IPC Electronics Midwest 2010

Addressing the Challenge of Head-in-Pillow Defects in Electronics Assembly

Mario Scalzo

Indium Corporation

Biography:

Senior Technical Support Engineer.

Mario supports all of Indium's current product lines, with emphasis on advanced surface mount (SMT) problem solving. He has worked closely with the Asian & North American regional teams on several customer projects, including a long-term assignment with Indium's Asia-Pacific Operations in Singapore.

Mario joined Indium in 2000 as a Quality Flux Technician, and spent 2 years as a Quality Engineer. This troubleshooting experience has given him a depth-of-knowledge beyond the normal product training and taught him how to anticipate customer concerns.

Mario is active in several industry organizations, including the Surface Mount Technology Association (SMTA) and the American Chemical Society (ACS). He has presented at several conferences nationally and internationally.

Mario has a bachelor's in chemistry from Saint Anselm College, with a certificate from the American Chemical Society for Professional Education and minors in Physics and Fine Art. He is an SMTA-certified SMT Process Engineer, an IPC A-600/610 Certified Inspection Specialist and has earned his Six Sigma Black Belt from Dartmouth College's Thayer School of Engineering.

Executive Summary:

The head-in-pillow defect has become a relatively common failure mode in the industry since the implementation of Pb-free technologies, generating much concern. A head-in-pillow defect is the incomplete wetting of the entire solder joint of a Ball-Grid Array (BGA), Chip-Scale Package (CSP), or even a Package-On-Package (PoP) and is characterized as a process anomaly, where the solder paste and BGA ball both reflow but do not coalesce. When looking at a cross-section, it actually looks like a head has pressed into a soft pillow. There are two main sources of head-in-pillow defects: poor wetting and PWB or package warpage. Poor wetting can result from a variety of sources, such as solder ball oxidation, an inappropriate thermal reflow profile or poor fluxing action. This paper addresses the three sources or contributing issues (supply, process & material) of the head-in-pillow defects.

It will thoroughly review these three issues and how they relate to result in head-in-pillow defects. In addition, a head-in-pillow elimination plan will be presented with real life examples will be to illustrate these head-in-pillow solutions.

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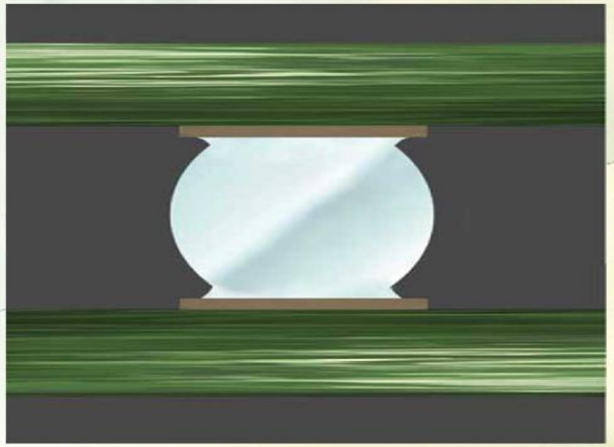
Electronics IPC Midwest



Solder Sphere Head-In-Pillow

Causes & Solutions

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Association Connecting Electronics Industries

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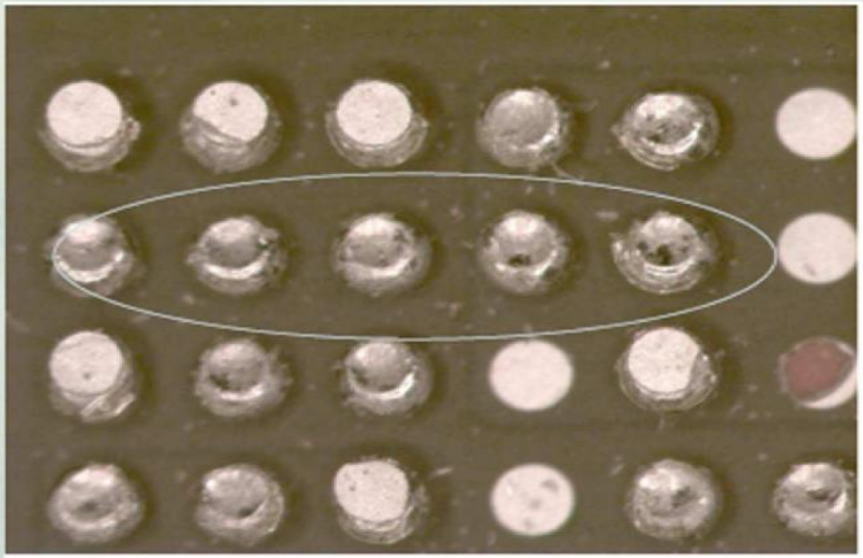
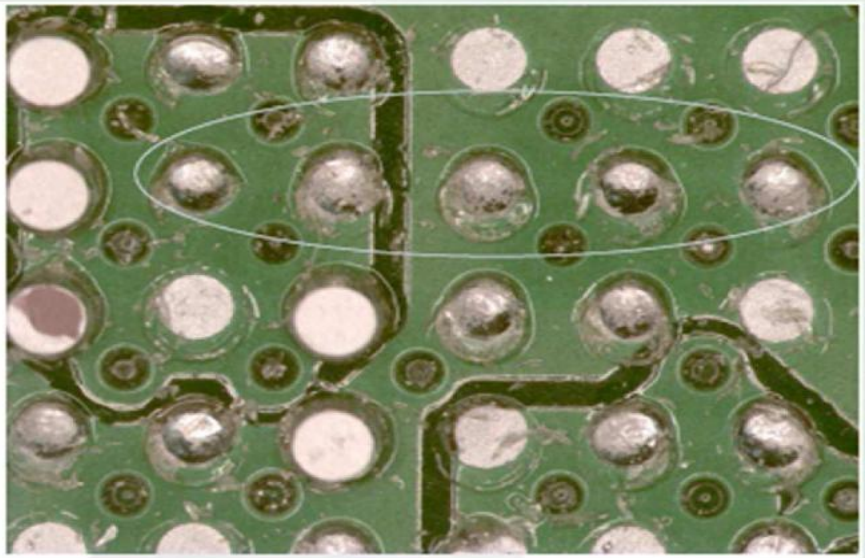
Agenda

- Overview
- Issues
  - Supplier
  - Process
  - Material
- Solutions
  - Supplier
  - Process
  - Material
- Steps forward
  - Current solutions
  - Case study
  - Technology roadmap

Overview

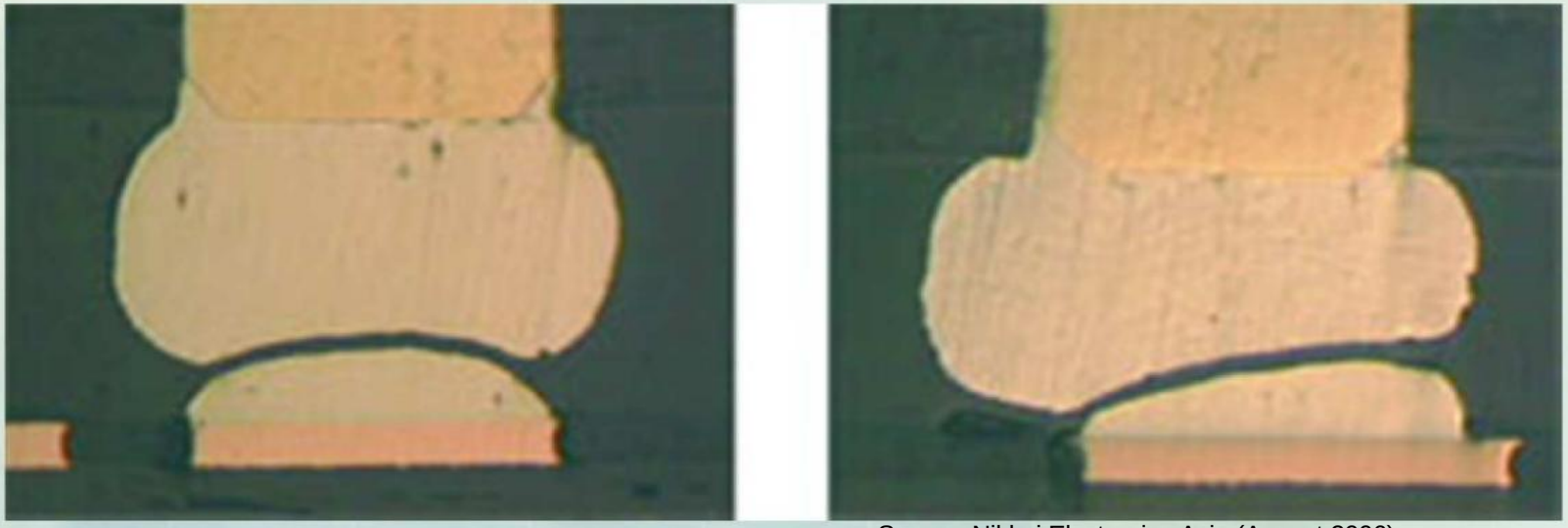
- Why is it an issue?
  - Still passes ICT & function testing
  - Cause of field failures





Overview

- Type A - Poor Wetting
  (Random)

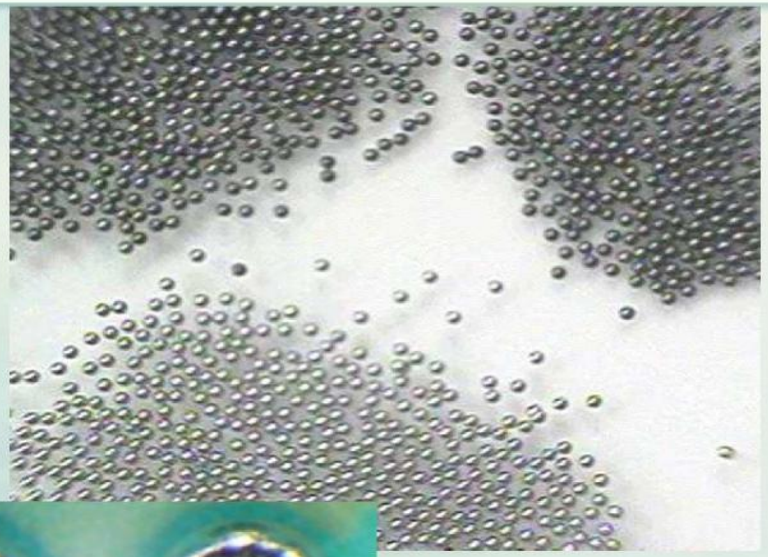


Source: Nikkei Electronics Asia (August 2006)

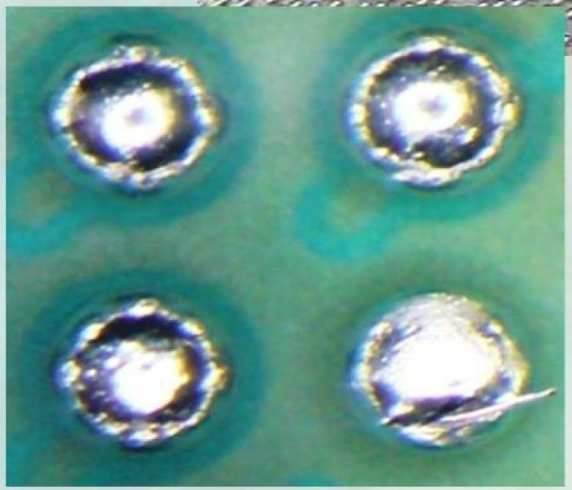
- Type B - Warpage
  (Edge or center effect)

Supplier Issues

- Sphere Oxidation
  - Uncontrolled manufacturing
  - Packaging
  - Storage



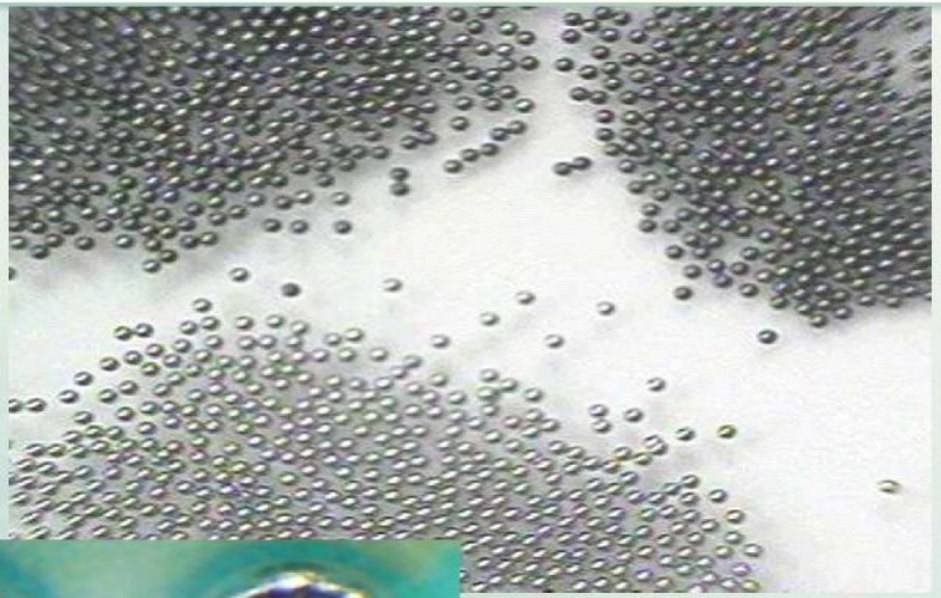
- Silver Segregation
  - Cases seen as high as 36% silver content at the surface.
  - Silver tailing

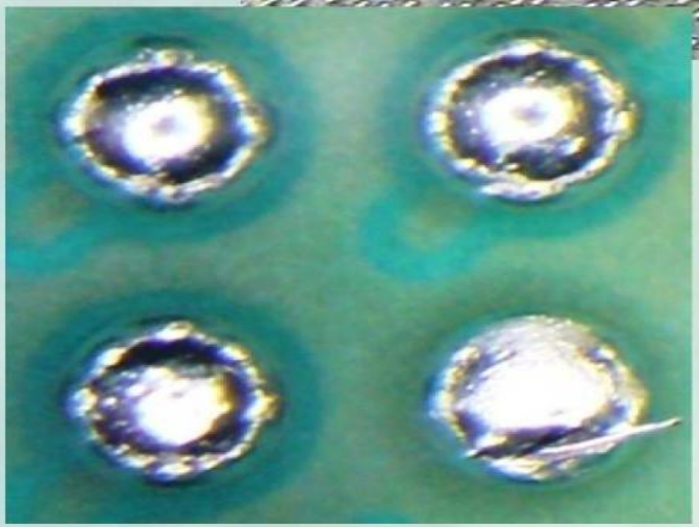


- Beyond Indium's control

Process Issues

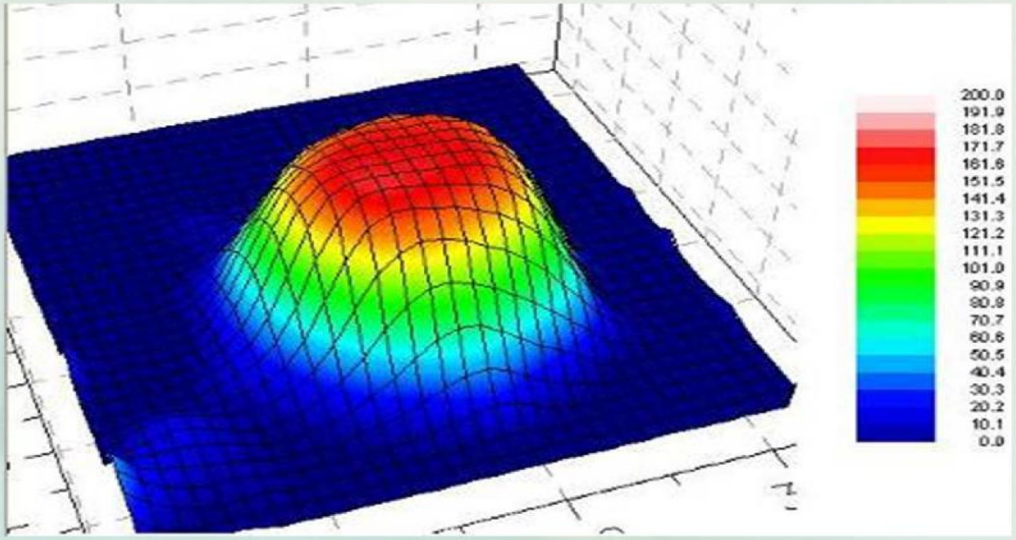
- Printing
  - Registration accuracy
  - Improper printer setup
  - Stencil Design
- Placement
  - Off pad
  - Out of plane
  - Pressure
- Reflow
  - Warpage
  - Flux exhaustion





Material Issues

- Poor transfer efficiency
- Insufficient oxidation barrier
- Low stability

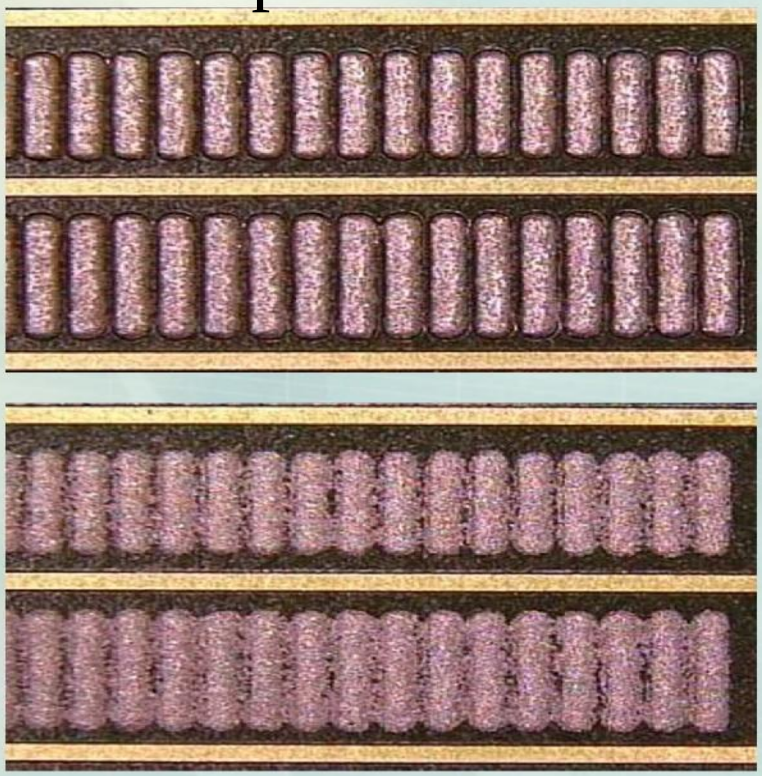


Process Solutions

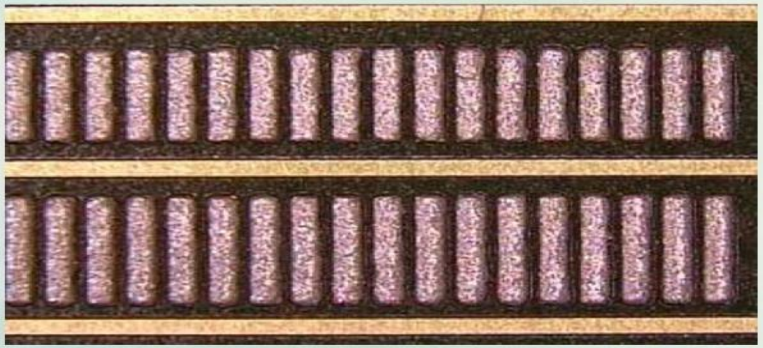
- Printing optimization
  - Print measurement & data tracking
  - Calibration / upgrade
- Placement
  - Local fiducials (pad)
  - Establish process controls
  - Calibration / upgrade
- Reflow
  - Aware of component temperature restraints
  - Avoid excessive heat exposure (time & temperature)
  - Adequate time above liquidus (TAL)
- On site Indium technical support

Testing...

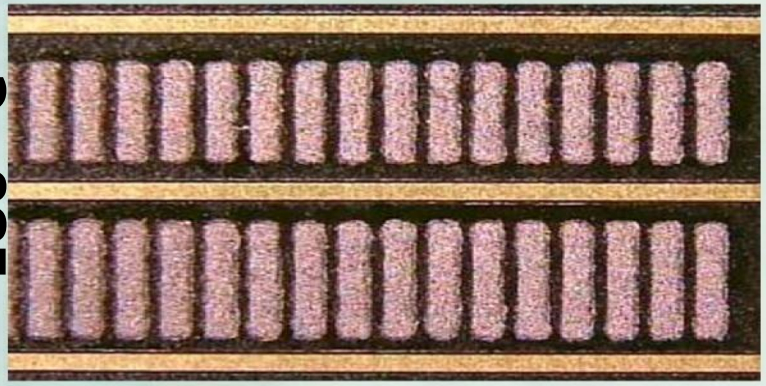
Slump Resistance



Fresh



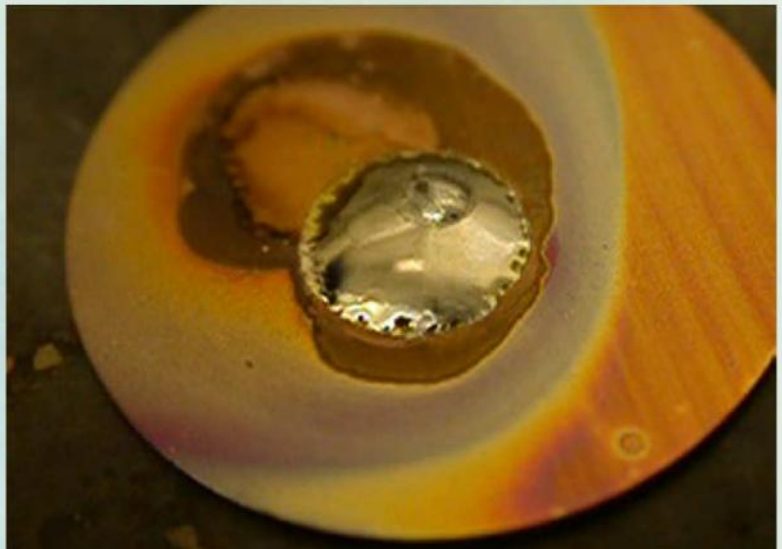
Hot Slump 180° C



Undesired Reflow Phenomena

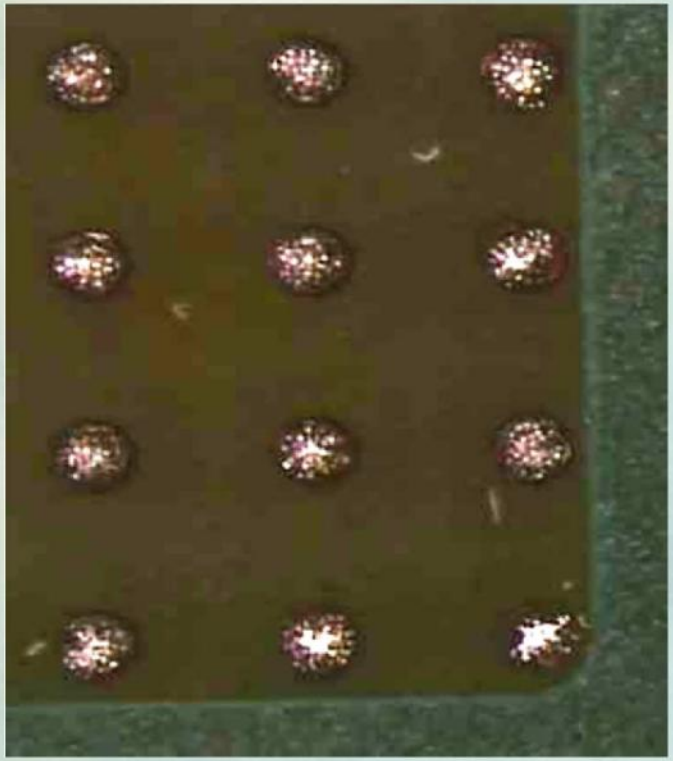
Oxidation Resistance Testing

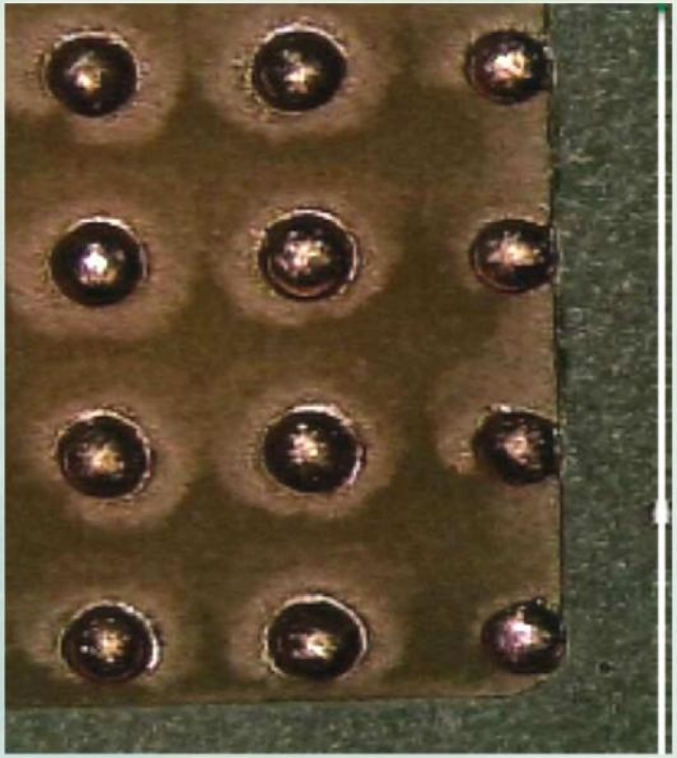
- 90s Time above liquidus (TAL)
- 25ºC above liquidus
- Sn/Pb and SAC alloy
- SAC sphere



Undesired Reflow Phenomena

Graping

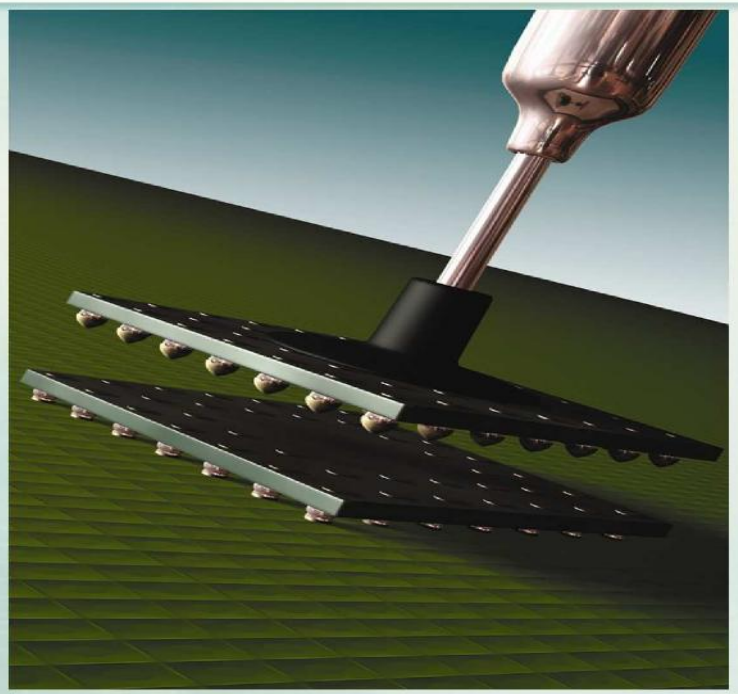




Material Solutions

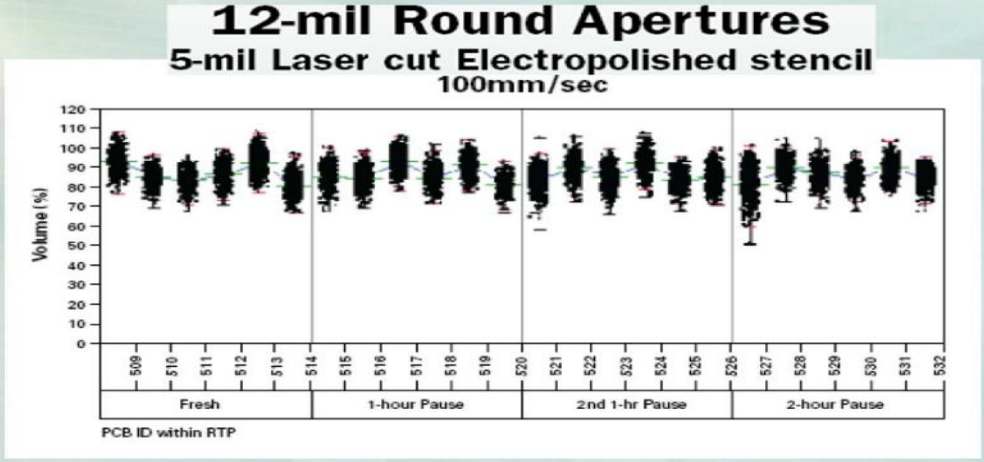
Dipping process (flux or paste)

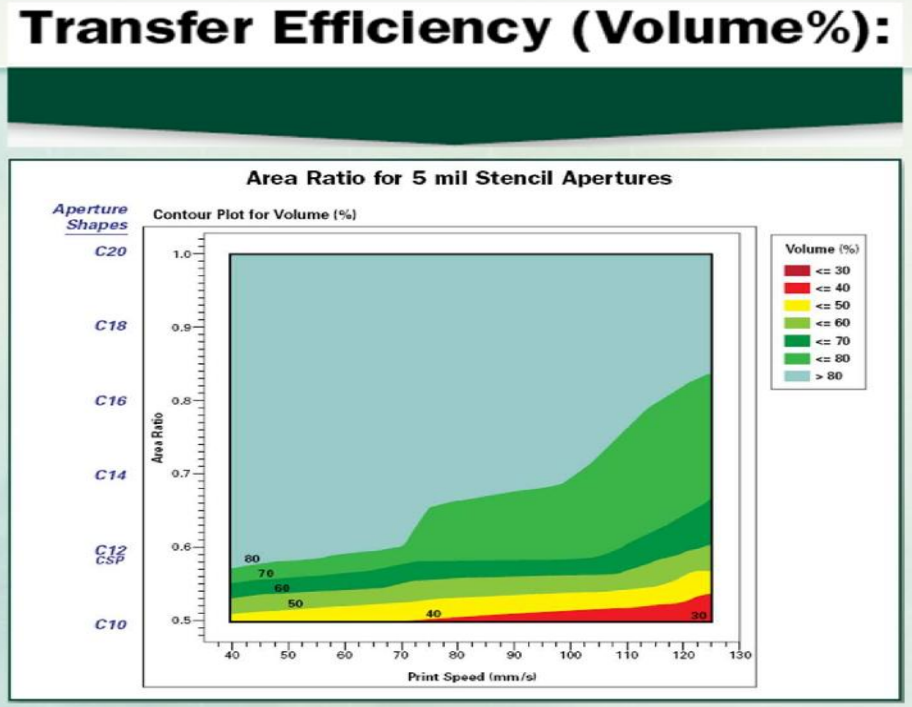
- Flux
  - Increases activity
  - Extra oxidation barrier
- Paste
  - Type 5
  - Metal load
  - Flux rheology
- Flux or paste can also be rework



Material Solutions

- Paste properties
  - High transfer efficiency
  - Oxidation barrier
  - Long stencil life & response to pause
  - Increased activity





Conclusion

- Random HIP Defects
  - Look for supplier / storage issues
- Edge / Center HIP Defects
  - Look for process issues (placement / warpage)
- Paste properties can overcome HIP defects
  - Look for high transfer efficiency
  - Look for "stringy" pastes
  - Look for a high oxidation barrier
  - Look for slump resistance
- You are not alone