

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



Assembly Reliability for Two CCGA Packages

by

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Outline

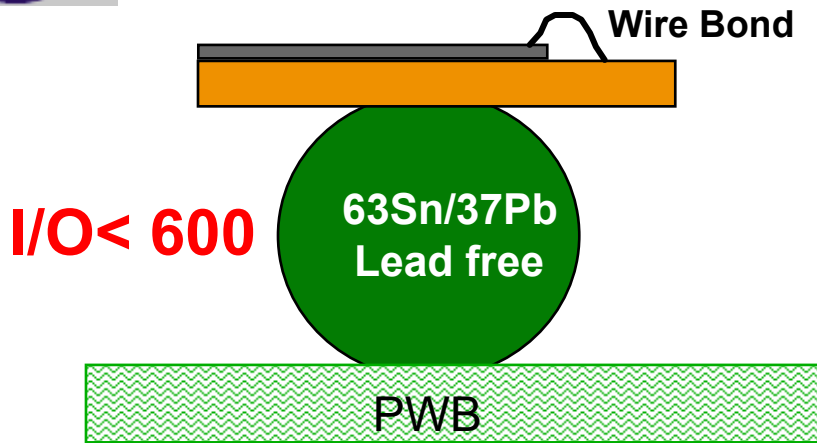
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- Electronic Package Trend
 - Package shrink trends
 - Resources
- CCGA/PBGA Qual
 - Key parameters- Literature data
 - Objectives and test matrix
- Test Results
 - CCGA 560 I/Os- Peripheral
 - CCGA 717 I/Os – Full Array
 - PBGA
 - PTH via
- Conclusions

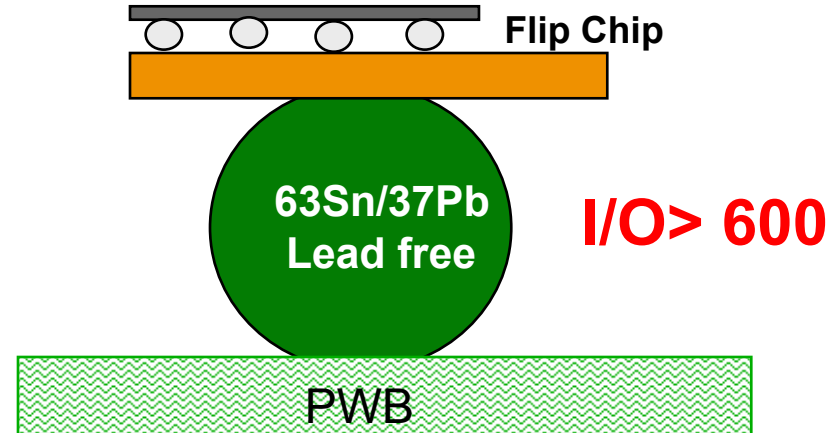


BGA Package Types

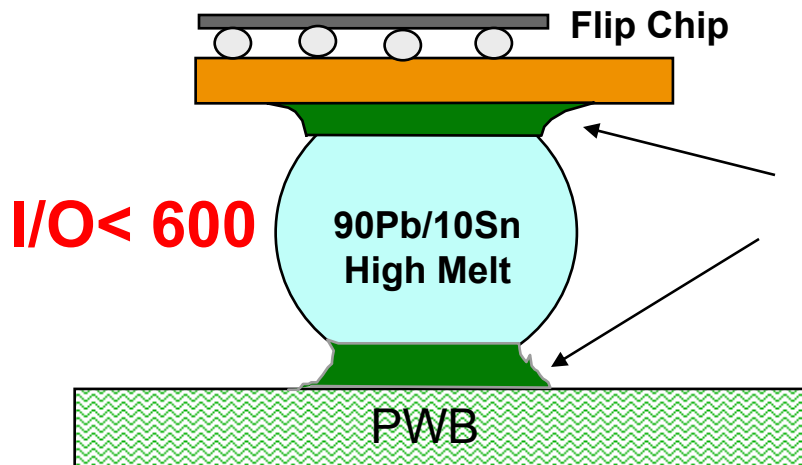
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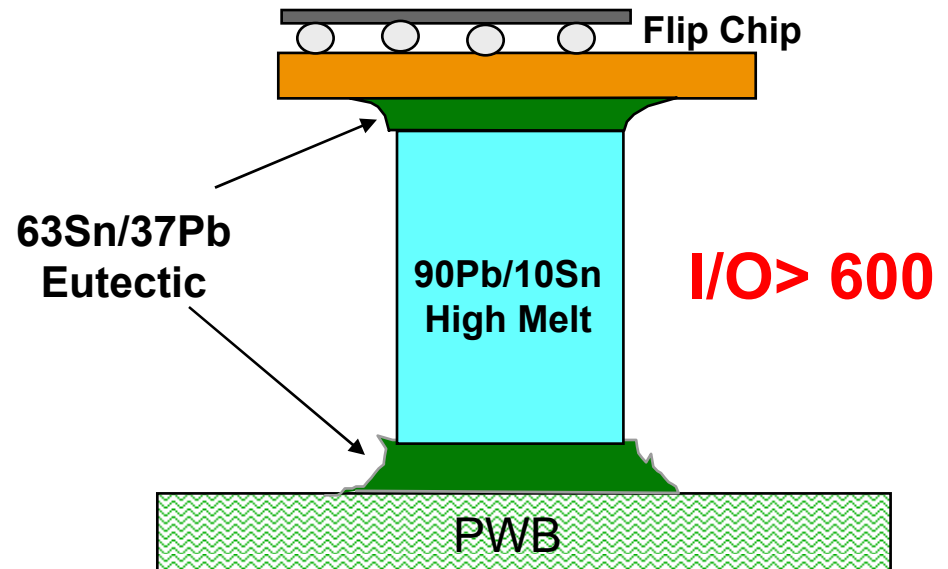
Plastic BGA (PBGA)



Flip Chip BGA (FCBGA)



Ceramic BGA (CBGA)



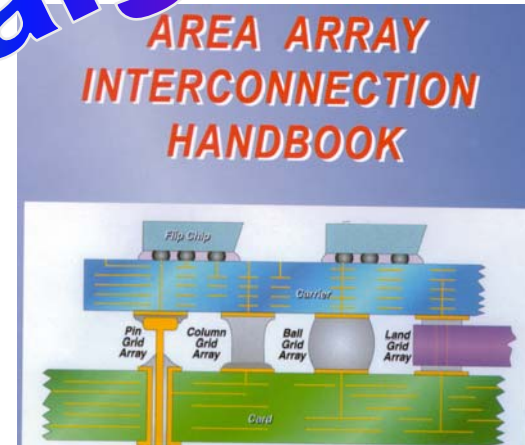
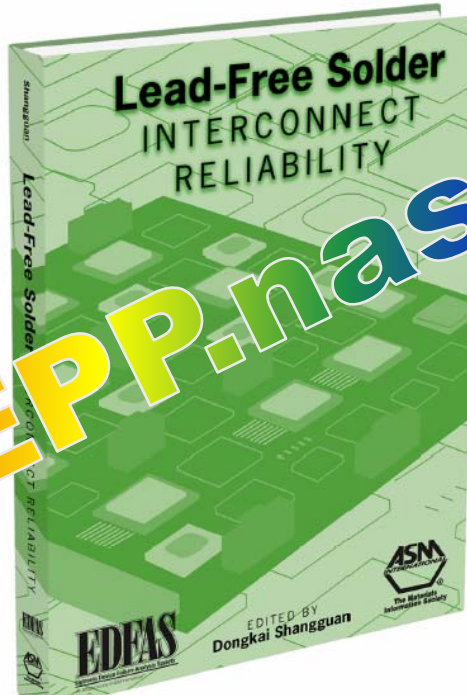
Column CBGA (CCGA)

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References

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Objectives

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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



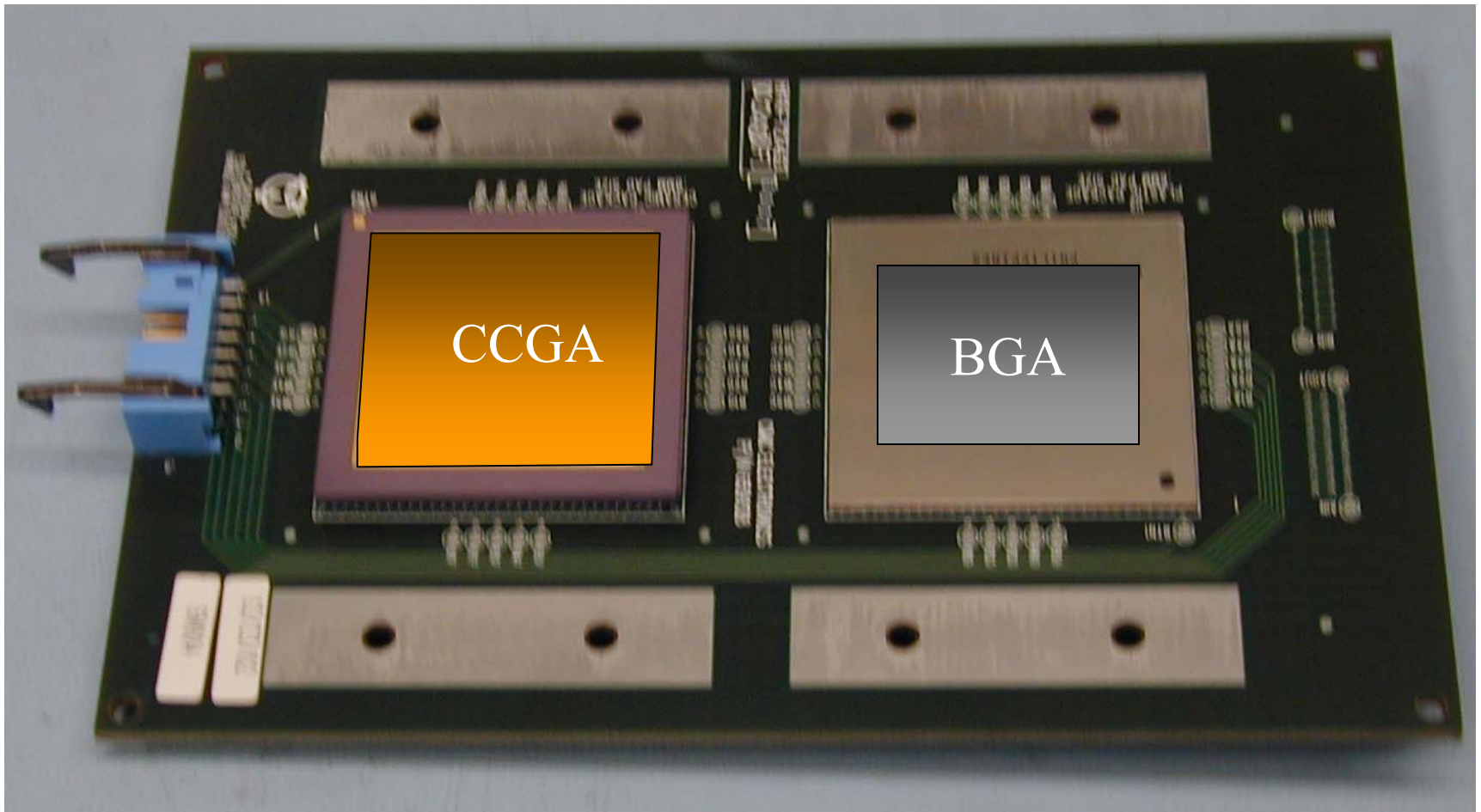
Determine risk for unknowns at design

- **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

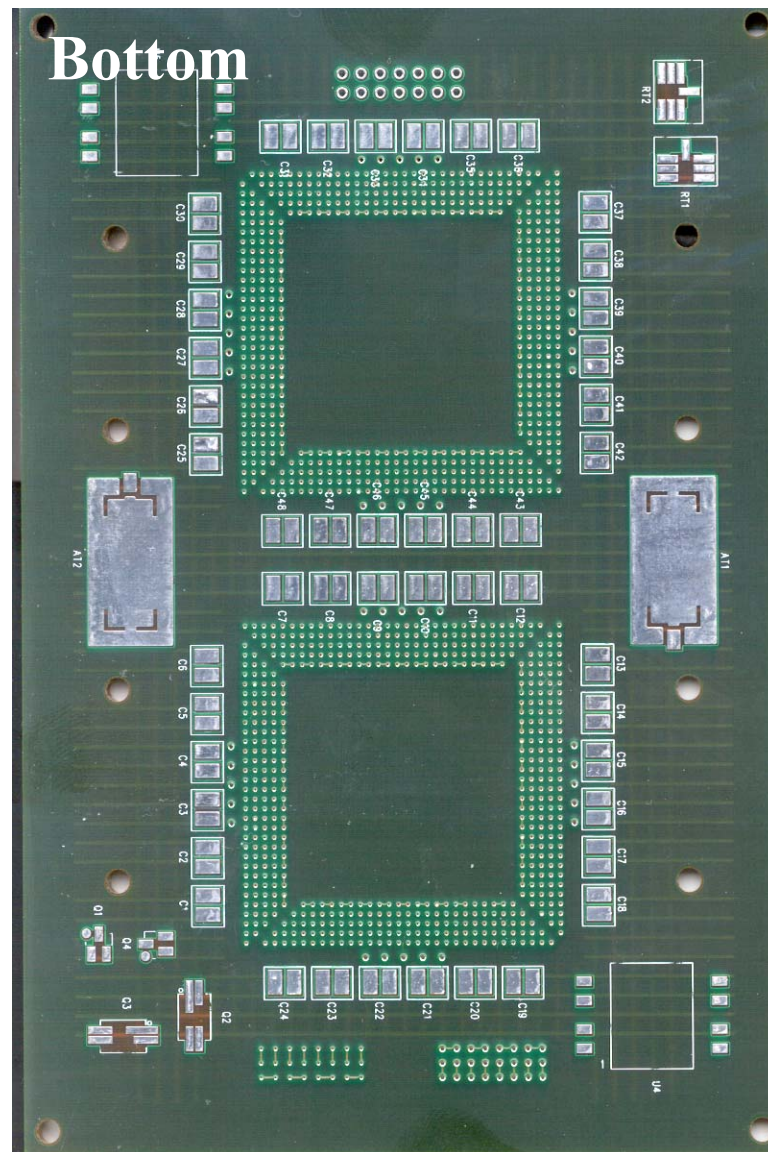
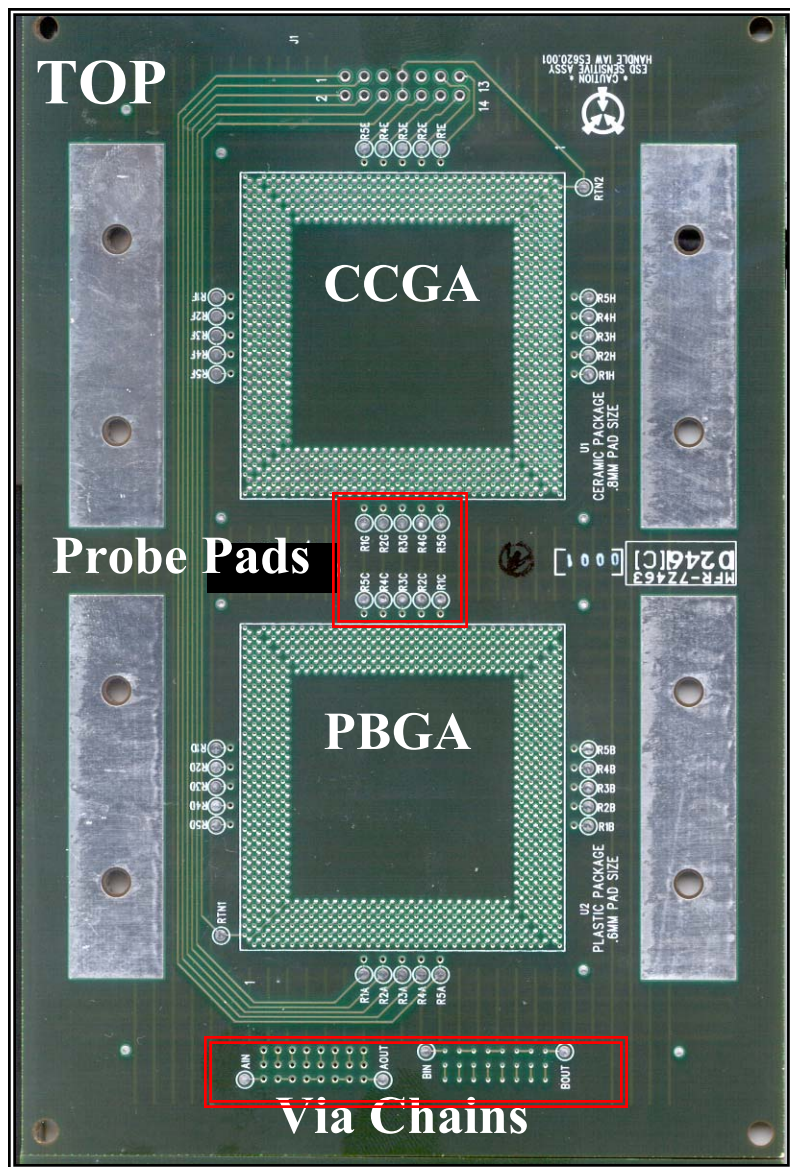
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PWB Design

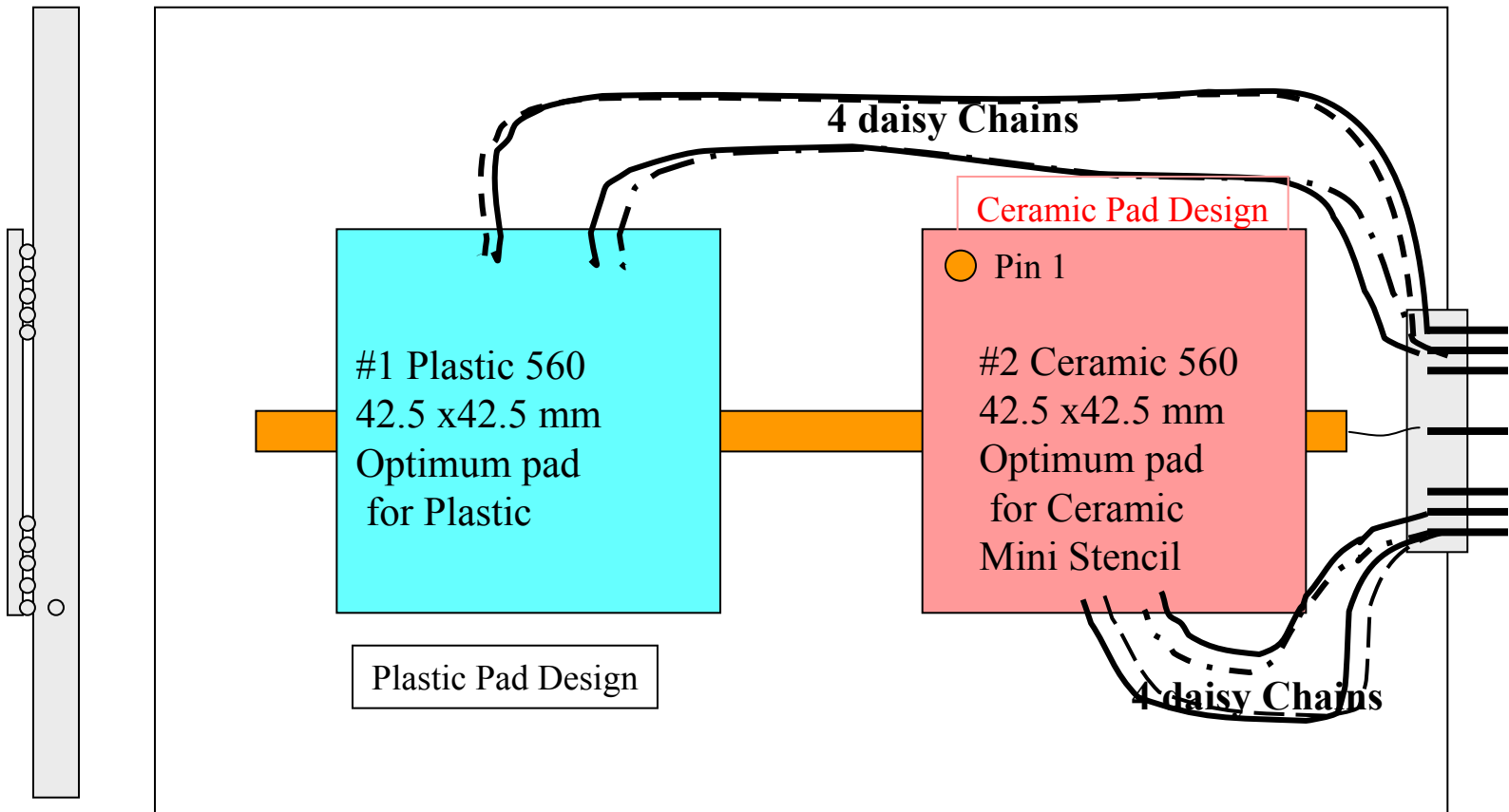
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Test Vehicle- PBGA/CCGA

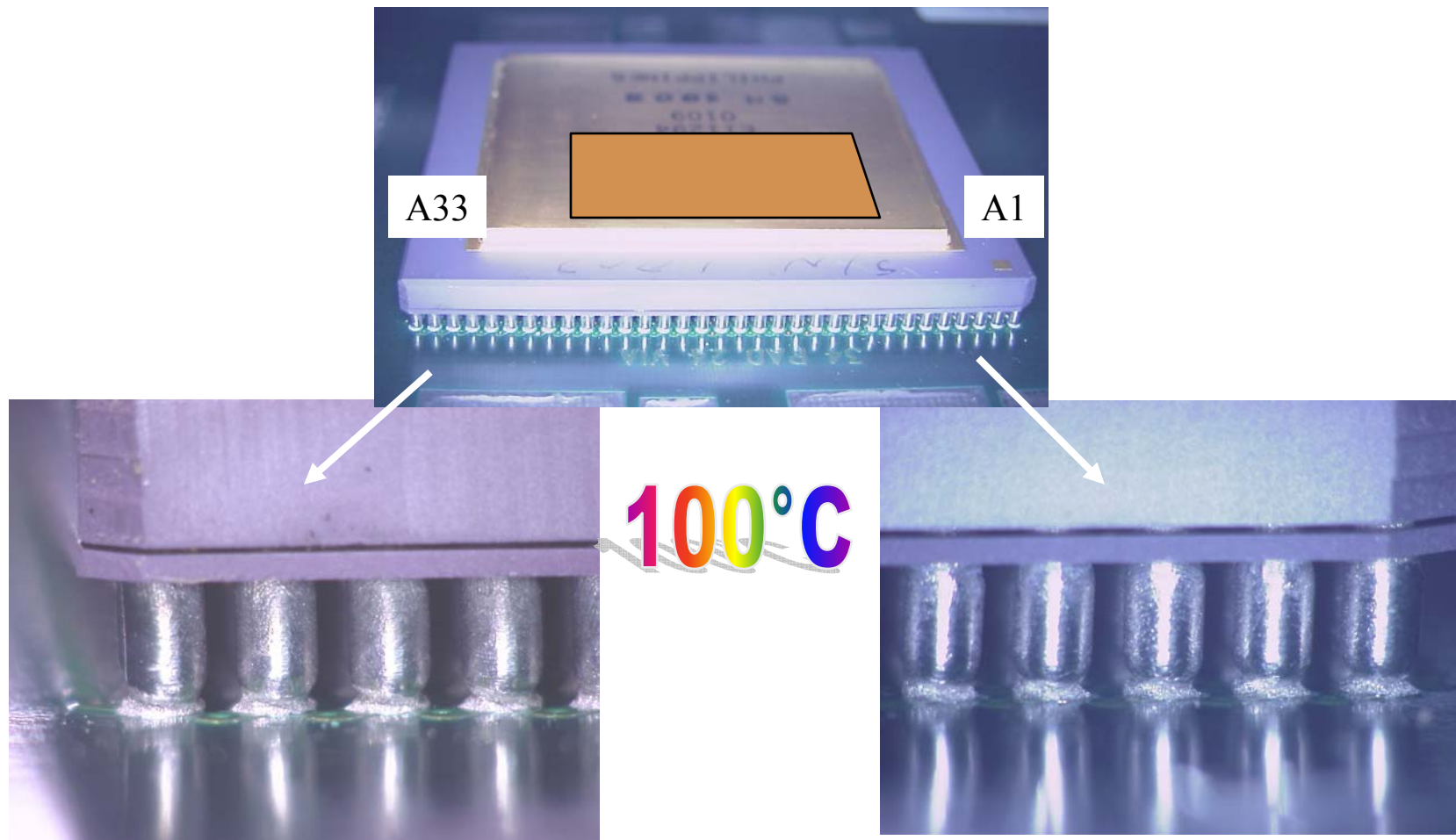
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Effect of TC Max Temp on CCGA

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200 cycles (-55/100°C)

Stencil 8 mil thick- CCGA

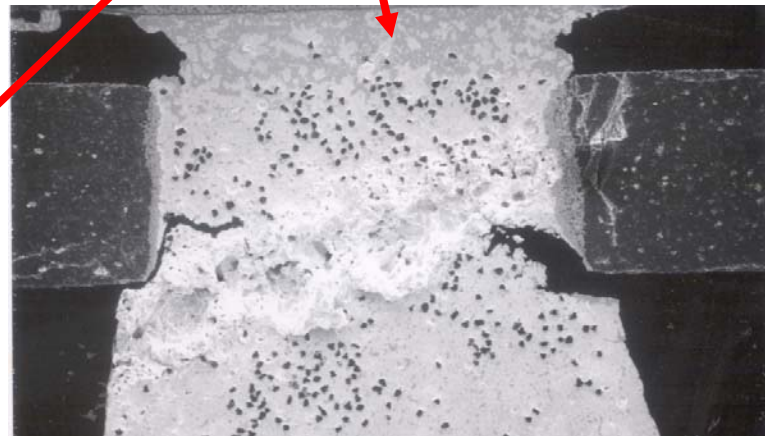
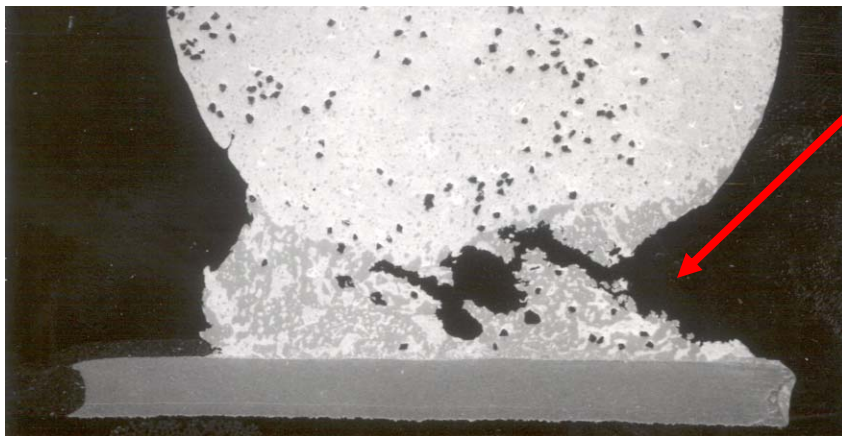
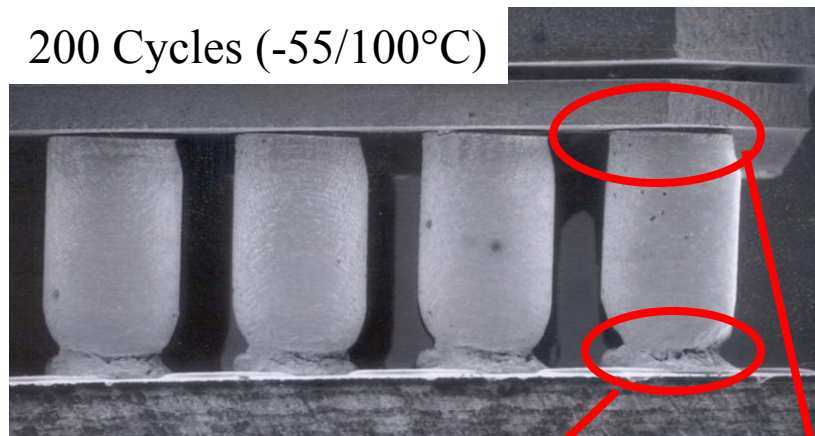
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CCGA X-section (-55/100°C)

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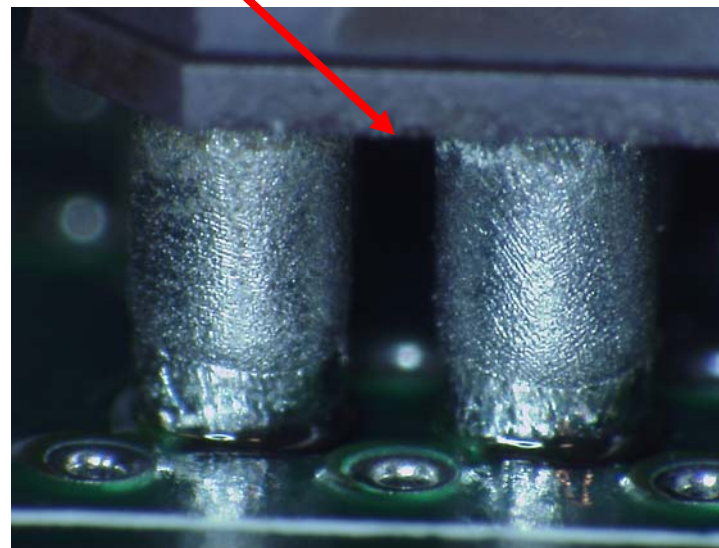
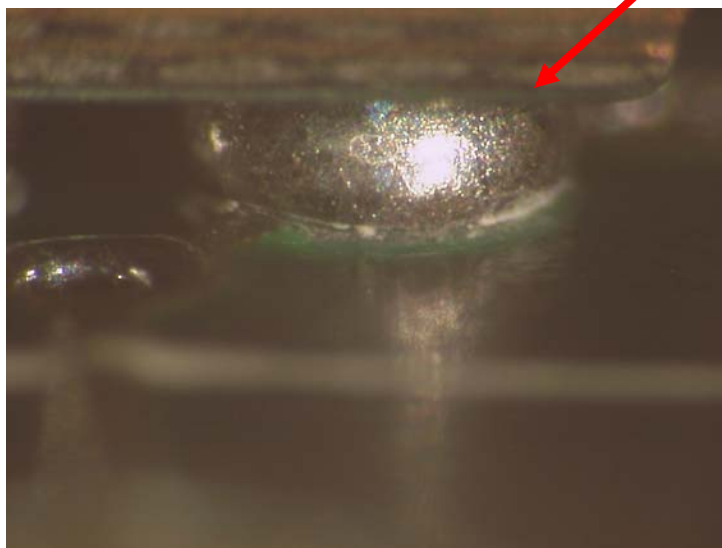
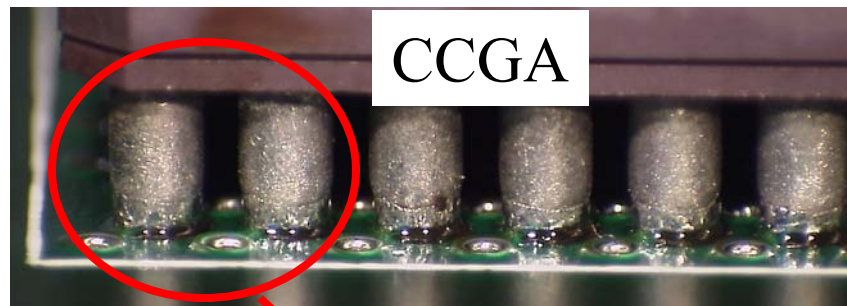
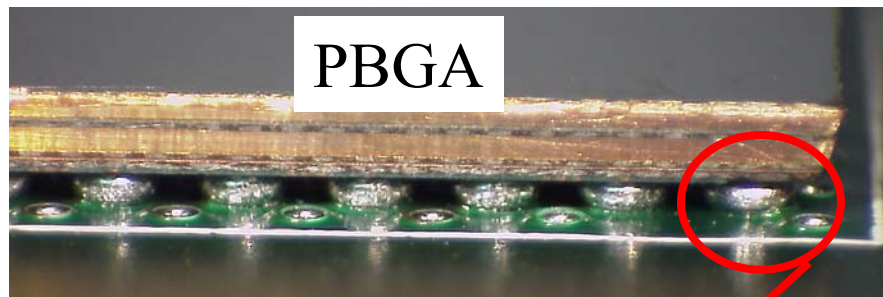
200 Cycles (-55/100°C)





Quality As Fab

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Stencil 10.5 mil thick-CCGA

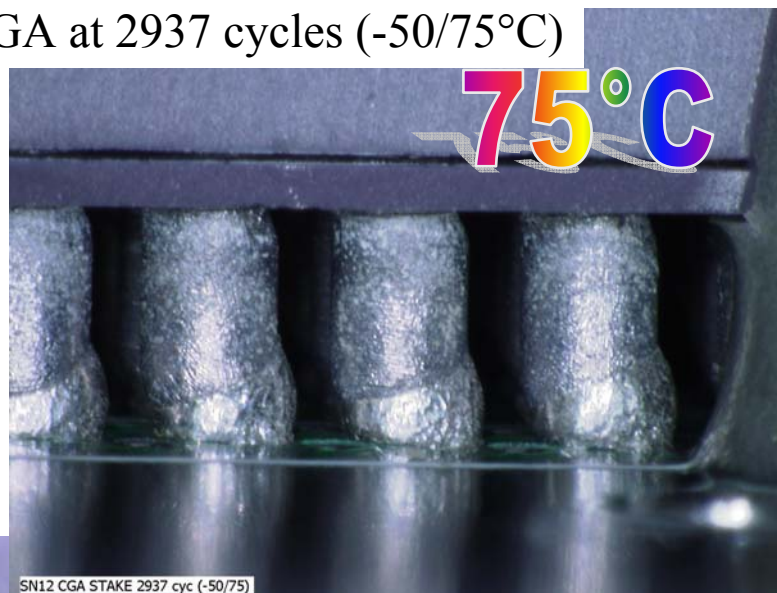
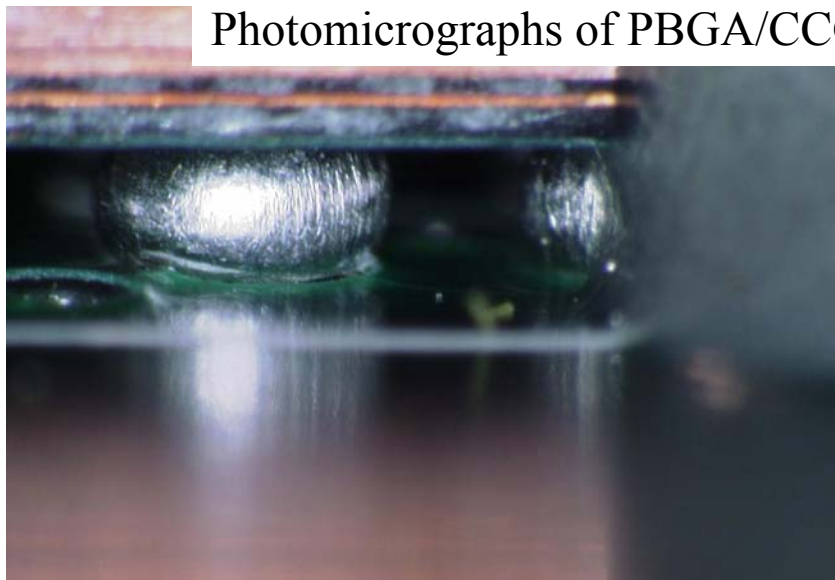
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Effect of Max Temp

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



SN12 CGA STAKE 2937 cyc (-50/75)



CCGA, after 478 cycles (-55/125°C)

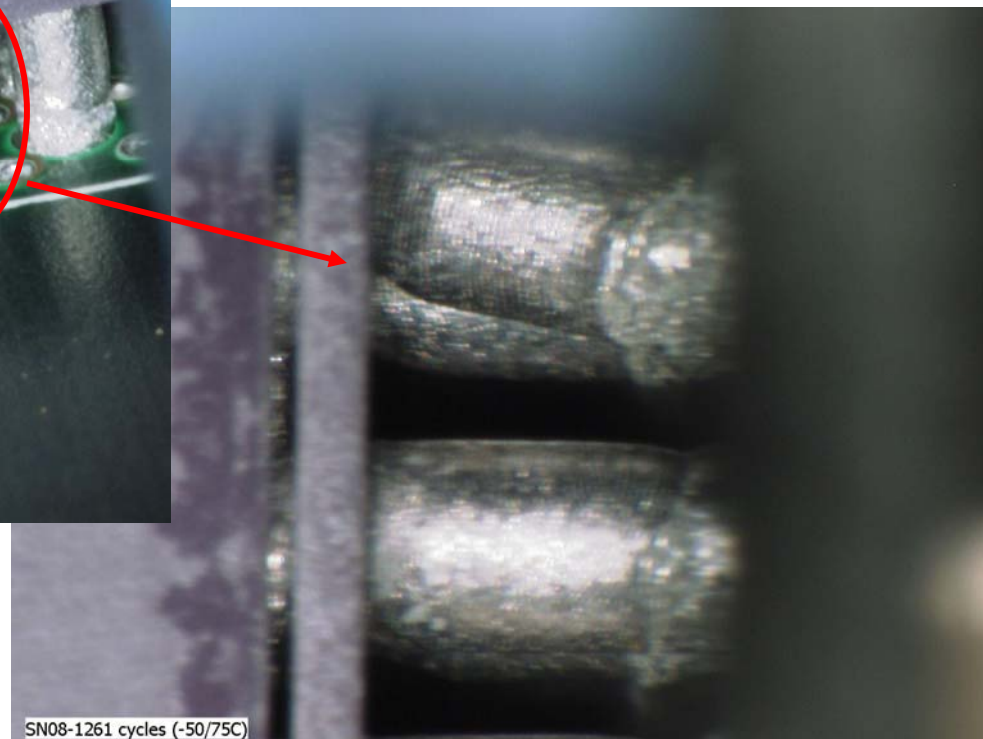
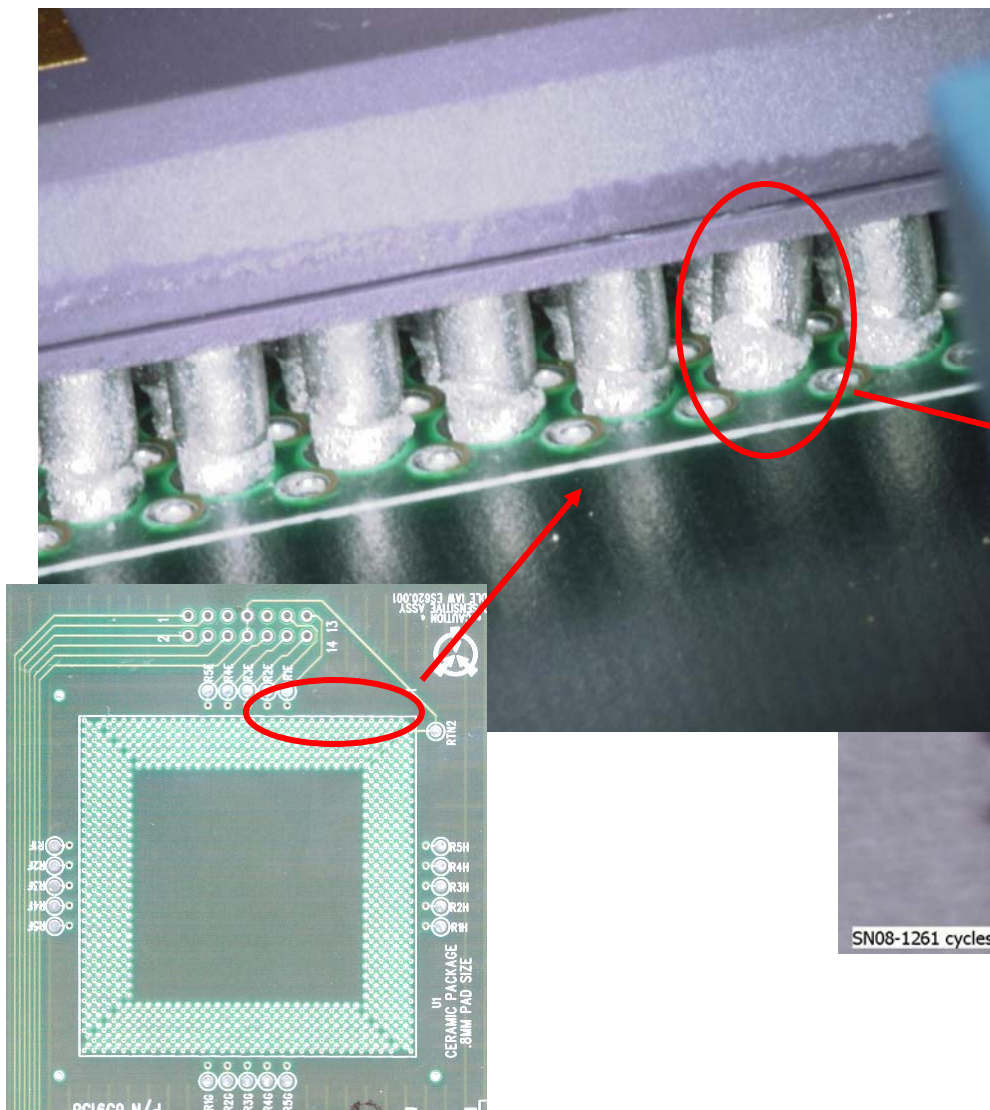
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1st Failure, CCGA, 1261 Cycles (-50/75°C)

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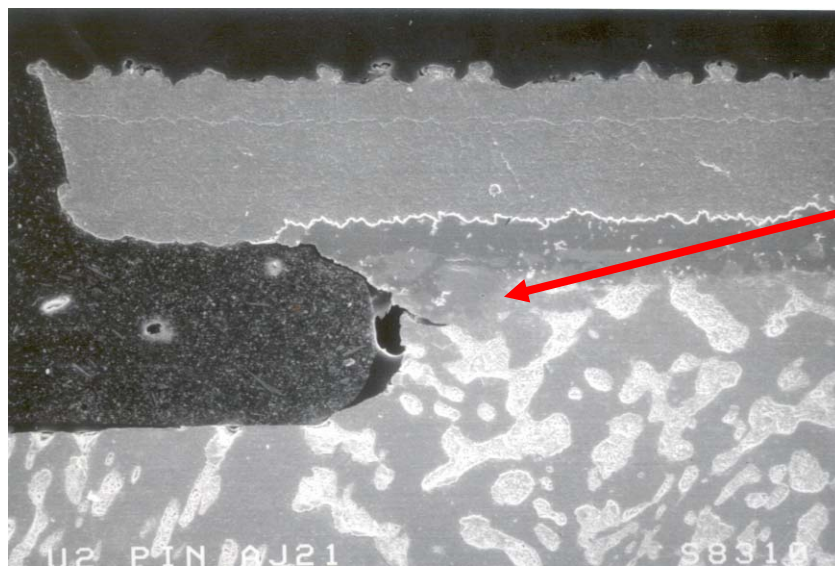
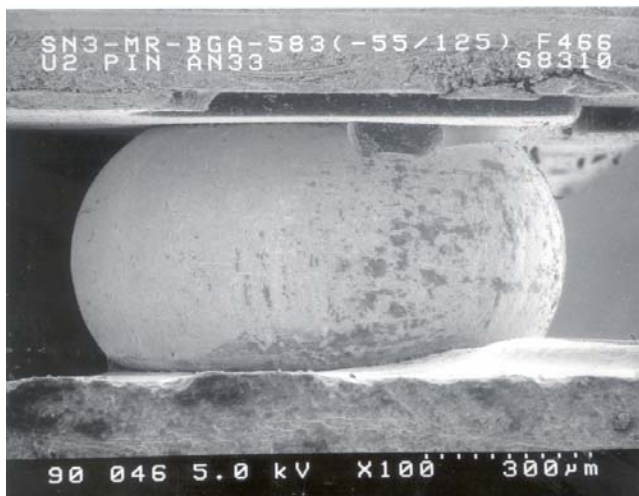


SN08-1261 cycles (-50/75C)



PBGA after 583 Cycles (-55/125°C)

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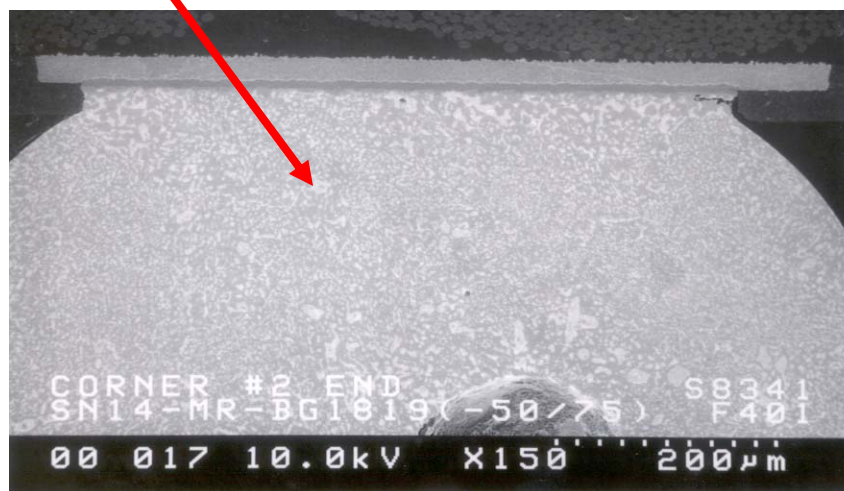
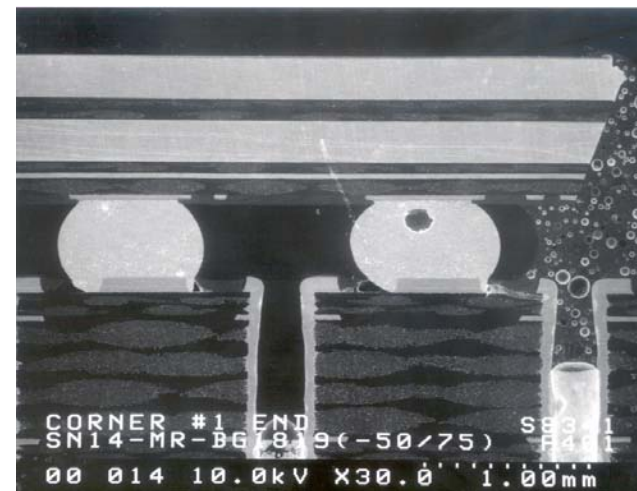
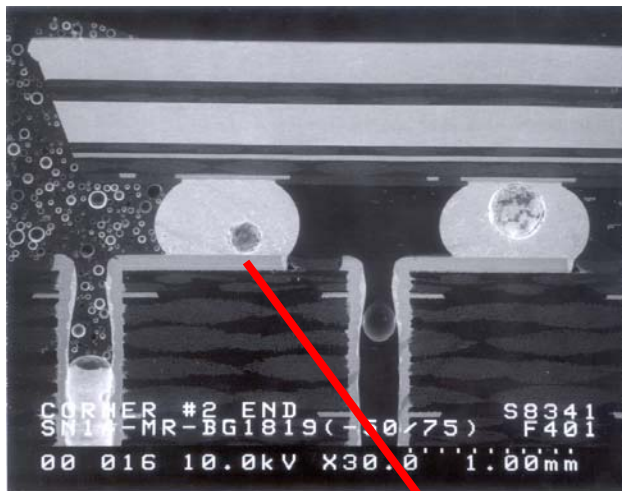
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Effect of Cycle/Corner Stake

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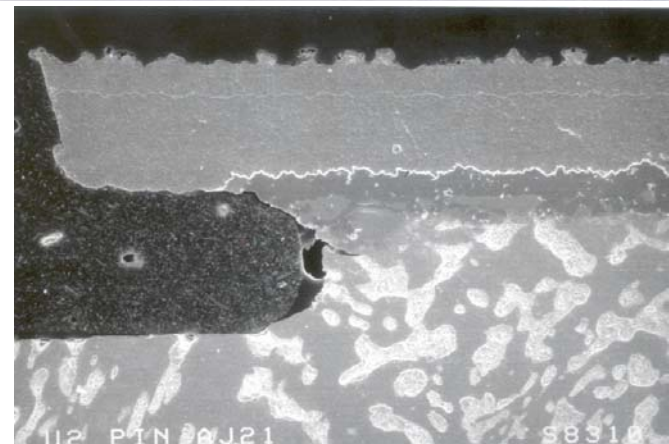
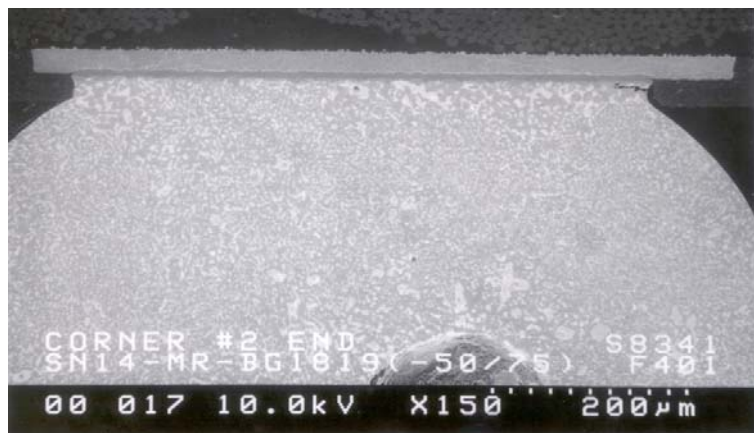
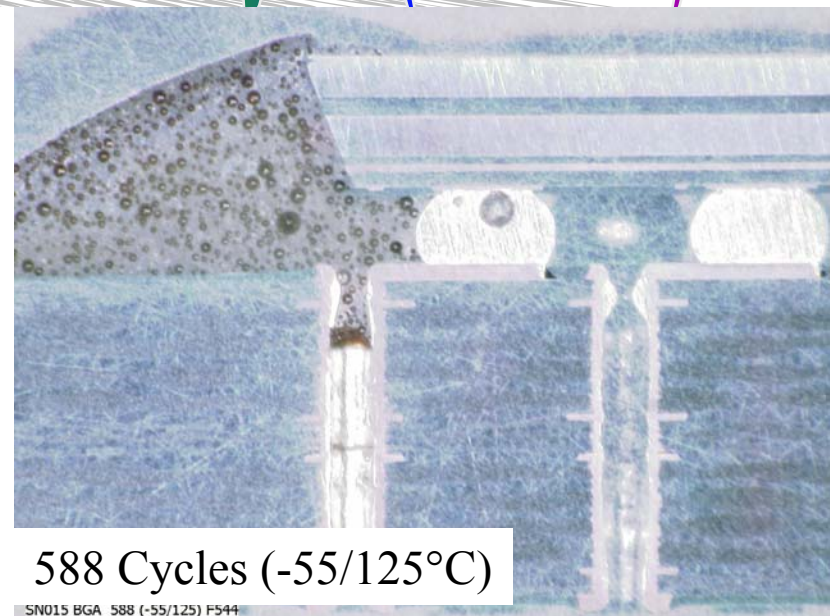
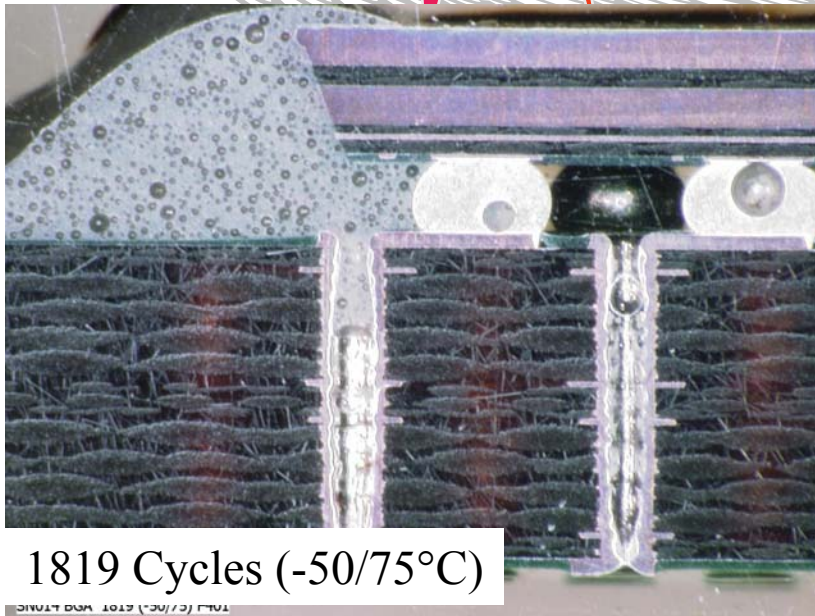
1819 cycles (-50/75°C)





PBGA- Effect of Cycle/Corner Stake

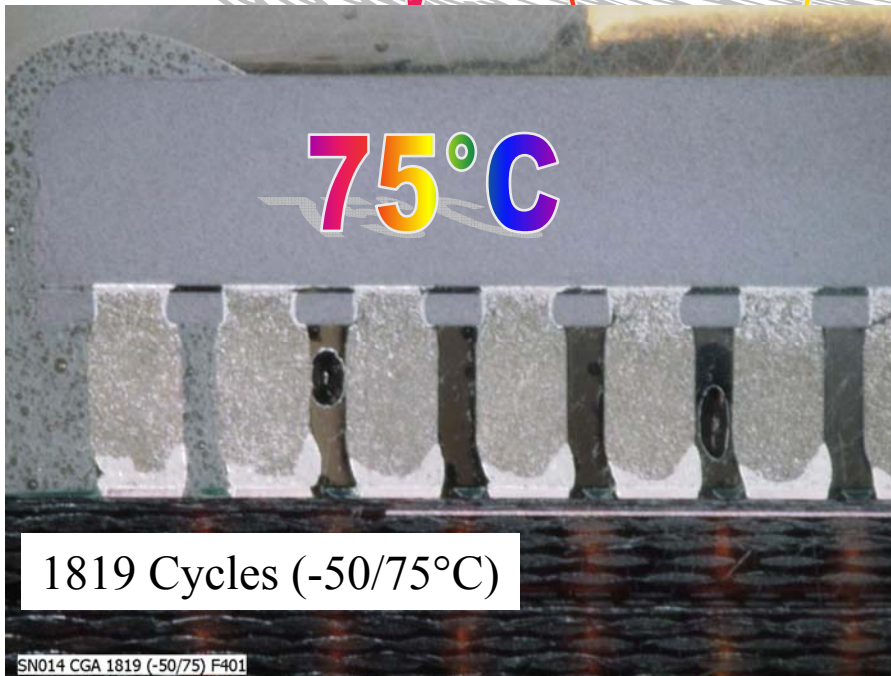
1819 cycles (-50/75°C) and 588 cycles (-55/125°C)





PBGA- Effect of Cycle/Corner Stake

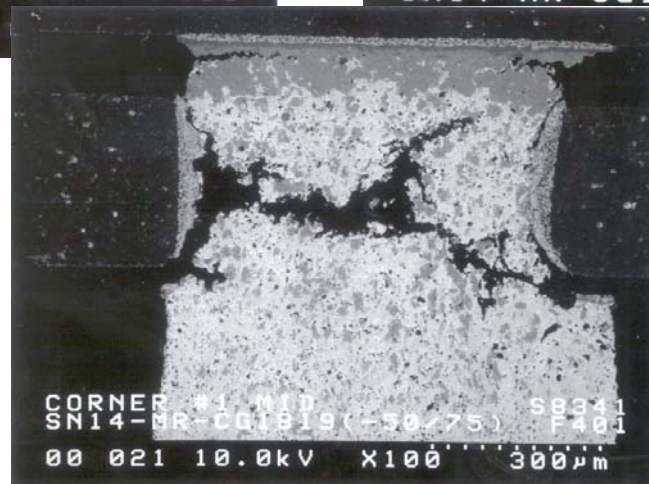
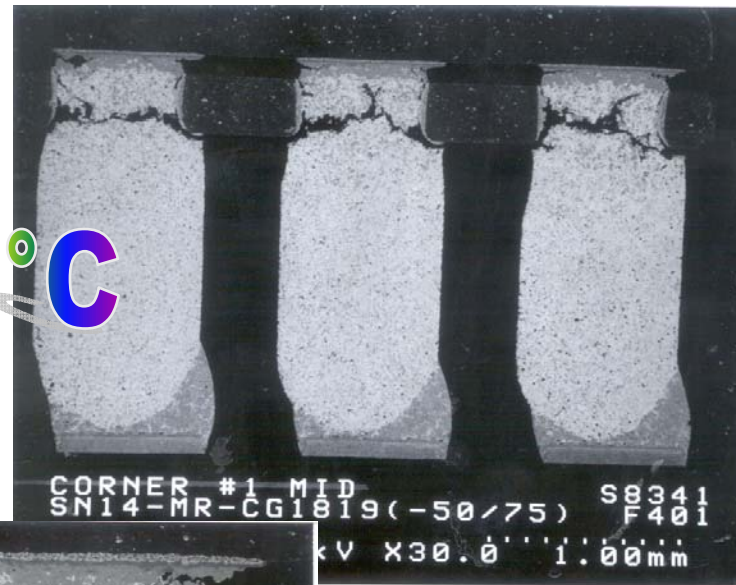
1819 cycles (-50/75°C) and 588 cycles (-55/125°C)





CCGA- Effect of Cycle/Corner Stake

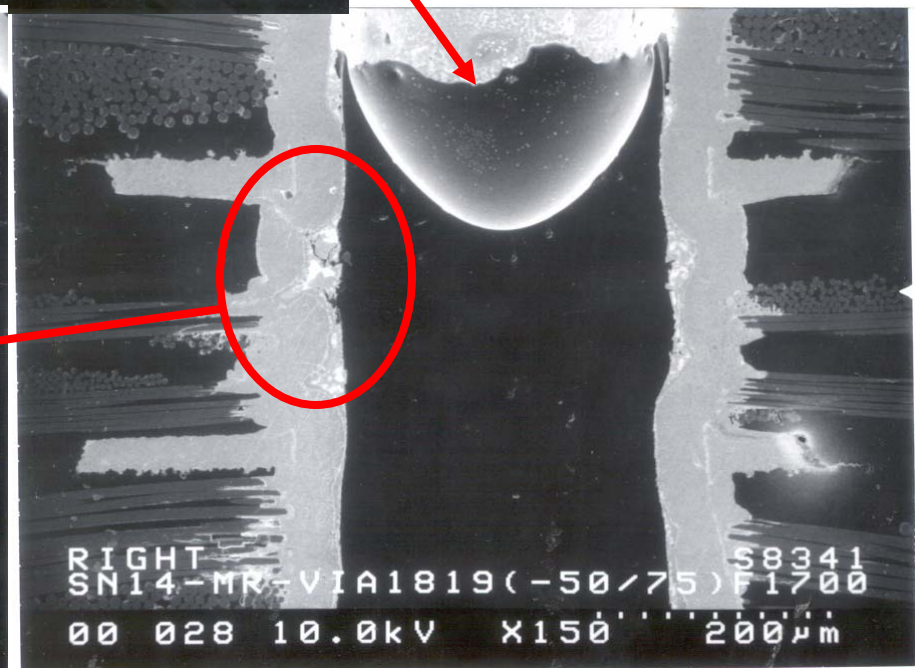
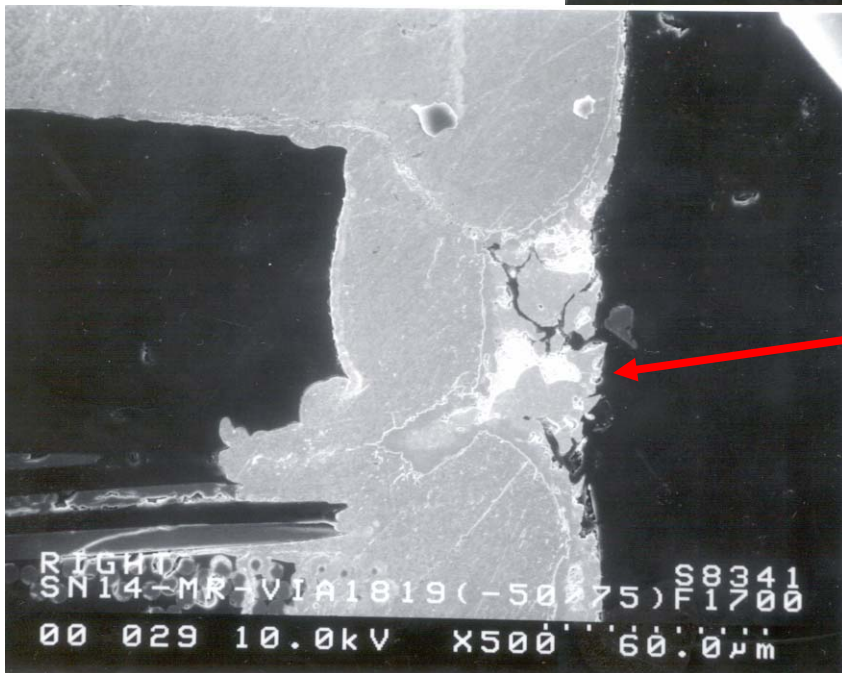
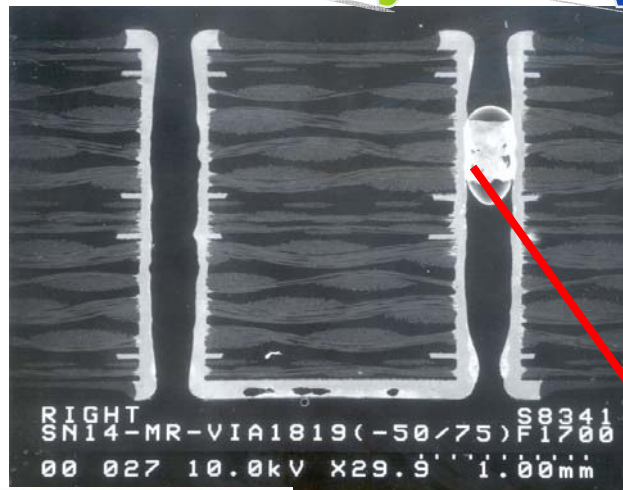
1819 cycles (-50/75°C)





PTH Via at 1819 Cycles (-50/75°C)

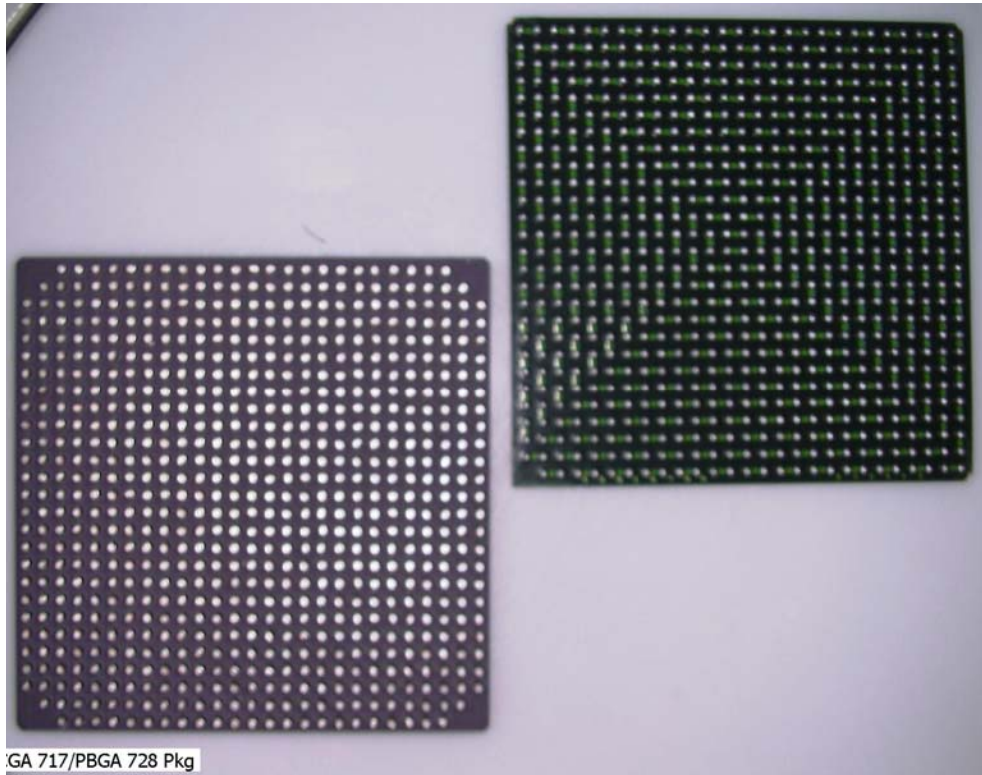
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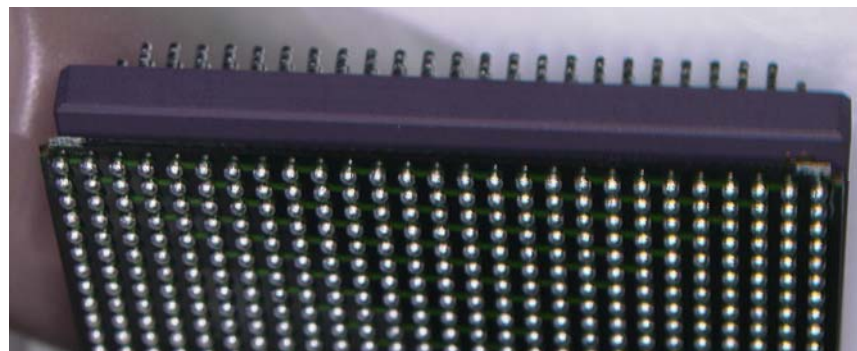


CCGA 717 & PBGA 728 I/Os

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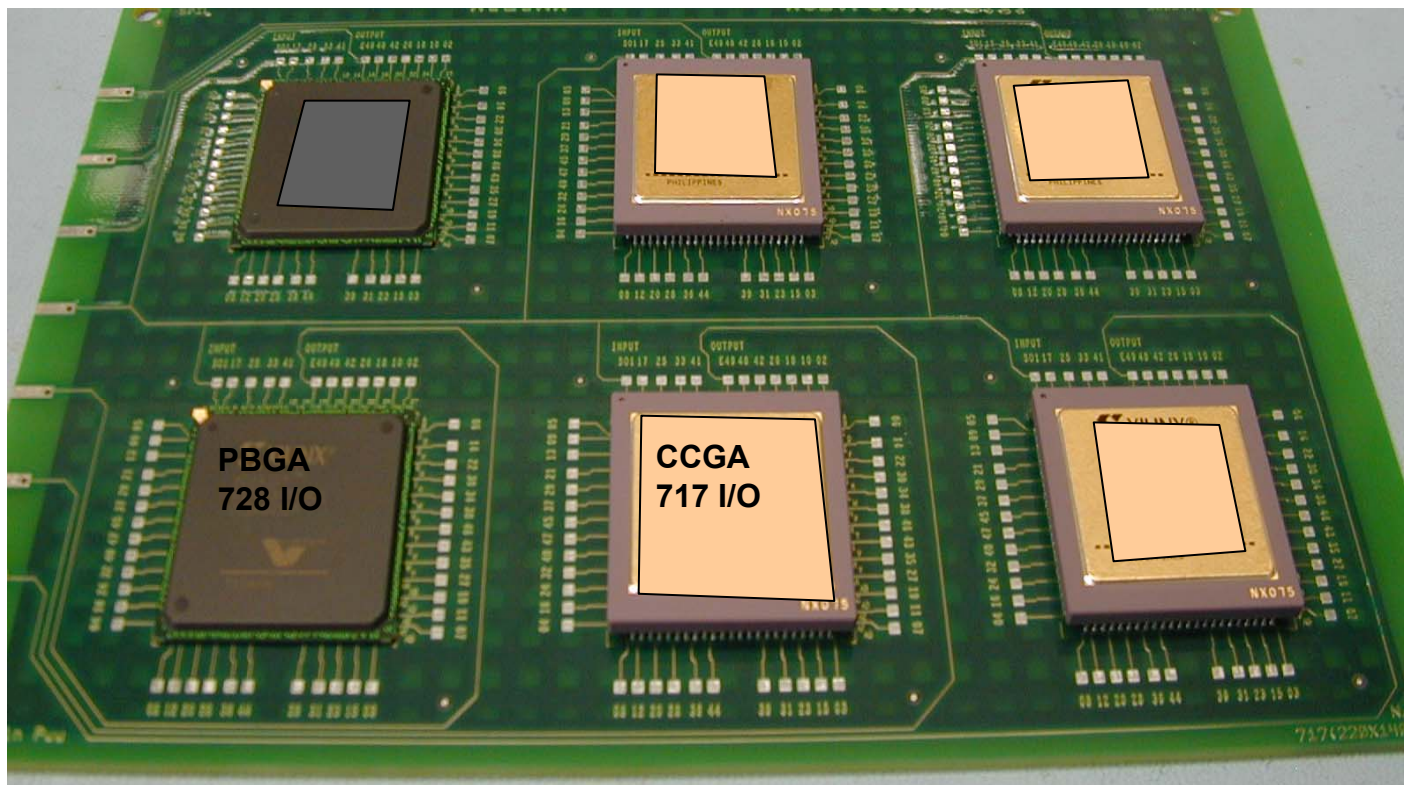
GA 717/PBGA 728 Pkg





CCGA 717 & PBGA 728 I/Os TV

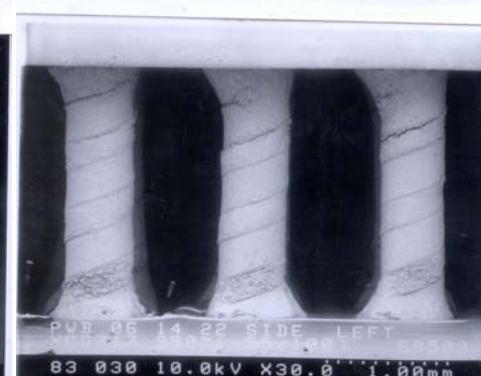
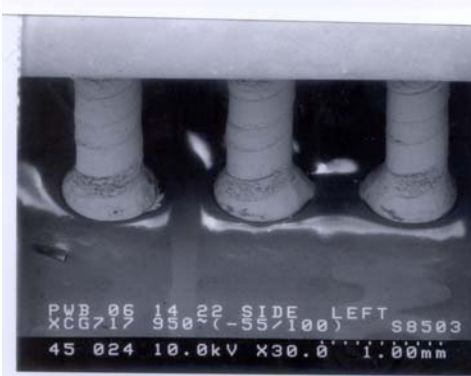
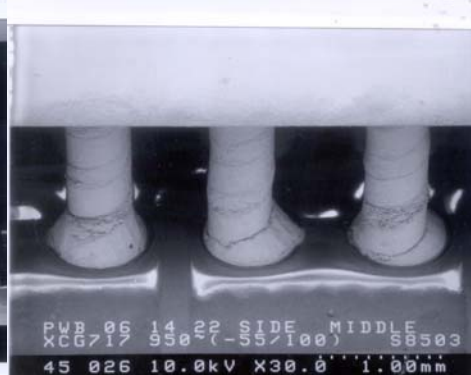
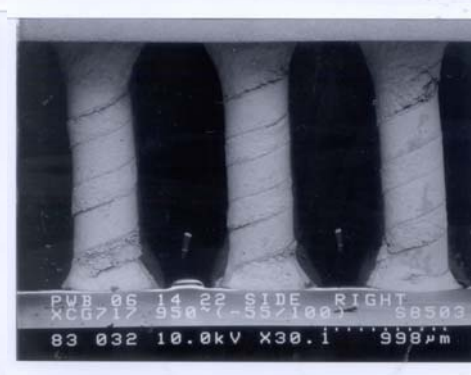
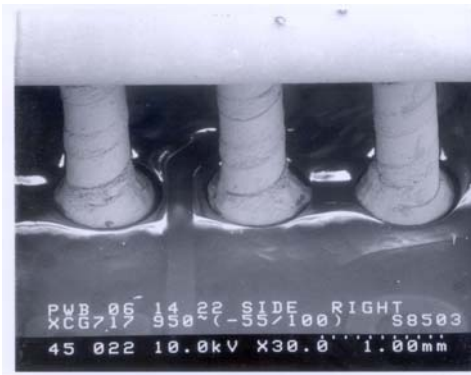
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950 Thermal Cycles (-55°/100°C)

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Conclusions-I

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- 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

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- **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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