Jet Propulsion Laboratory
National Aeronautics & Space Administration
California Institute of Technology

Assembly Reliability for Two CCGA Packages

by

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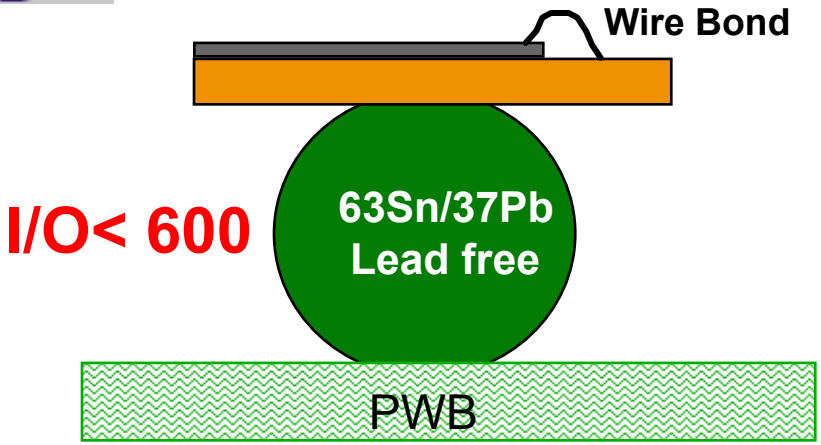
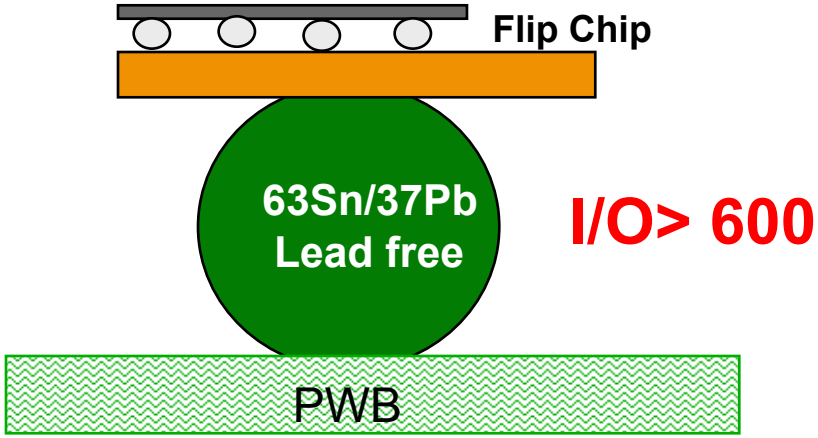
Outline

- Electronic Package Trend
  - Package shrink trends
  - Resources
- CCGA/PBGA Qual
  - Key parameters- Literature data
  - Objectives and test matrix
- Test Results
  - CCGA 560 I/Os- Peripheral
  - CCGA 717 I/Os – Full Array
  - PBGA
  - PTH via
- Conclusions

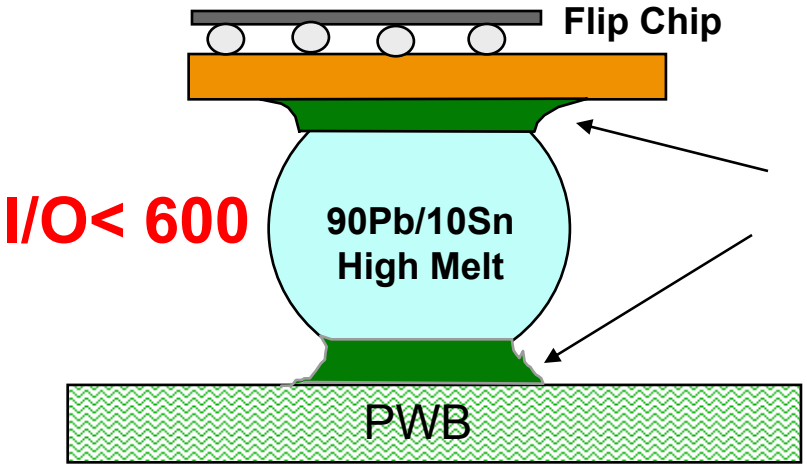
BGA Package Types



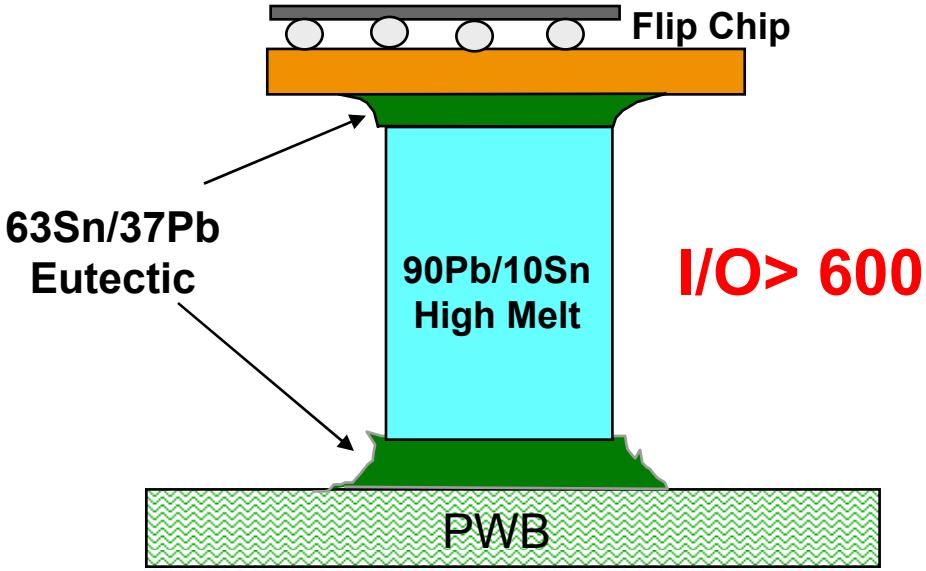
Plastic BGA (PBGA)



Flip Chip BGA (FCBGA)



Ceramic BGA (CBGA)



Column CBGA (CCGA)

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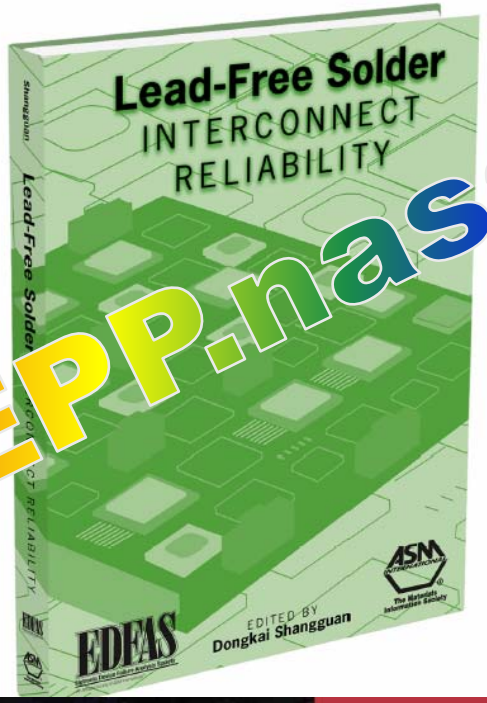
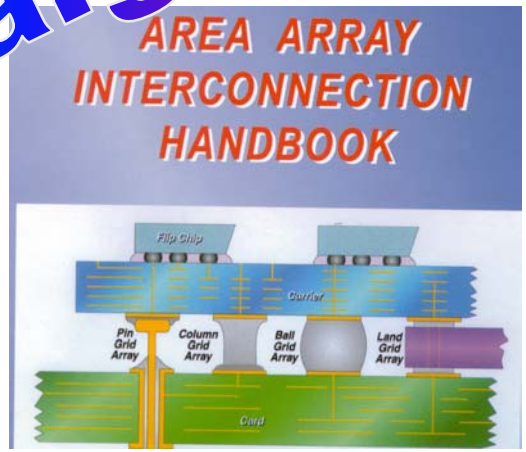
References

http://NEPP.nasa.gov





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Objectives

Determine risk for unknowns at design

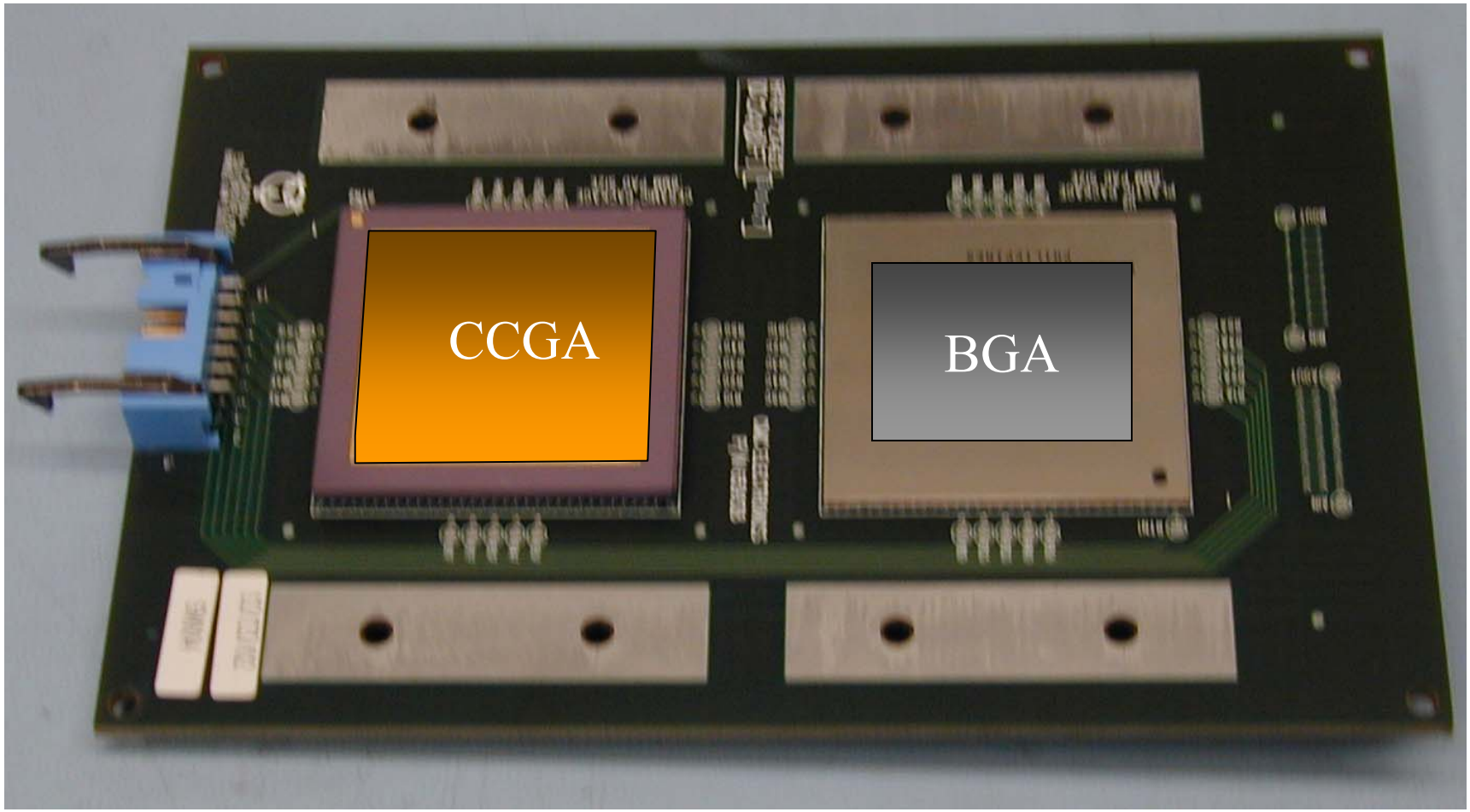
- **PBGA? Or CCGA?**
  - Two PWB pad sizes, CCGA larger
  - PBGAs assembled on both pads, interchangeability with CCGA
- **Two stencil designs**
  - PBGA thinner and a thicker mini stencil for the CCGA
  - Measured solder paste volumes
- **Use of corner stake**
  - Improve resistance to mechanical vibration and shock
  - Failure mechanisms with corner stake
- **Added heat straps to the top of PBGA**
  - **Bonding attachment durability of heat strap**

Objectives

Determine risk for unknowns at design

- **Daisy chain**
  - **Package through PWB pads**
  - **Additional vias and daisy chain**
- **Behavior under four thermal cycle conditions**
  - Highly accelerated cycle, -55/125°C
  - Milder version representative of flight, -50/75°C
  - NASA cycle (-55/100°C)
  - Extreme Martian environment (-120/85°C)- Limited cycles, not presented
- **Inspection**
  - Continuous/manual monitoring
  - Optical inspection for verification at intervals of 50-200 cycles
  - SEM before cross-sectioning
  - Cross-section

BGA/CCGA Test Vehicle Per IPC 9701



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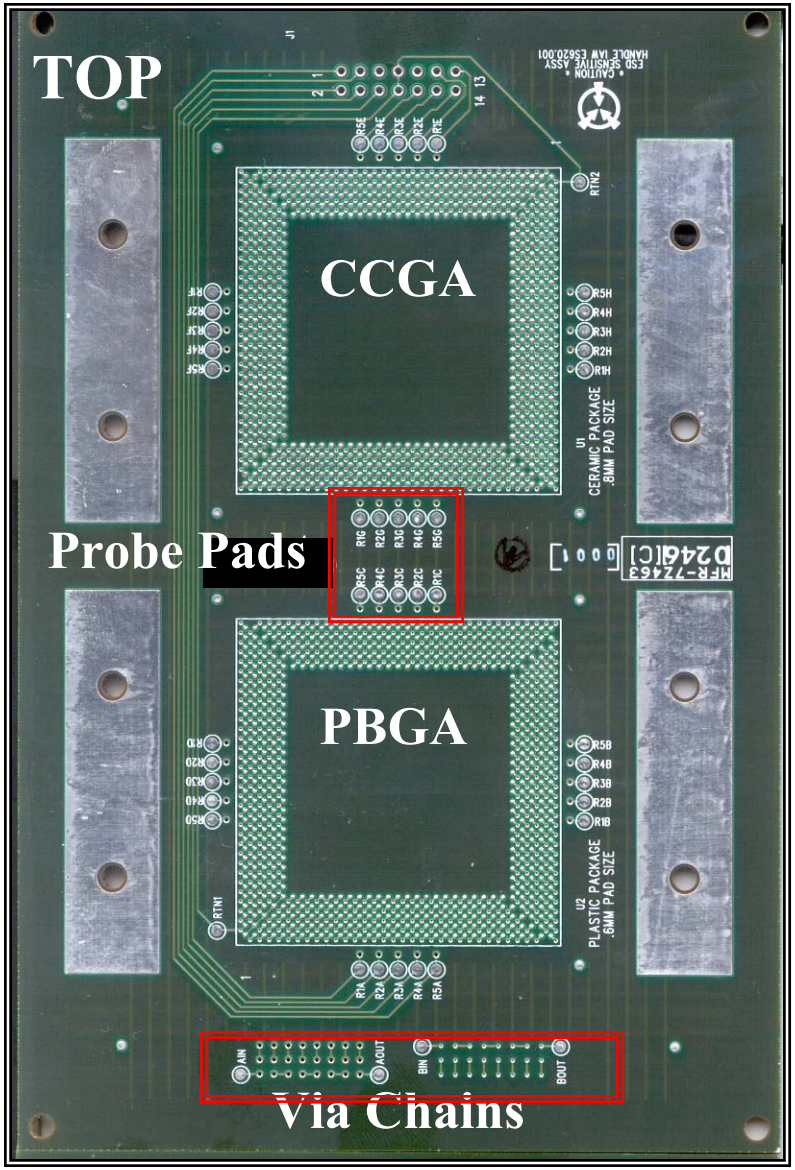
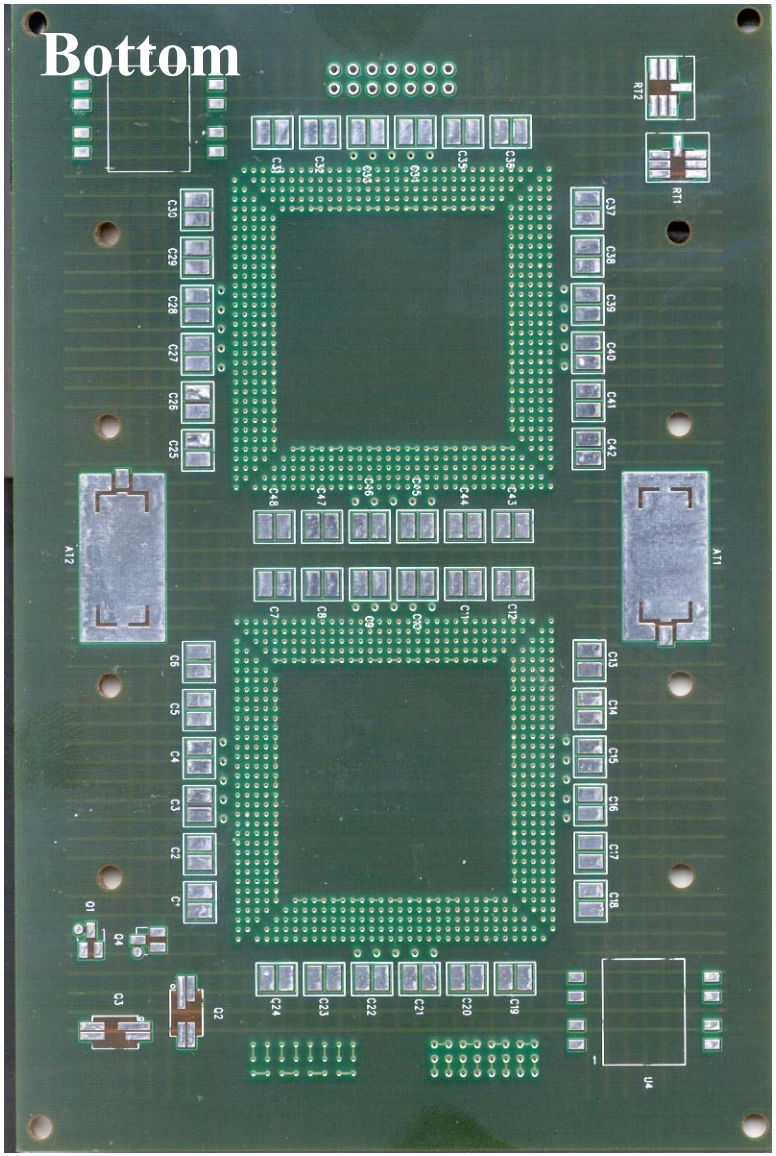
PWB Design





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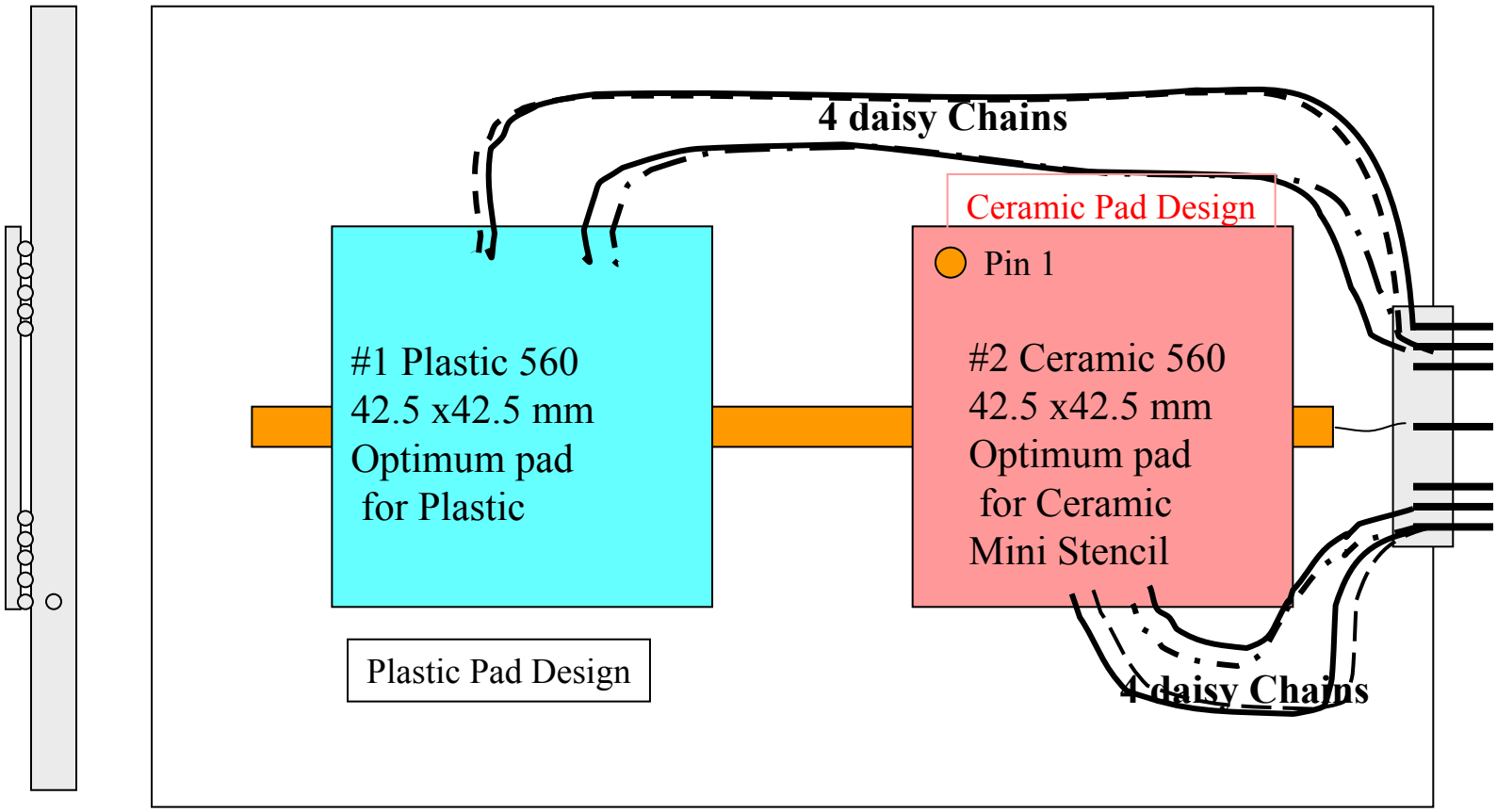
Test Vehicle- PBGA/CCGA



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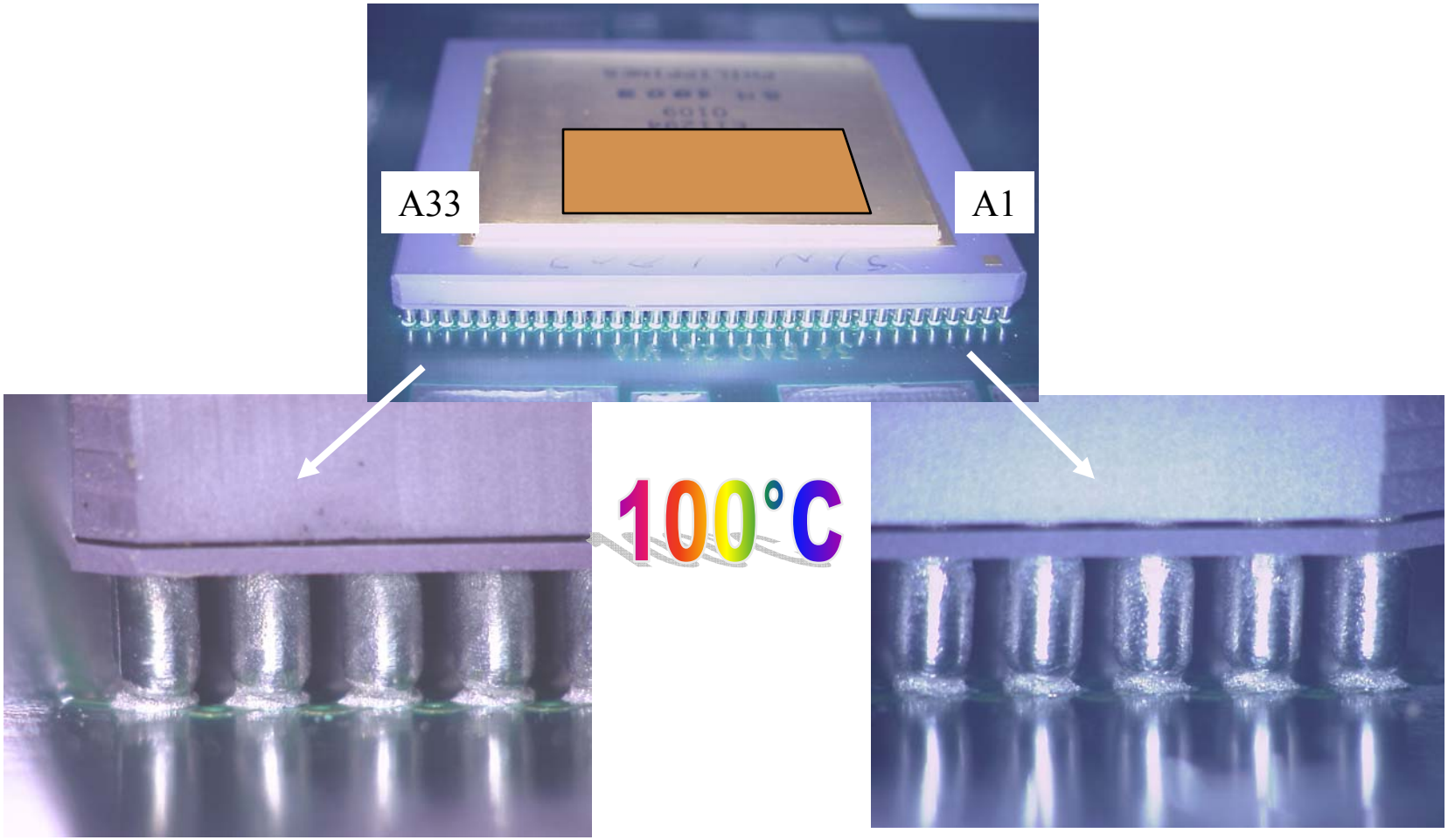
Effect of TC Max Temp on CCGA



200 cycles (-55/100°C)

Stencil 8 mil thick- CCGA

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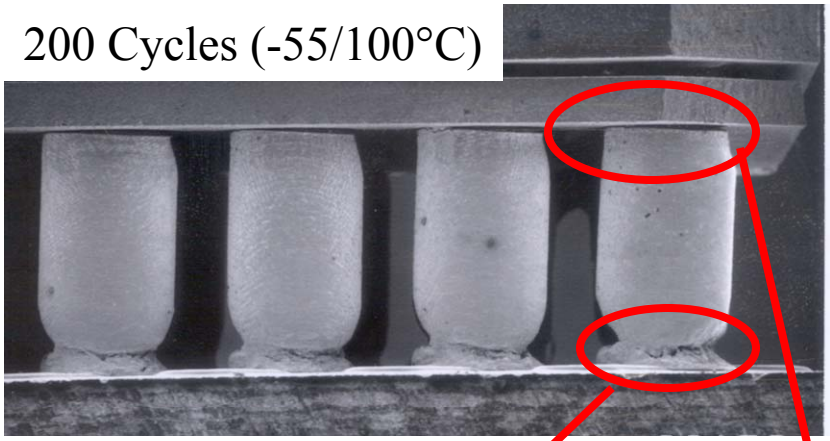
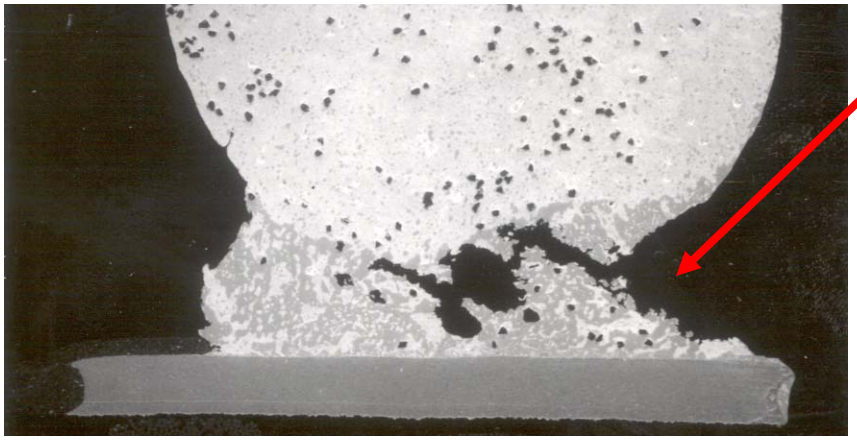
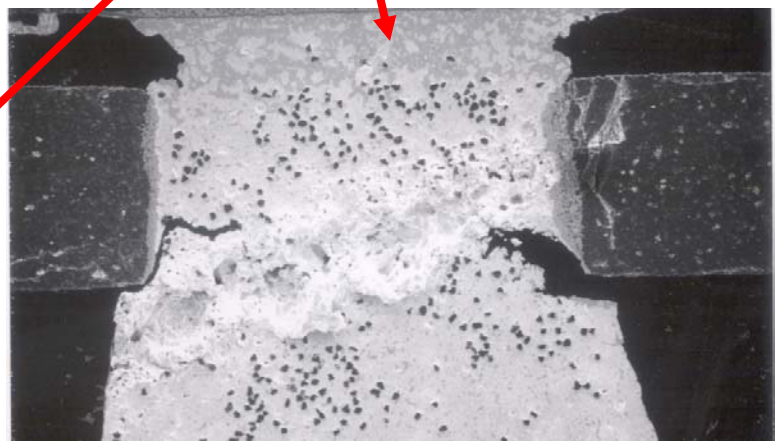
CCGA X-section (-55/100°C)

200 Cycles (-55/100°C)







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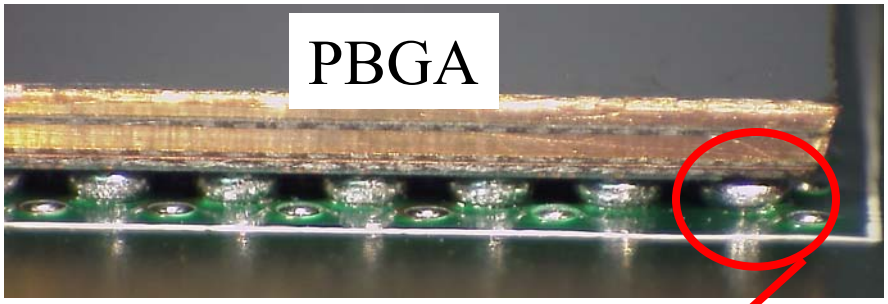
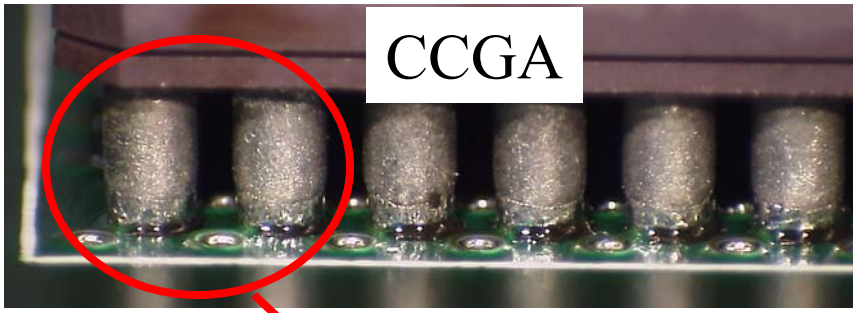
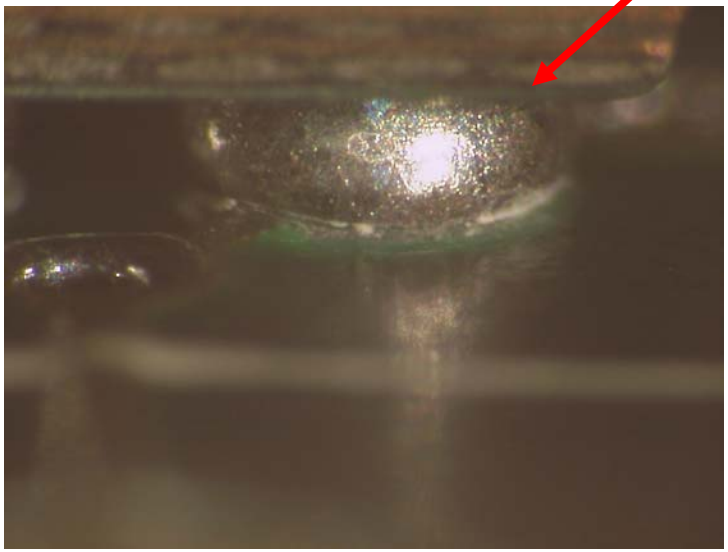
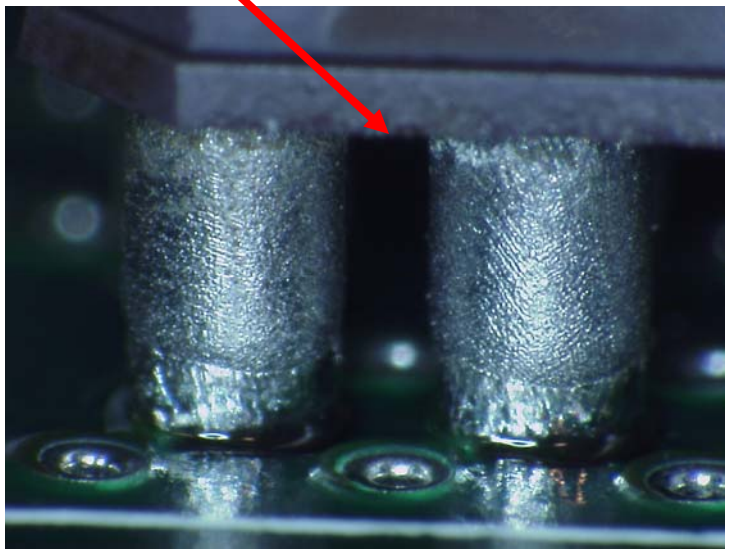
Quality As Fab









Stencil 10.5 mil thick-CCGA

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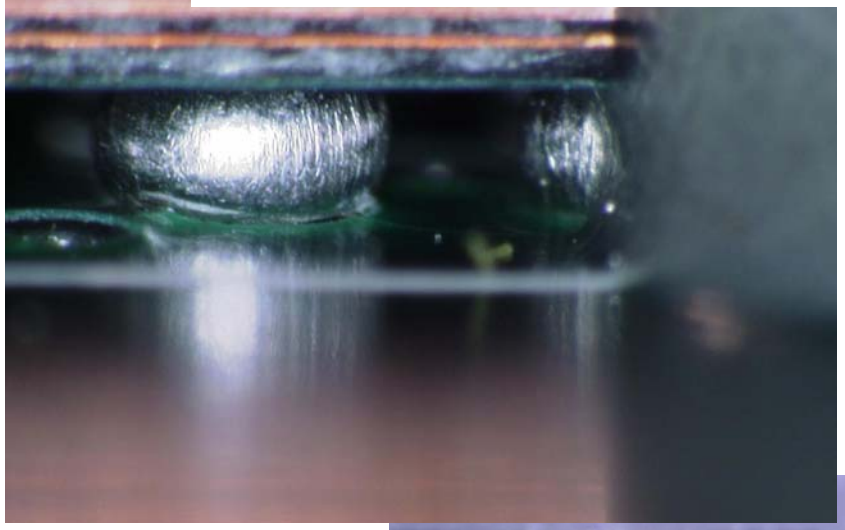
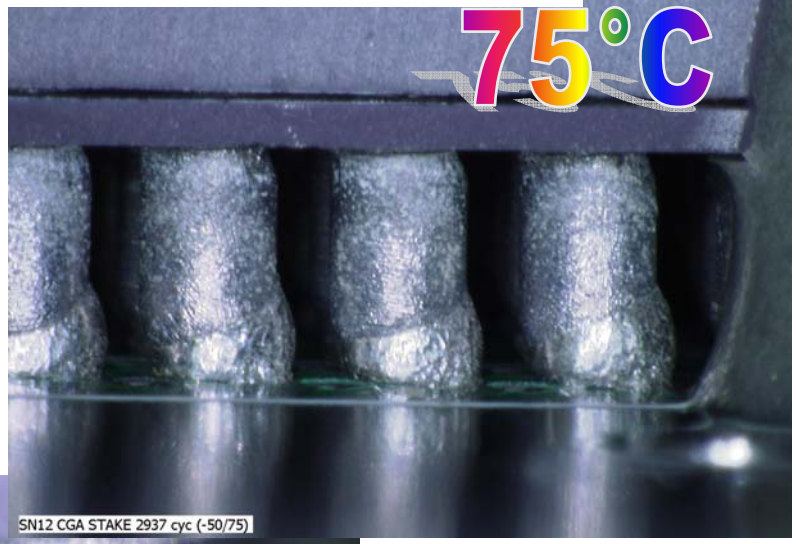
Effect of Max Temp

Photomicrographs of PBGA/CCGA at 2937 cycles (-50/75°C)





CCGA, after 478 cycles (-55/125°C)

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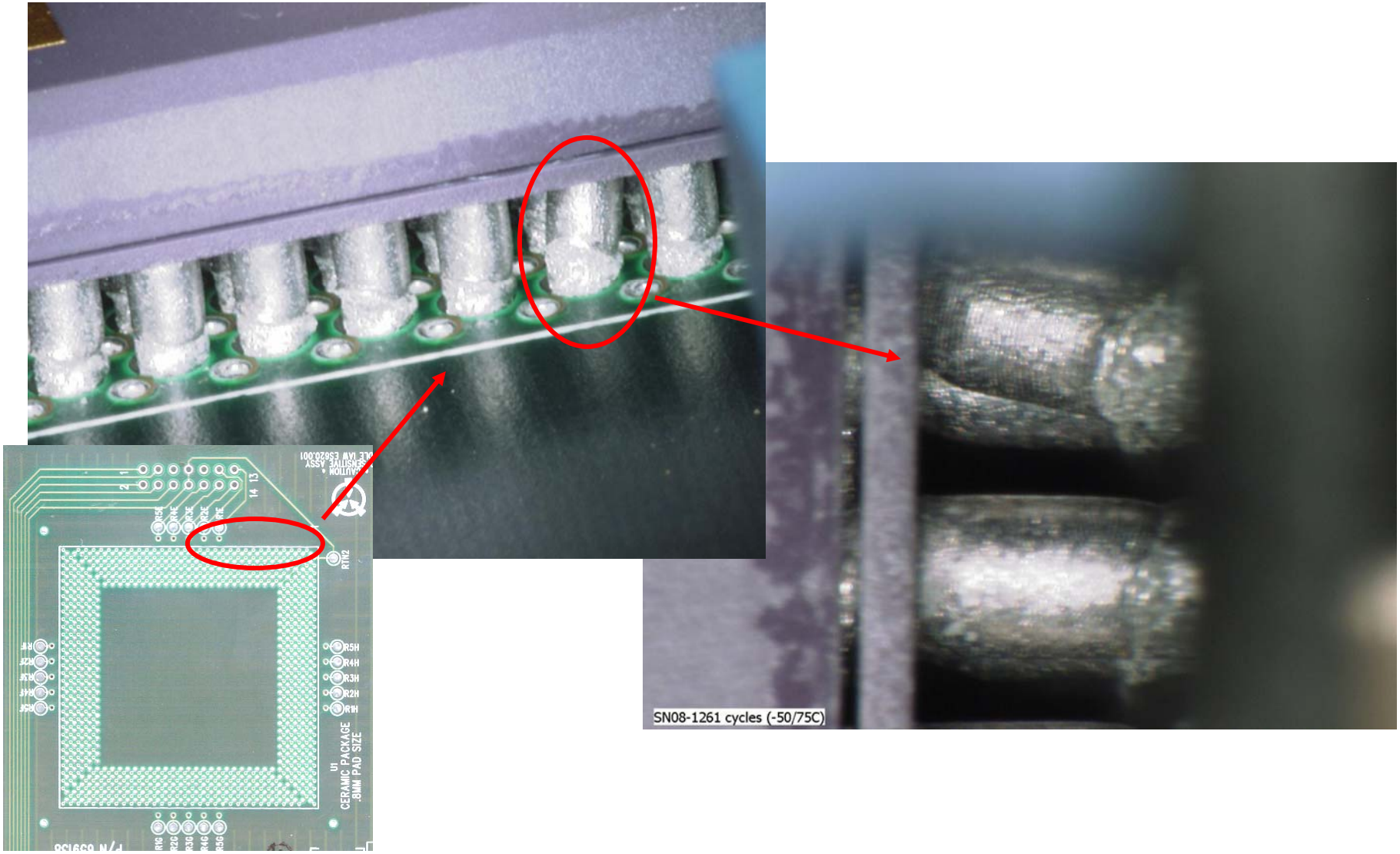
1st Failure, CCGA, 1261 Cycles (-50/75°C)



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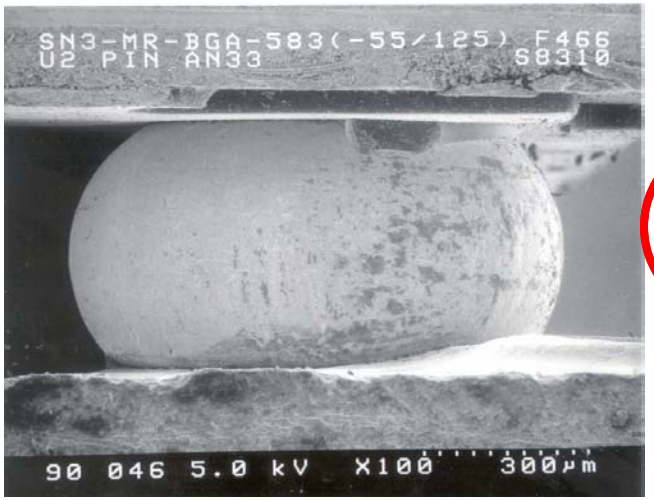
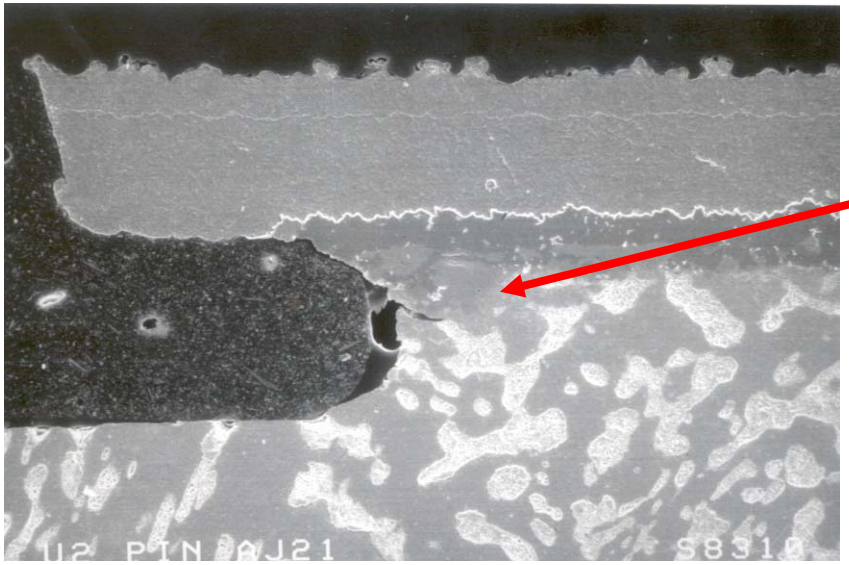
PBGA after 583 Cycles (-55/125°C)





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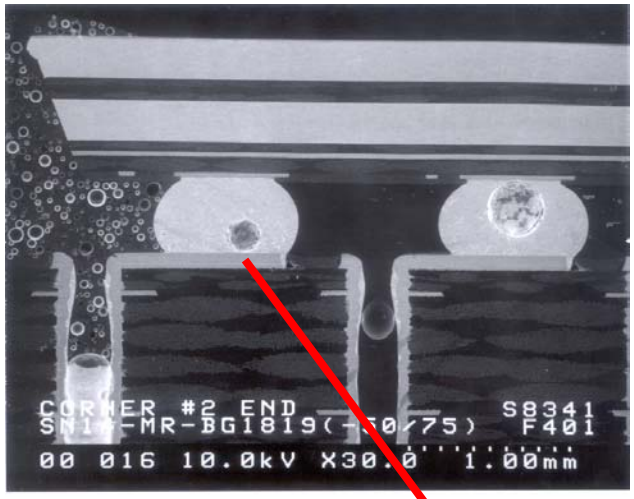
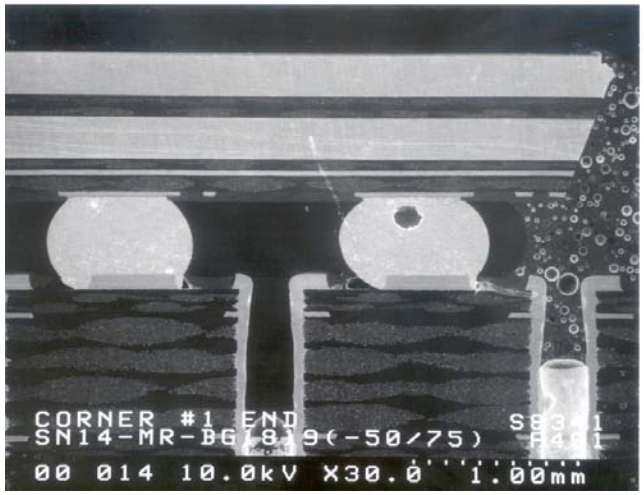
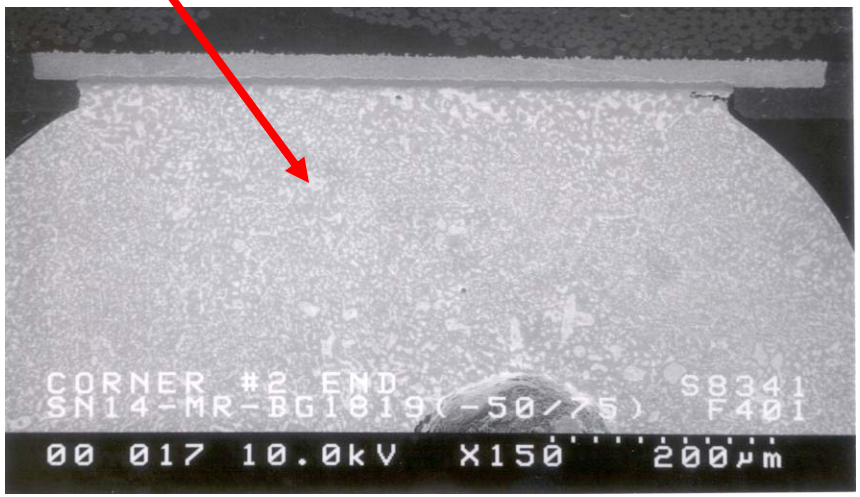
Effect of Cycle/Corner Stake

1819 cycles (-50/75°C)







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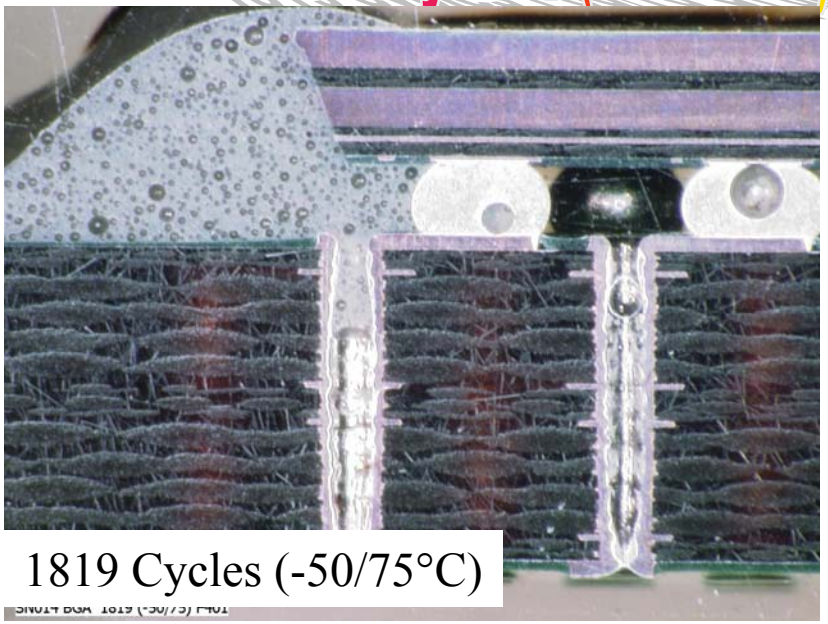
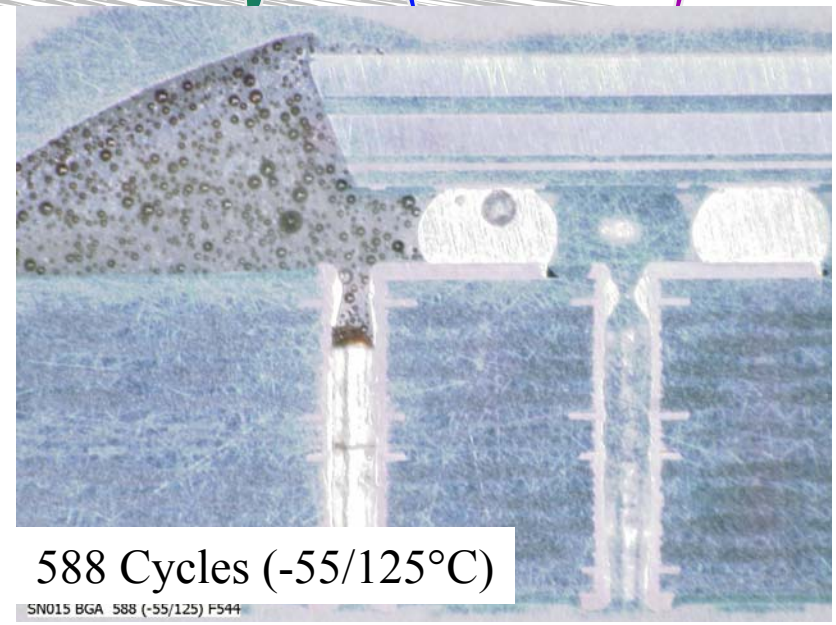
PBGA- Effect of Cycle/Corner Stake

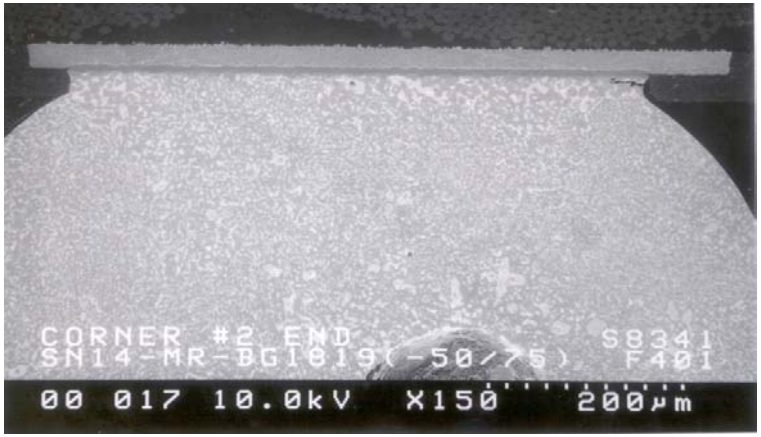
1819 cycles (-50/75°C) and 588 cycles (-55/125°C)

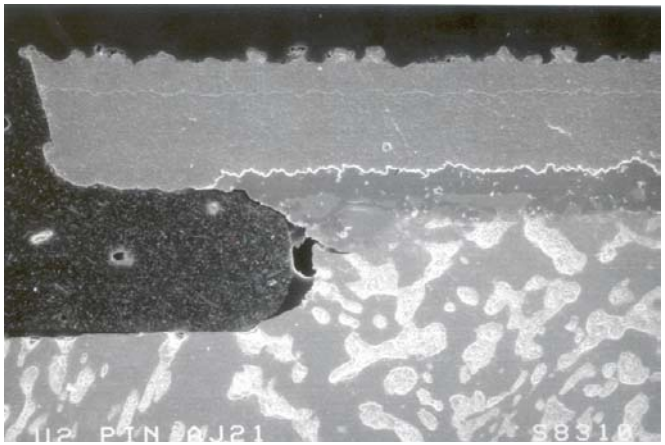


1819 Cycles (-50/75°C)



588 Cycles (-55/125°C)





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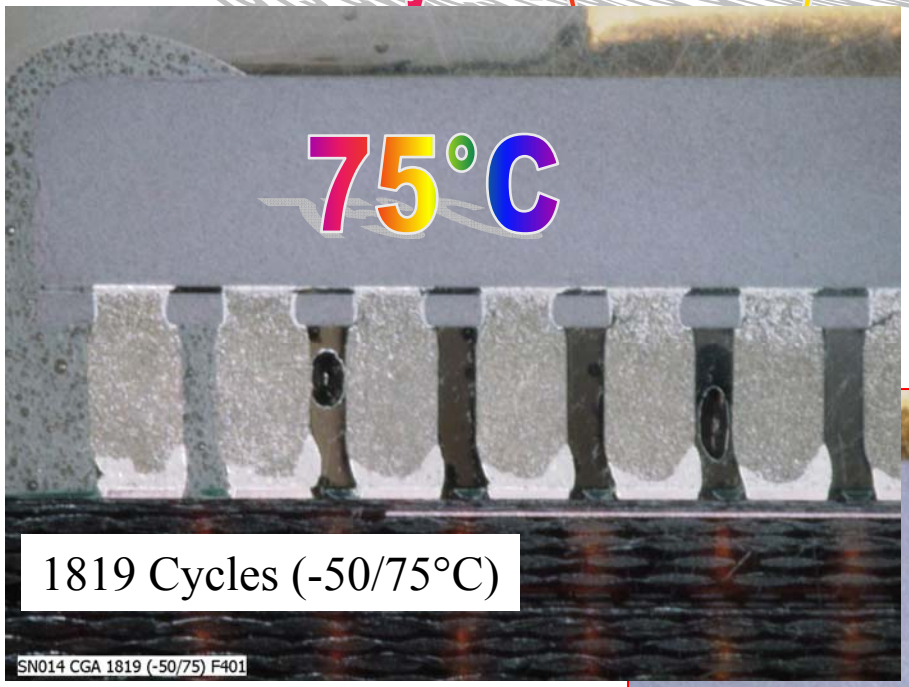
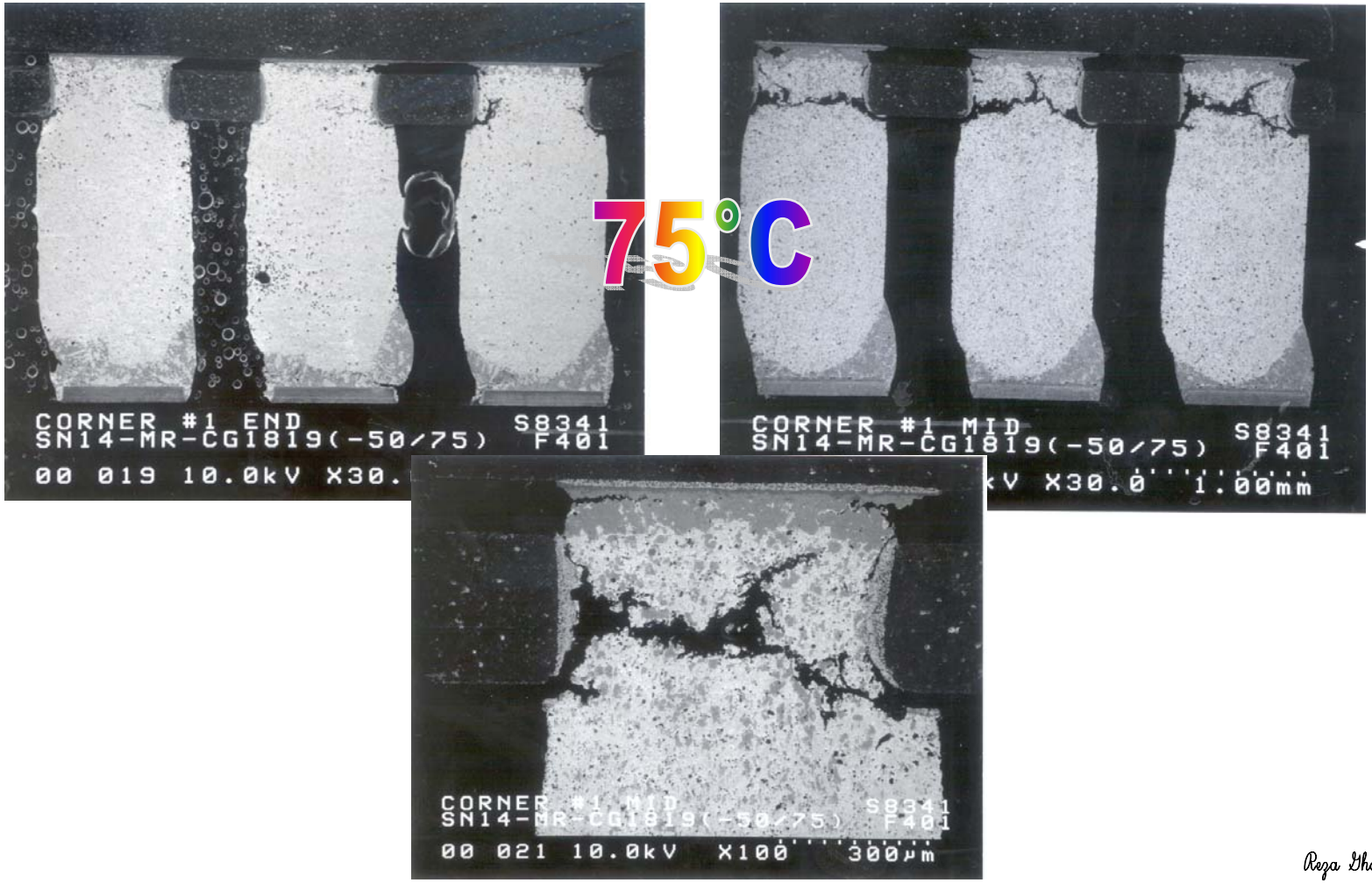
PBGA- Effect of Cycle/Corner Stake

1819 cycles (-50/75°C) and 588 cycles (-55/125°C)



CCGA- Effect of Cycle/Corner Stake
1819 cycles (-50/75°C)



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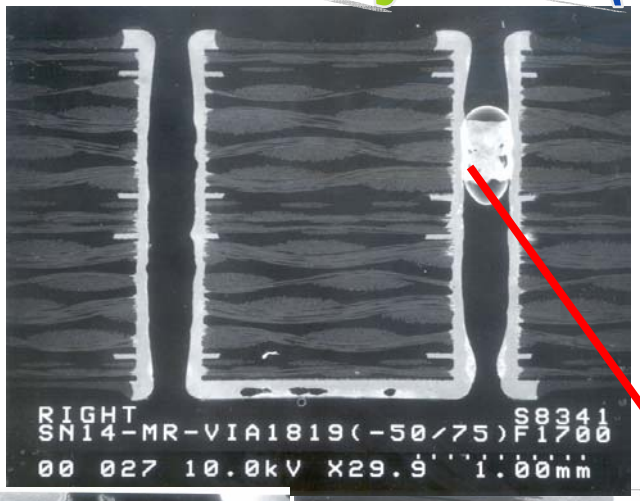
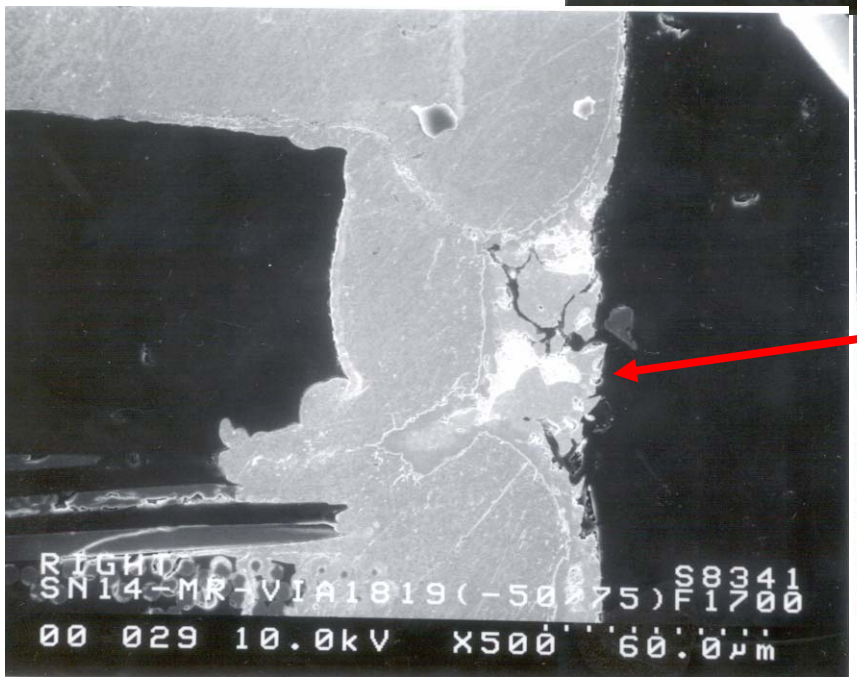
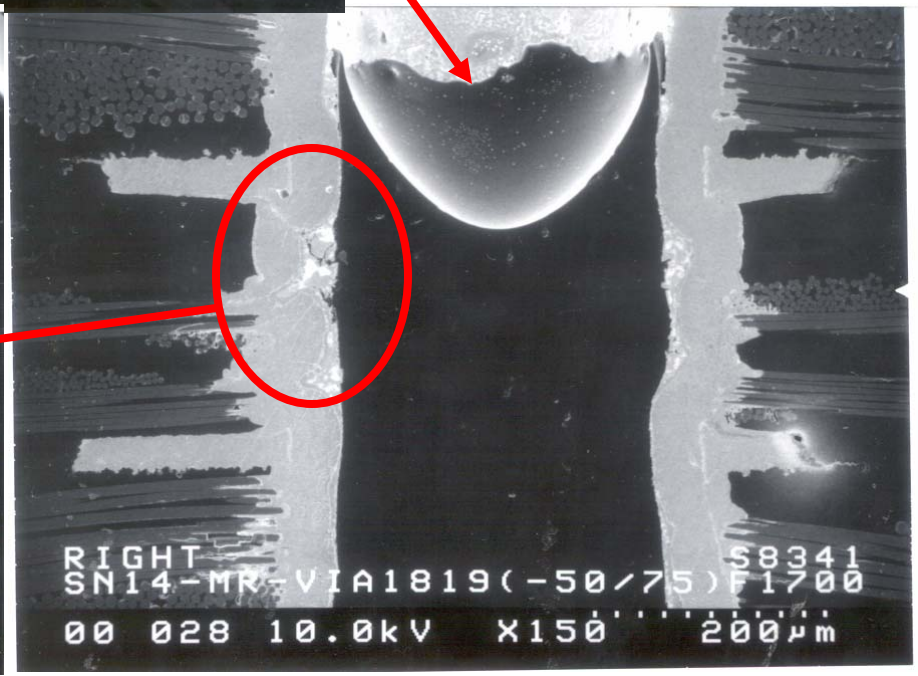
PTH Via at 1819 Cycles (-50/75°C)







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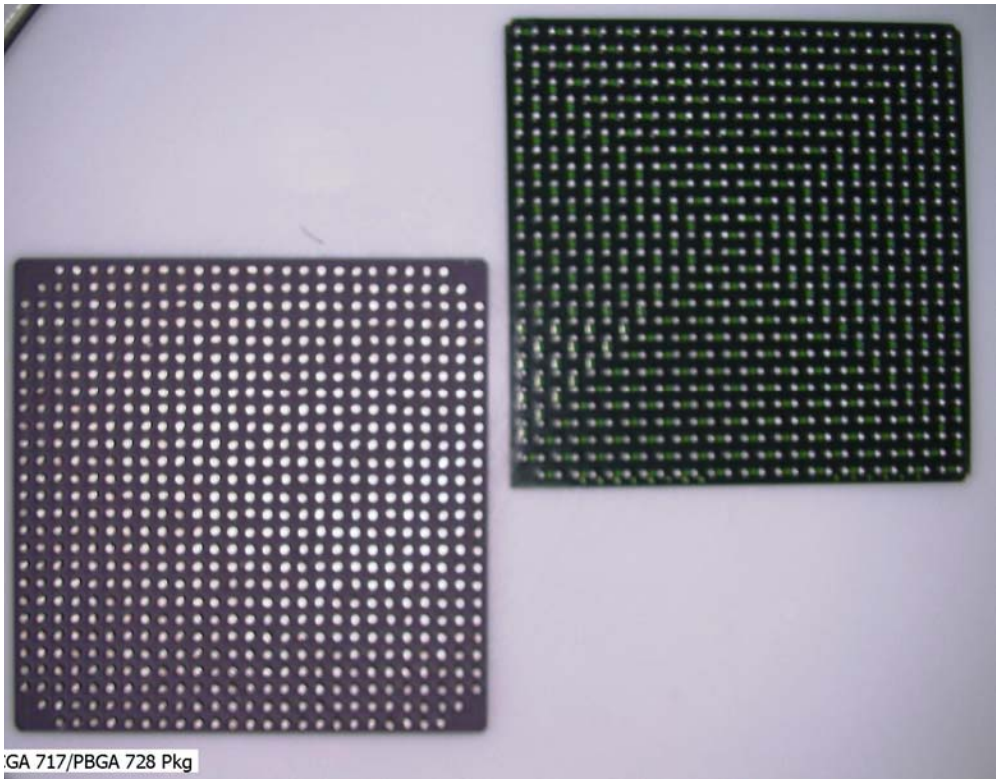
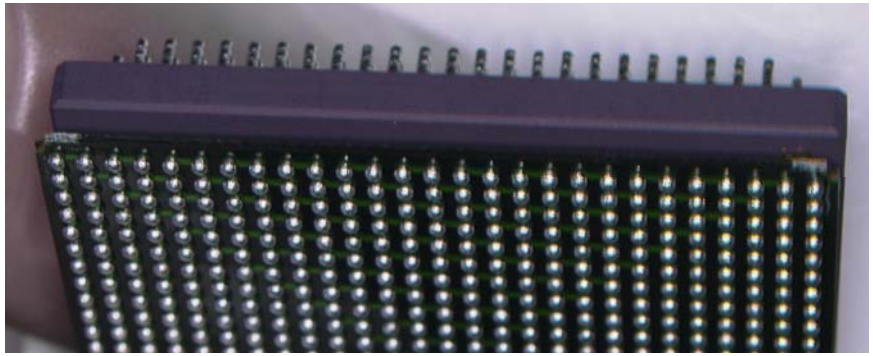
CCGA 717 & PBGA 728 I/Os





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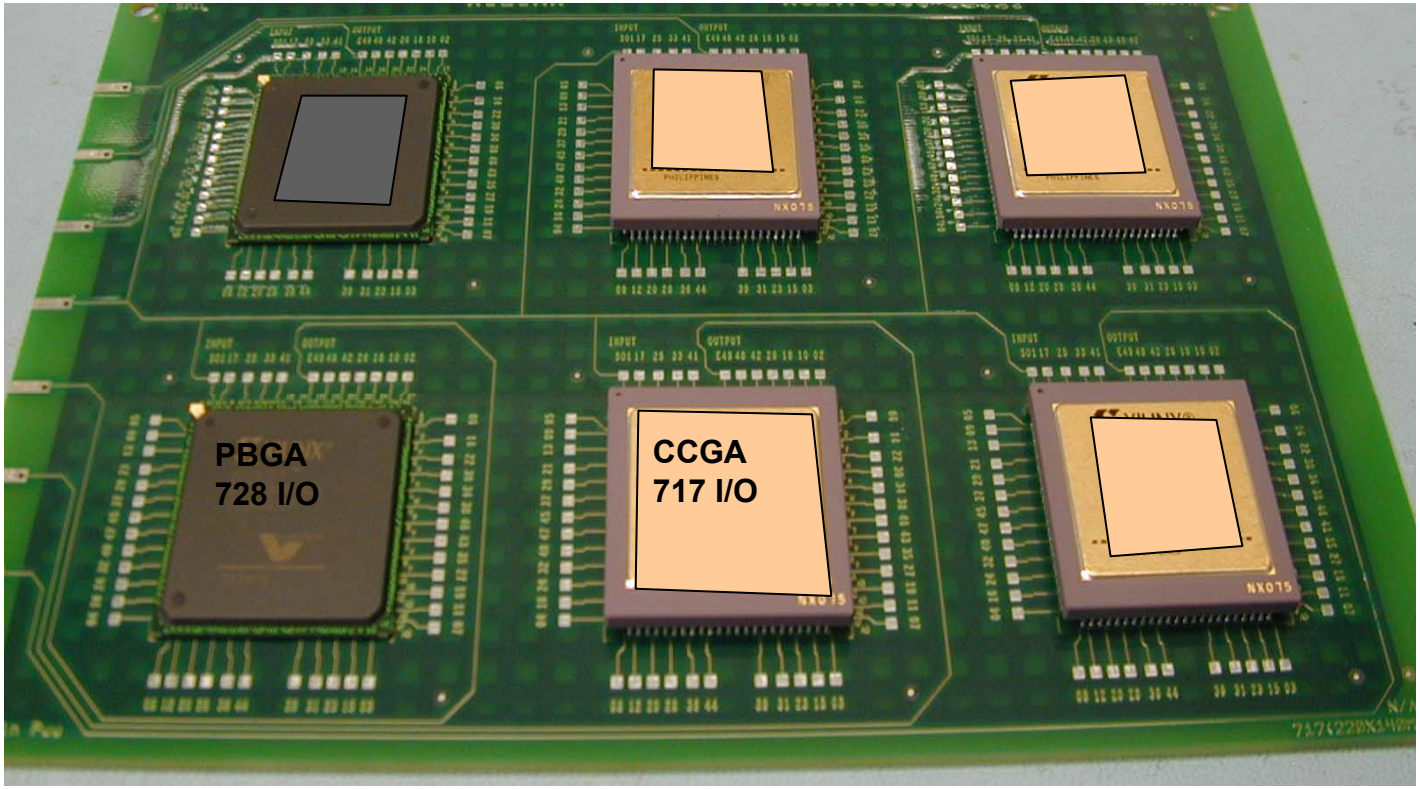
CCGA 717 & PBGA 728 I/Os TV



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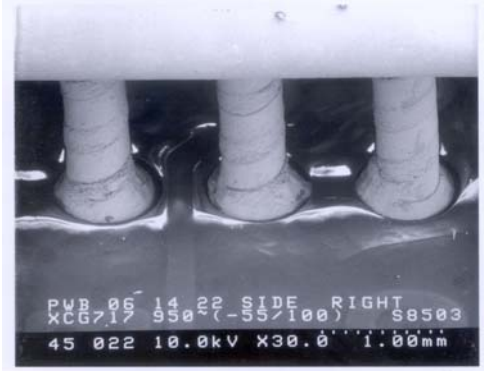
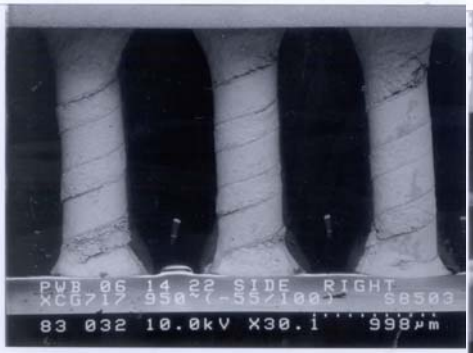
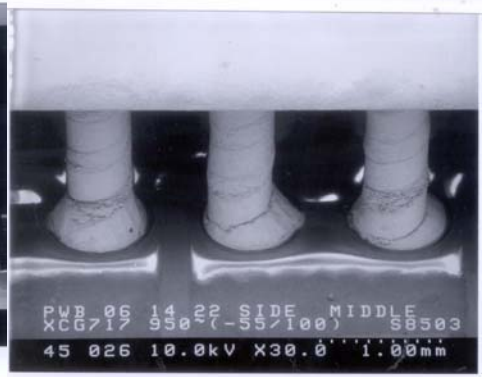
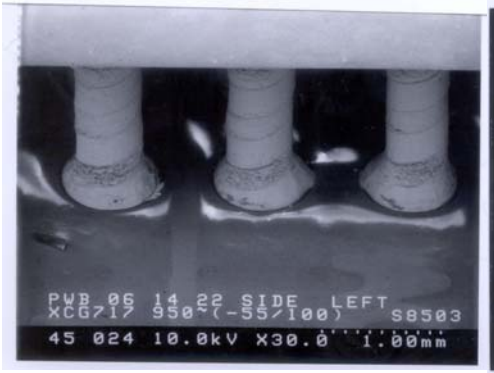
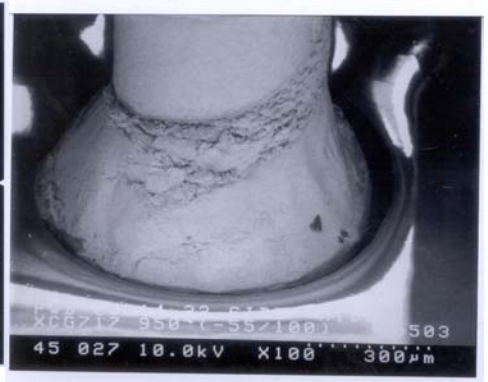
950 Thermal Cycles (-55°/100°C)

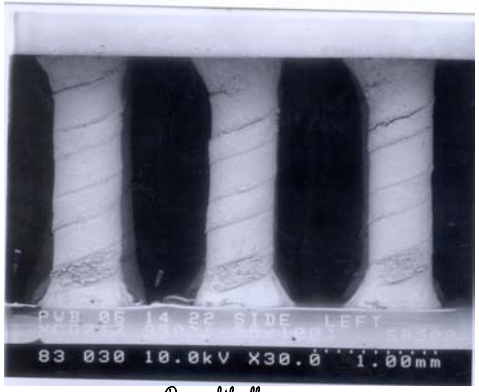












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Conclusions-I

- **PBGAs- No failures to 2,000 cycles (-50/75°C)**
- **CCGAs @ 100°C or 125°C Max Temp**
  - Signs of graininess
  - Reduction in solder volume
- **CCGAs @ 75°C- No Changes**

- **Failures affect by staking on columns**
  - **Failures in staking at package interposer for -55/125°C**
  - **Failures away from staking, but at interposer for -50/75°C**

- **PTH microcracks at 1819 cycles (-50/75°C)**

Conclusions-II

- CCGA560
  - 1st failure ~ 1,000 cycles (-50°/75°C)
  - 1st failure from package site/high solder volume
  - Heavy cracking at 200 cycles (-55°/100°C)
- CCGA717- OK to 1000 cycles (-55°/100°C)
- CCGA 717- OK with conformal/corner staking
- PBGA 728- OK for all above

Acknowledgment

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