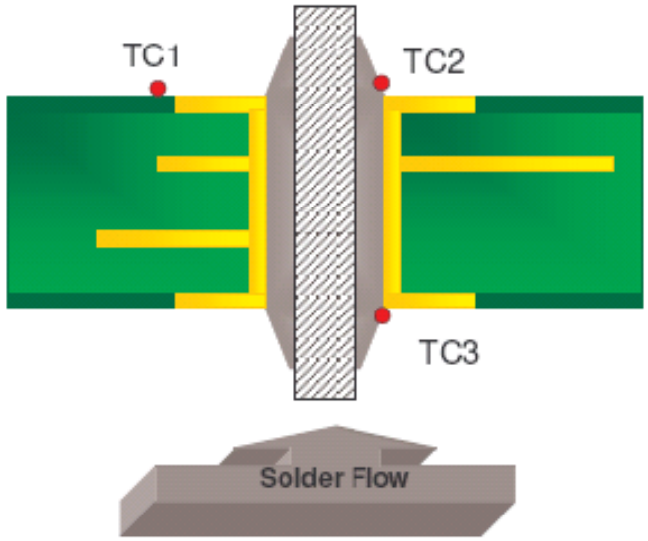


Top Side

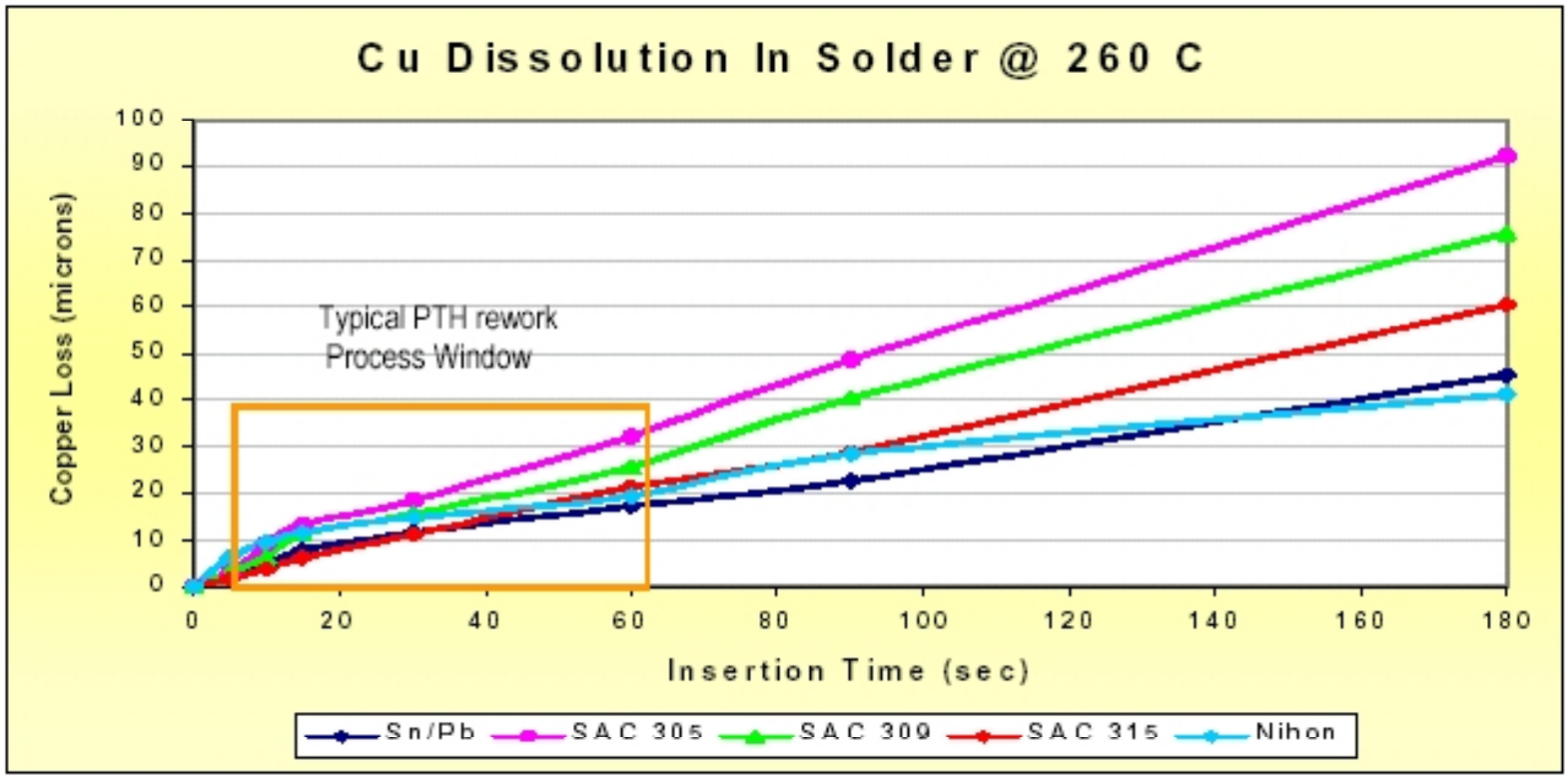


Bottom Side

- LF ATC Reliability
- Finish Compatibility
- Laminate Materials
- PTH Rework
- Hole Fill
- 305 vs 405 Alloy Reliability



iNEMI



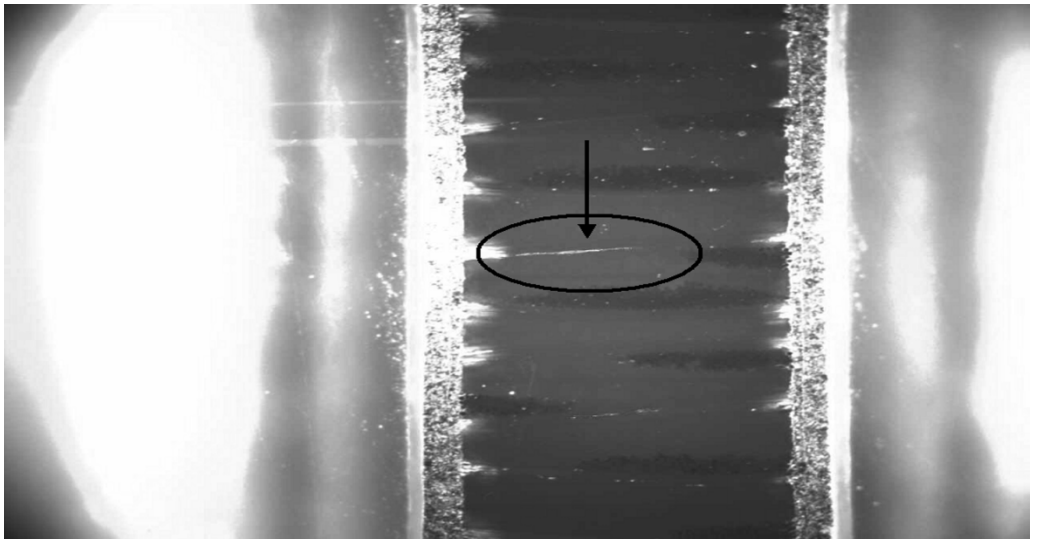
- Increased content of Cu does decrease the overall rate of dissolution.
- Surprising results noted with the dissolution rate of Nihon Superior alloy (SN100C)… after 140 seconds, the rate is lower than that of SnPb. However, it was observed that the intermettalic layer continues to grow as a factor of dwell time.

UNOVIS High Reliability Conversion Concerns

- Lead Free ATC Reliability – Thermal Fatigue & Creep
- Laminate Materials (large thick boards, large area array devices)
- BGA Under-Fill & Reliability

IPC Standards Committees

- 5-32e: Electro-chemical Migration & Conductive Anodic Filaments (Ex: CAF Test Method & User Guide)



- 3-11g: Metal Finishes (corrosion testing)
- 4-14: Solder Joint Microvoids

- 3-11: Laminate/Prepreg Materials Subcommittee (Ex: 4101-B)

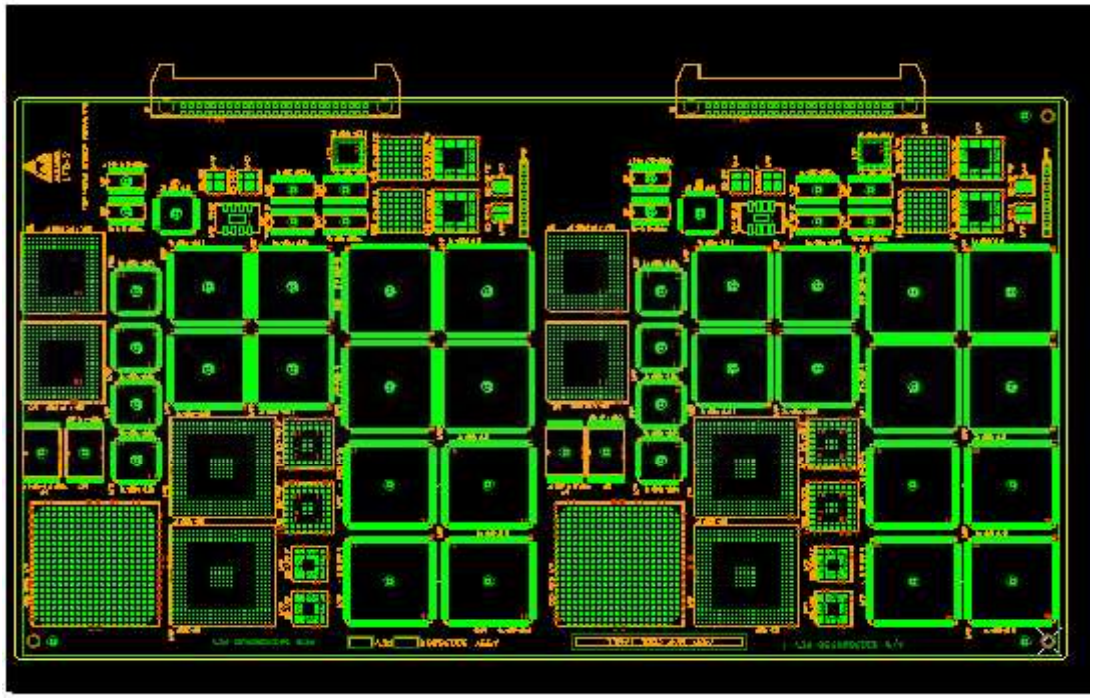
HDPUG

- Mechanical Stress Characterization – Via Integrity
- Mechanical Stress Characterization – Mild Acceleration
- Board Finishes

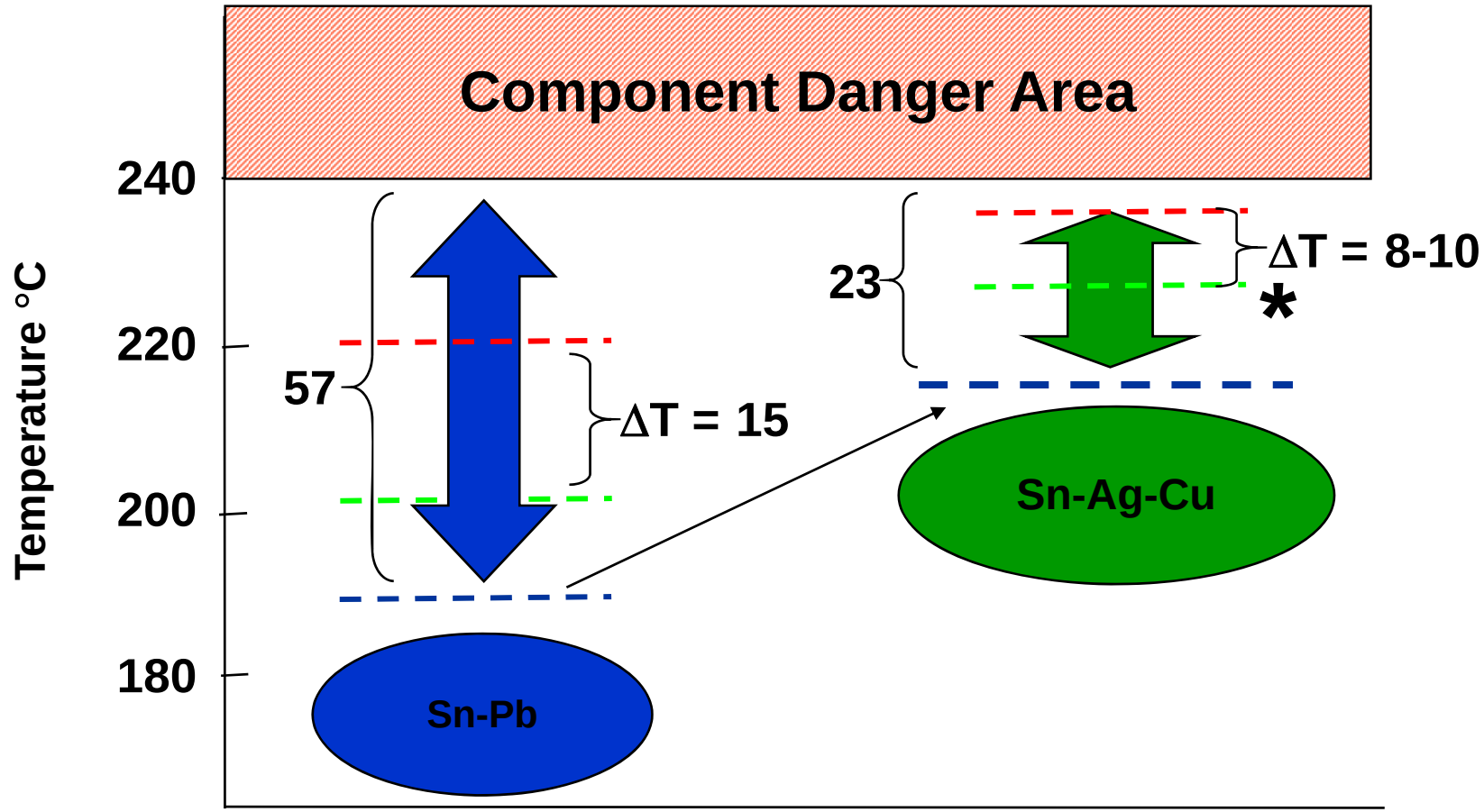
- Microvoids

- Laminate

Materials -
Large Thick
High Temp
Test Board

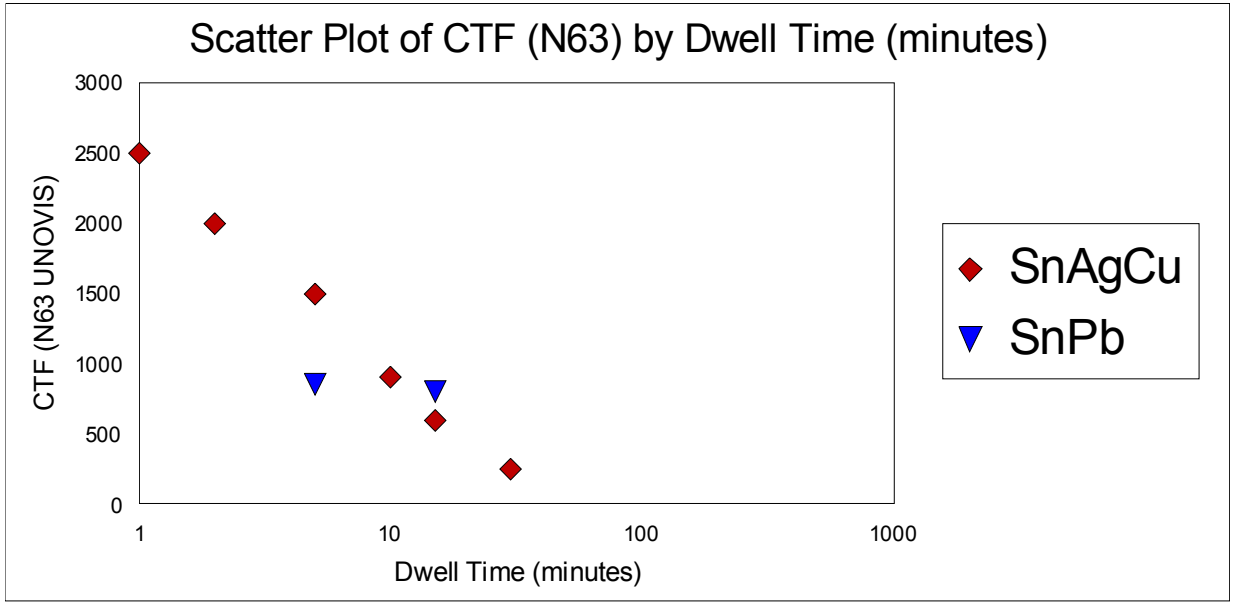


HDPUG: Components



Mechanical Stress Characterization (*ATC Reliability*)

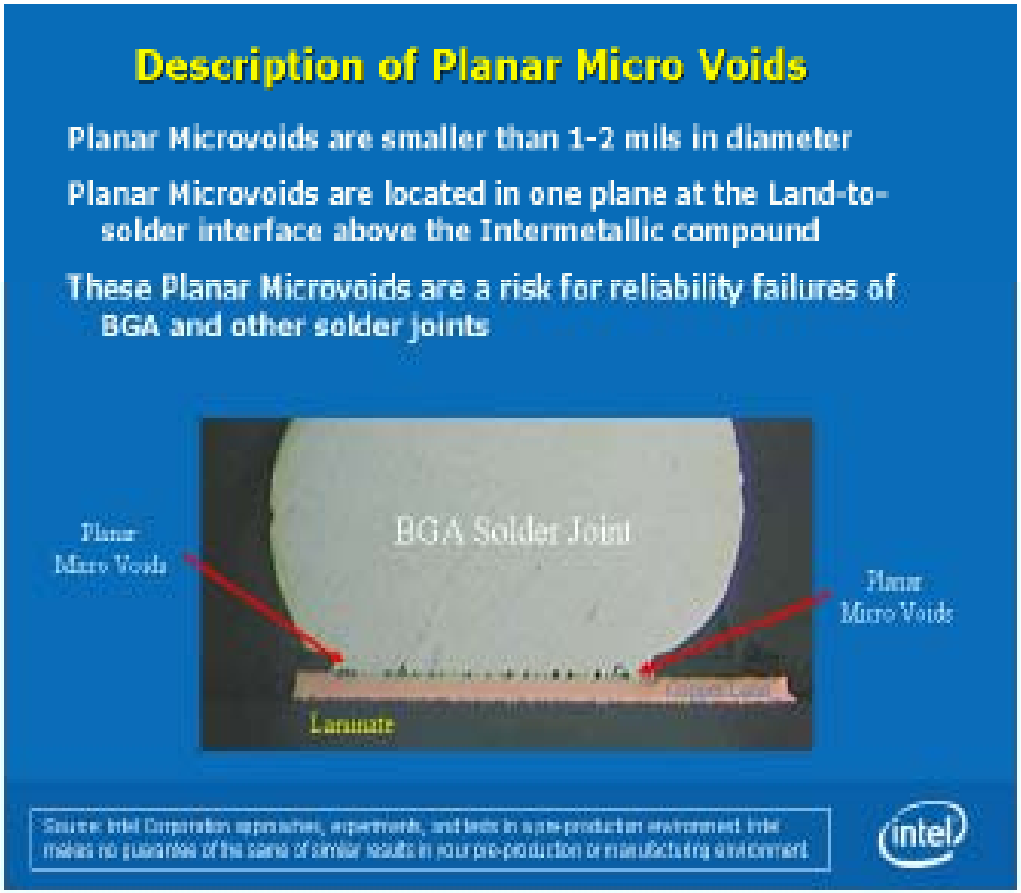
Product: Large/Thick High Density Boards (Large BGAs)
Concerns: Alloy Proliferation, Area Array Reliability
Primary Issue: Development of new processes/procedures (copper plating, flux compatibility, pre-heat, surface finish compatibility, underfilling)



Board Surface Finishes - Selection

OSP / Immersion Tin / Immersion Silver

- Reliability Concerns: Planar Microvoids, Solder Joint Voids
- Working Group: HDPUG Mild AF
- Issues: Board Pre-Heat, Flux Activity, Copper Voids, Contamination



Description of Planar Micro Voids

Board Surface Finishes - Contamination

Electrical Conductivity / Solderability / Cosmetic Tarnish

- Solder Joint Concerns: Planar Microvoids, Solder Joint Voids
- Working Group: IPC Surface Finishes
- Issues: Contamination, Operator Training, Cleanliness, Board Protection

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Laminate Material Selection

- Types: Dicy-Cured, Phenolic-Cured, Anhydride-Cured
- Working Groups: IPC (4101-B)
- Issues: CAF, Delamination, Pad Cratering, Moisture Outgassing, Reliability (CTE-Z, IST, HATS)

Overall Board Thickness=>		*.062*	*.093*	*.124*	*.155*
Eutectic Tin-Lead	220 C				
Lead-Free	245 C				
Lead-Free	260 C				
Lead-Free	285 C				

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Material Delamination

- Product: Large/Thick Multilayer Boards
- Working Group: Unovis
- Issues: Pre-heat time/ temperature, moisture content, outgassing

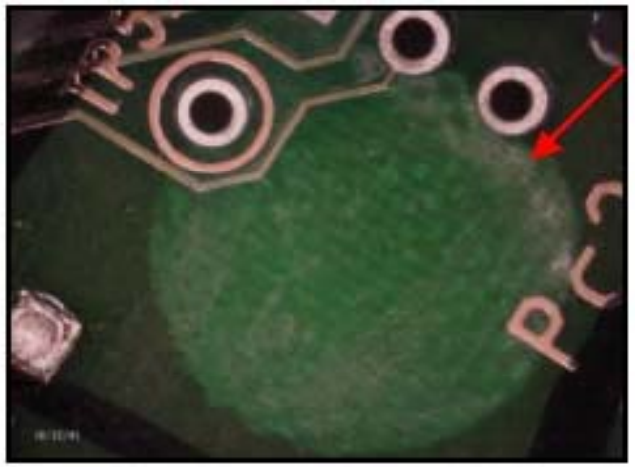


Fig 1

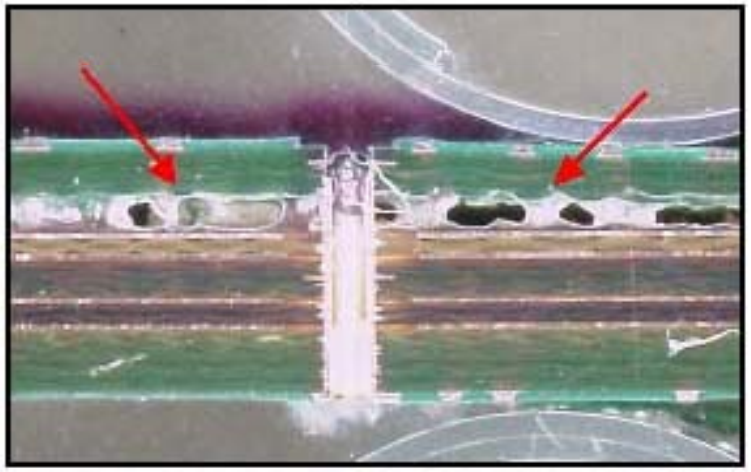
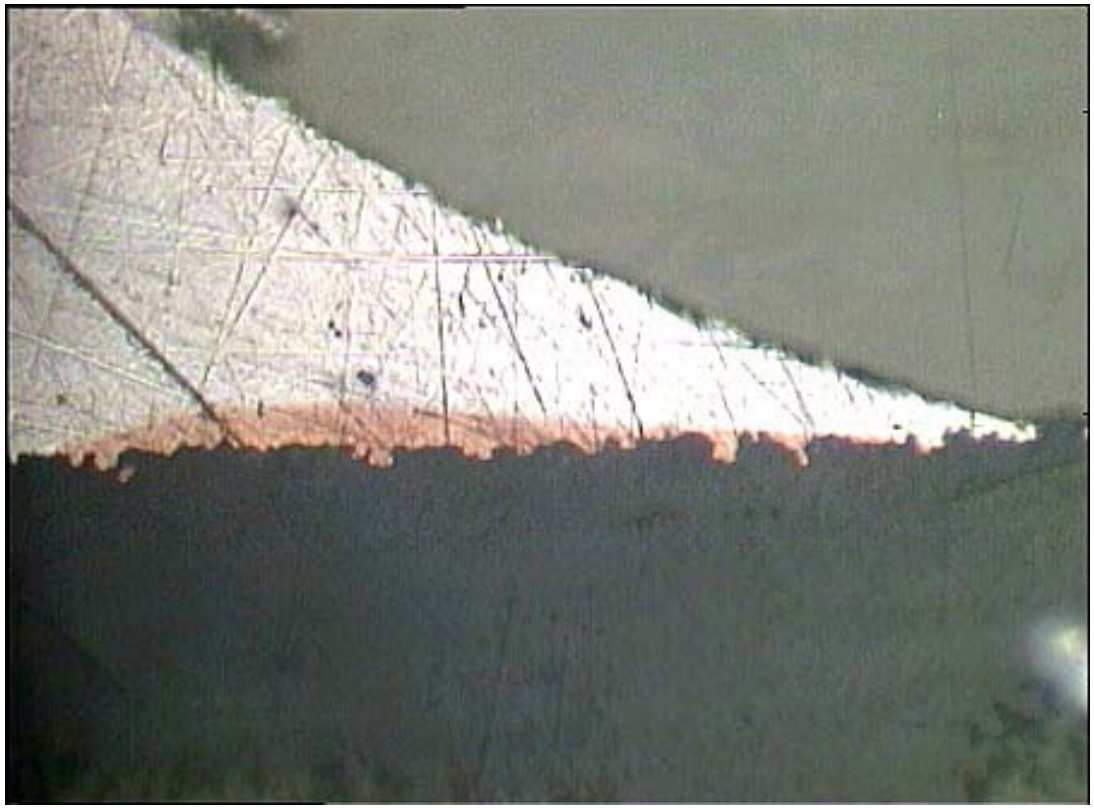


Fig 2

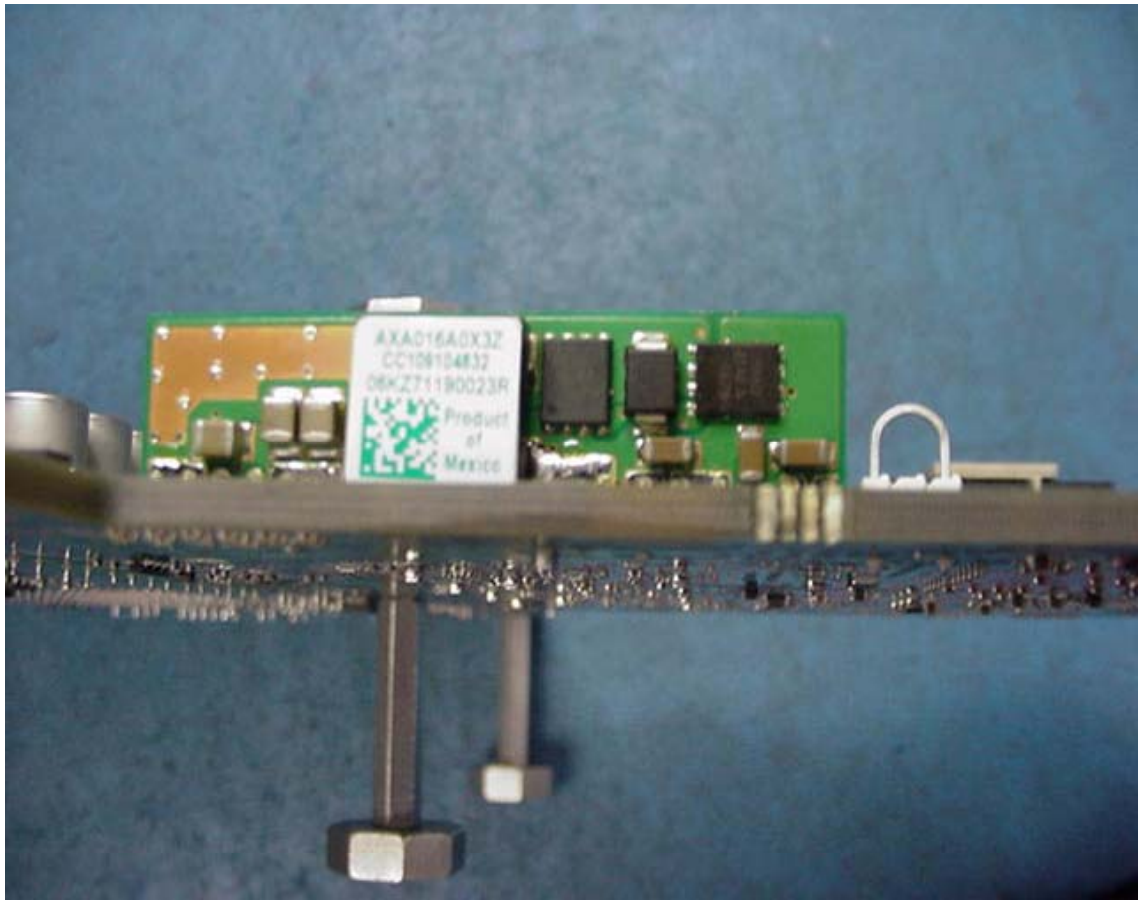
Component PTH Rework & Copper Dissolution

- Product: Large Complex (High Density) Thick Boards
- IPC Concerns:
High Resistance,
Open Circuits,
Special Rework,
Low Copper,
Copper Dissolution,
Alternate Alloys
(Example:
Sn/Cu&Ni=0.7)



Hole Fill: Soldered-In Pin Component Hole Fill

- Component: Power Devices
- Working Groups: IPC, Telcordia
- Concerns: Mechanical Stress, Reliability



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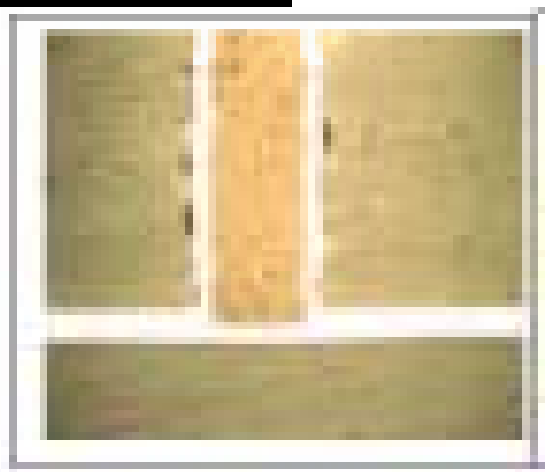
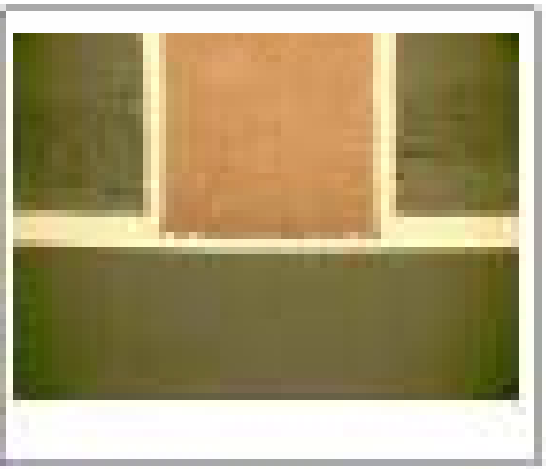
Hole Fill: Filled & Capped Through-Hole Vias

Product: High Density
Working Groups: OEMs
Concerns: Assembly Yields, Reliability

✓ After 5x@288 °C





Proliferation of Lead Free (LF) Alloys

Thermal Fatigue Reliability Testing (every alternate alloy / every different final solder ball metallization)

- Drop reliability concerns of hand-held industry are driving increased variety of LF alloys for solder ball termination
- Reduced silver(Ag) content can improve drop reliability, but also generally reduces thermal fatigue reliability
- Addition of other alloying elements affects LF solder ball undercooling, microstructure, IMC formation, and can increase the melting point by as much as 10 degrees C
- If assembly EM is unaware of these alloy changes; improper assembly, poor yields, and/or loss of product reliability can result

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LF Assembly Reliability – Not Covered

- Thermal Robustness of Components: Discretes, JSTD-020D (Standard for Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices)
- Assembly / BGA SJ Drop Testing (IPC)
- BGA Backwards Compatibility (hybrid SnPb/Pb-free SJs)
- Wave Solder Development / Vapor Phase Soldering
- Bus Bar Finish Compatibility (fretting corrosion)
- Tin Whiskers (iNEMI)
- Pad Cratering (test method development)
- High Speed Connectors
- BGA Underfill

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