XTREME Semiconductor

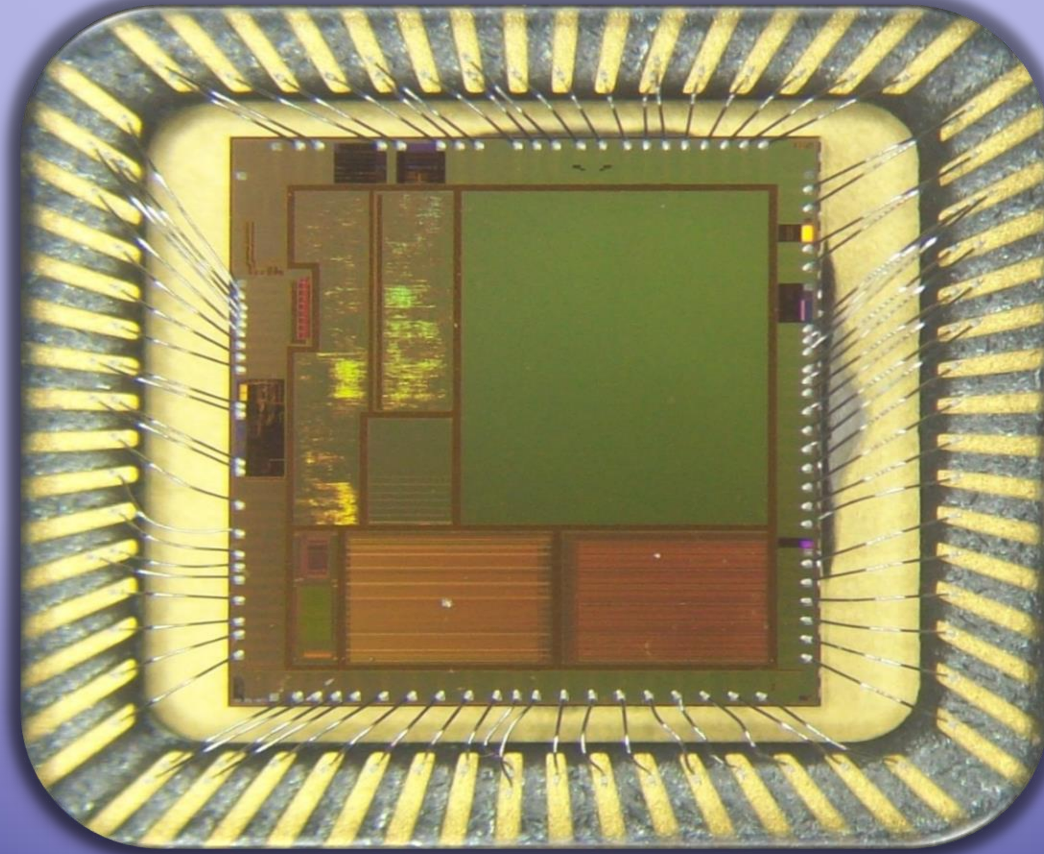
Chip Recovery "ChiPR" Product: Breathing New Life Into Obsolescence

In Partnership with

2015 ERAI Executive Conference
Hyatt Bayfront, San Diego CA
April 21-23, 2015
Presented by Marty Lanning, XTREME Semiconductor
and Erick Spory, Global Circuit Innovations

*Chip Recovery "C*hi*PR*" Product*

"Breathing New Life into Obsolescence"



Chip Recovery "ChiPR" Product

Innovation

- EOL Product Support
- Solutions Company
- Manufacturing & Test

Partners in Innovation & Technology

Technology

- Process Development & Manufacturing
- IC Design
- Failure Analysis

What Drives Today's Component Obsolescence in Military Systems?

Military Demand for IC's in Critical System Designs with 20+ Year Life Cycles

+

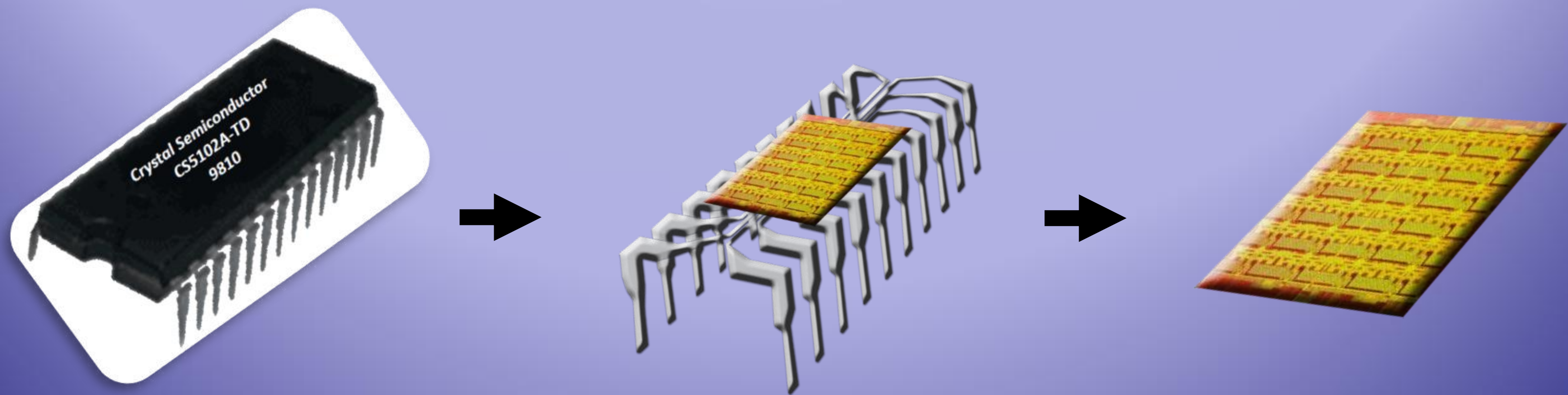
Military Dependence on Commercial IC's with 2-3 Year Product Life Cycles

=

Increasing Demand for Obsolete Components

What is *Chip Recovery "ChiPR" Product?*

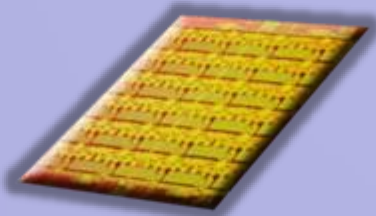
- Innovative Solution for Obsolete IC's
- Cost Effective Alternative Solution to other higher cost solutions such as redesign
- Semiconductor design, manufacturing, and testing programs meet or exceed Military Specs for Quality and Reliability



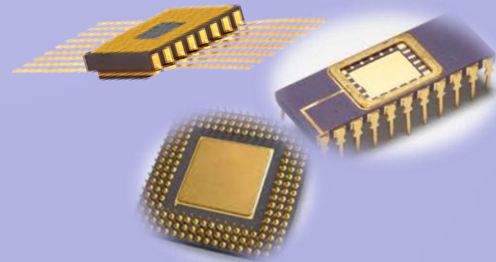
Benefits of Chip Recovery "ChiPR" Product

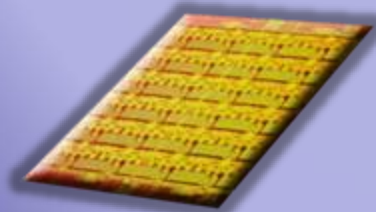
- **Access to *XTREME Semiconductor* and Global Circuit Innovations Engineering Staff, specializing in High Temperature and Obsolete part solutions**
- **Extend the life of your obsolete parts 5-10 years**
- **Eliminate the threat of counterfeit parts from entering your supply chain**

Uses for *Chip Recovery "ChiPR"* Die

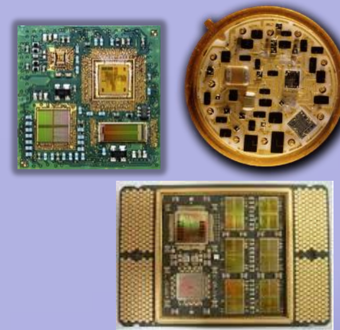


Hermetic Packaging

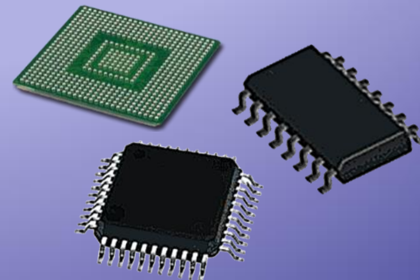




Hybrids & MCM's



Plastic Packaging

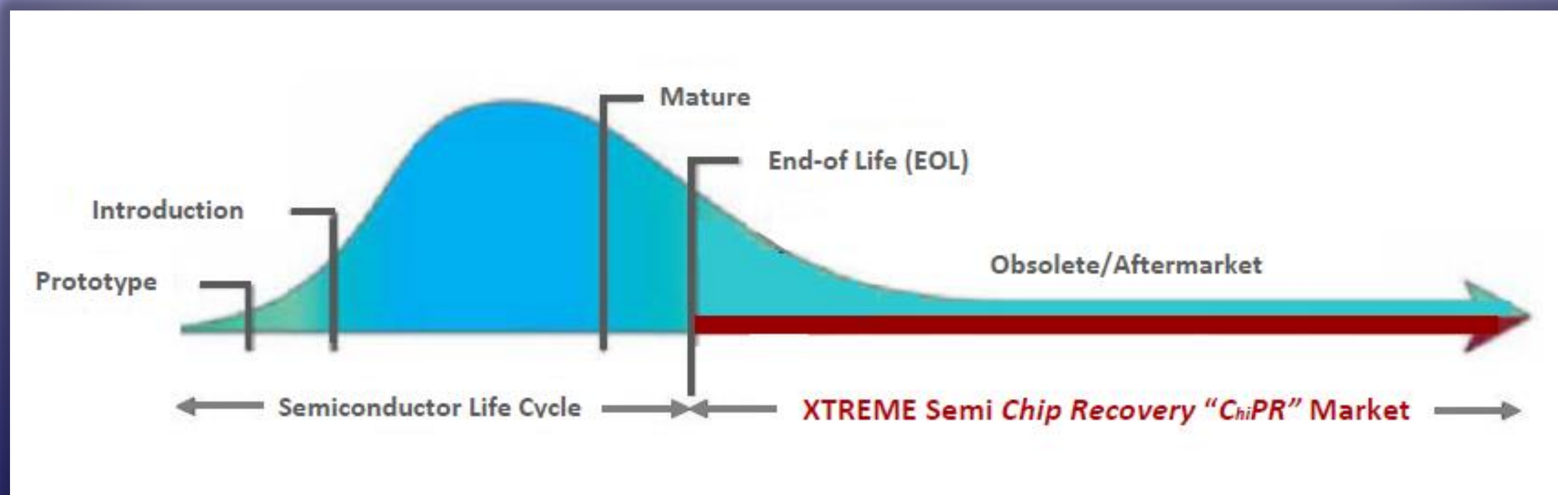


Uses for *Chip Recovery "ChiPR"* Product

- Re-manufacturing of Obsolete Components
  - Cost effective solution eliminating costly redesign
  - Guaranteed Performance of the original OCM device
- Enhanced Performance in High Temperature Applications
  - Industrial
  - Military
  - Down-Hole Exploration/Geophysical
- Customized Products to Maximize Performance

Chip Recovery: Product Standards

- *XTREME Semiconductor* manufactures in strict compliance with industry standard for assembly, test and qualification.
- Manufactured to be MIL-STD-883 compatible product
  - Manufactured on MIL-PRF-38535 QML Certified Line
  - Tested and Screened to MIL-STD-883 (processes and procedures)
- Guaranteed to meet original OCM data sheet or specification requirements.



Chip Recovery: Assembly, Test, & Qual

- Ceramic & Hermetic Package Design & Assembly
  - Monolithic, MCM, Custom Packaging
- Screening
  - MIL-STD-883 Compatible
  - Industrial, Military, Custom Screening Flows (SCD's)
- Electrical Test
  - Temperature Testing from -55° to +125°C
  - Burn In, Dynamic & Static
  - Software Development
- Quality Conformance Inspection
  - MIL-STD-883, Lot Qualification Group A, B, C and D

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Chip Recovery "ChiPR" Product

- All *Chip Recovery "ChiPR"* product is clearly identified;
- All correspondence, including the final quote, states the product contains extracted die;
- *XTREME Semiconductor* works closely with the customer to define the appropriate qualification plan based on their application and requirements.

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Successful *Chip Recovery "ChiPR"* Product

- **Solved Product Obsolescence issue for our Customer**
- **AD746SRC – Replacement for OP215BRC**
- **79% Overall Yield Die Extraction through finished product**
- **Test yield attributed to commercial grade product up-screening**

XT746SRC-2A MILITARY CLASS B ASSEMBLY/TEST		
Process	**Description**	**QTY**
Die extraction	AD746JRZ, 8-pin SOIC	154
Assembly	20-pin Ceramic LCC - MIL-STD-883 M5004 Class B	*149
Environmental	MIL-STD-883 M5004 (CA, TC, FL and GL)	139
Pre-Test	AD746 Data Sheet Electrical, +25C	122
Burn-in	MIL-STD-883 M5004, Test Condition 1015, 160hrs	122
Post-Test	AD746 Data Sheet Electrical, +25C	122
Final Test	AD746 Data Sheet Electrical, -55, +25 and 125C	122
* 10pcs pulled out for First Article Inspection		

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Successful *Chip Recovery “ChiPR”* Product

- Solved Product Obsolescence issue for customer
- ADSP1016ASE obsoleted by Analog devices
- Yield losses attributed to commercial grade product up-screening…..99% assembly/test yield

ADSP1016ASE-MT MILITARY CLASS B ASSEMBLY		
Process	**Description**	**QTY**
Die extraction	ADSP1016AJN, 16x16-bit CMOS Multilier	*252
Assembly	68-pin Ceramic LCC - MIL-STD-883 M5004 Class B	223
Environmental	Temp Cycle : MIL-STD-883 M5004, Cond.	223
Environmental	Const. Accel: MIL-STD-883 M5004, Cond.	223
Environmental	Fine Leak: MIL-STD-883 M5004, Cond.	223
Environmental	Gross Leak: MIL-STD-883 M5004, Cond.	223
Electrical Test	Test perfomred at -55 to +125C	221
Final	QC Inspection, 220pcs shipped to customer	220
* 5pcs used as assembly set-up samples		
* 18pcs failed M5004 Class B die visual however accepted as commercial grade product		
* 5pcs used for first article inspection.		
* 2pcs failed electrical test at Military temps, passed 25C testing		

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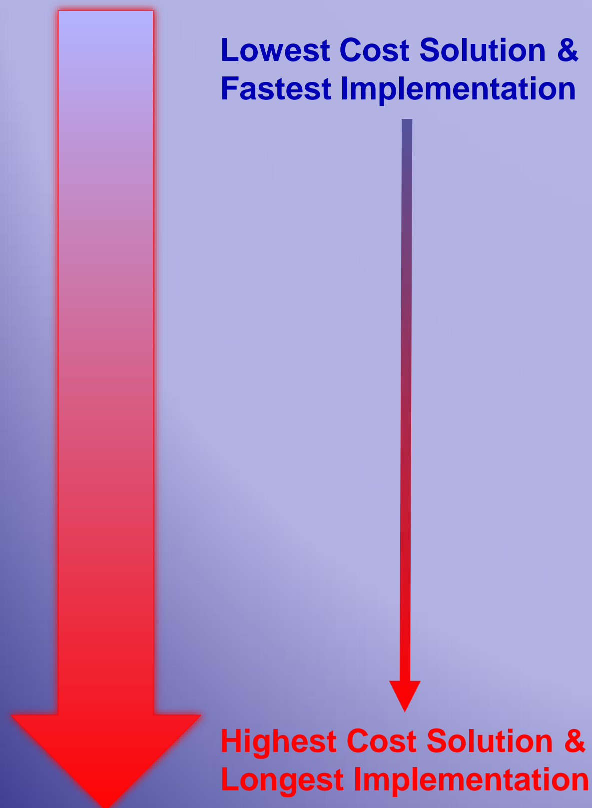
Other Successful Die Extraction Products

Part Type	Function	Part Type	Function
K6R4008V1C	4M SRAM	IXDD609S1A	MOSFET Driver
K9F5608OUA	8M Flash	MTP10N10M	N-Channel MOSFET
ADLX345	Acceleromter	CZT3120	NPN Switch
BMA250	Acceleromter	OP221GSZ	Op Amp
CS5102A-TEB	AD Converter	OPA2340	Op Amp
LP1114FBD48	ARM Flash MCU	OPA678AP	Op Amp
AD746	Bi-FET Op Amp	OPA684	Op Amp
ADSP1016AJN	CMOS Multiplier	THS31001CD	Op Amp
MCP6568	Comparator	THS4522	Op Amp
EN175	Custom ASIC	EL51661SZ	Op Amp
TMS320C6657	DSP	LT1019ACN8-2.5	Precision Reference
AT28C16	EEPROM	TC25C25	PWM Controller
S87C752	EPROM	SST25VF063C	Serial Flash
M1A3PE3000L-FGG	FPGA	ADG1219BRJZ	SPDT Swtch
XCV800-6BG560	FPGA	EF6840CM	Timer
A500K130	FPGA	UCC2581	Voltage PWM
EF6821JV	I/O Controller	REF5025	Voltage Reference
SN65LVDM176	Line Transciever	MAX6350	Voltage Regulator
ISL88705	Micro Supervisor	TLV70233DBVR	Voltage regulator
MC6809CM	Microprocessor	ICL8038CCPD	Waveform Generator

Analysis of System Redesign Options



- Original OCM Product Available

Value Ranking of Available Options

- $ - Chip Recovery Product *“C$_{hi}$PR”*
- $$ - Fabricate New Original OCM Chips
- $$$ - Board Redesign
- $$$$ - Emulation/Reverse Engineer
- $$$$$ - New System Design

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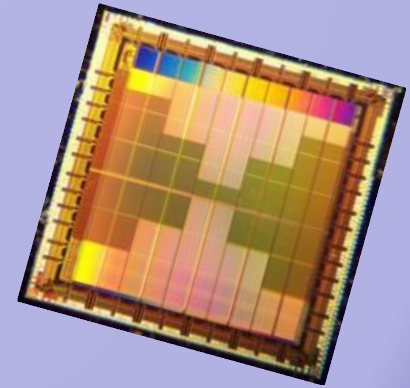
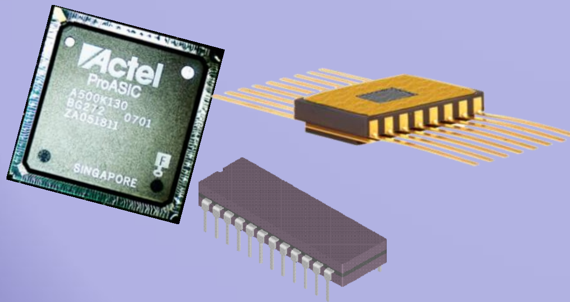
Chip Recovery "ChiPR": Processes

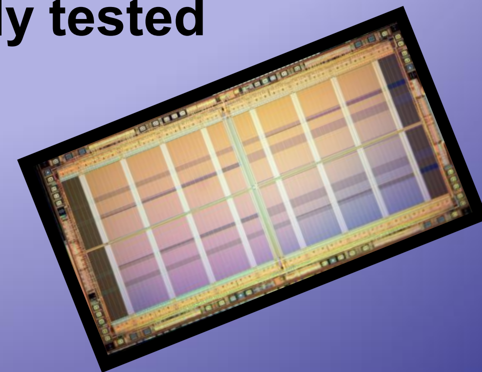


- **Removes die from a package undamaged, maintaining original electrical characteristics**



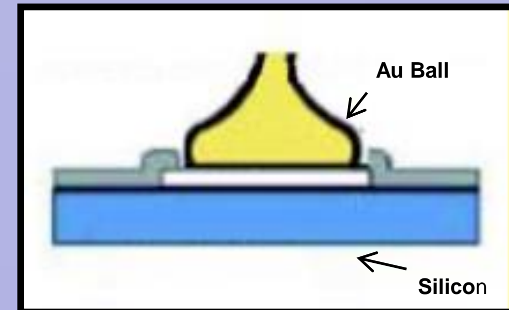
- **Can be performed on any package type**

- **Results in a "Known-Good" electrically tested die, ready for reassembly**
  - **Die thinning may also be achieved**

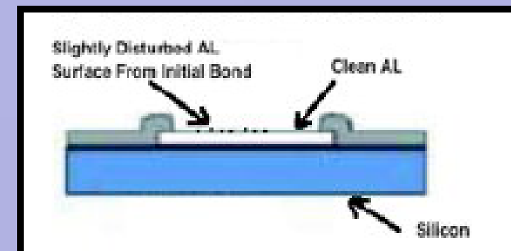


Chip Recovery: Bond Pad Preparations

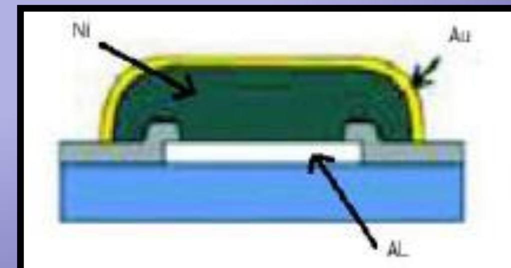
1. **Re-Bonding**:
   - **Wire dressing leaving original Gold Ball bond remnant, allowing for subsequent Gold Ball re-bonding**



2. **Bond Pad Cleaning**:
   - **Gold Ball removal followed by Aluminum Pad cleaning, allowing for Gold Ball or Aluminum Wedge bond**



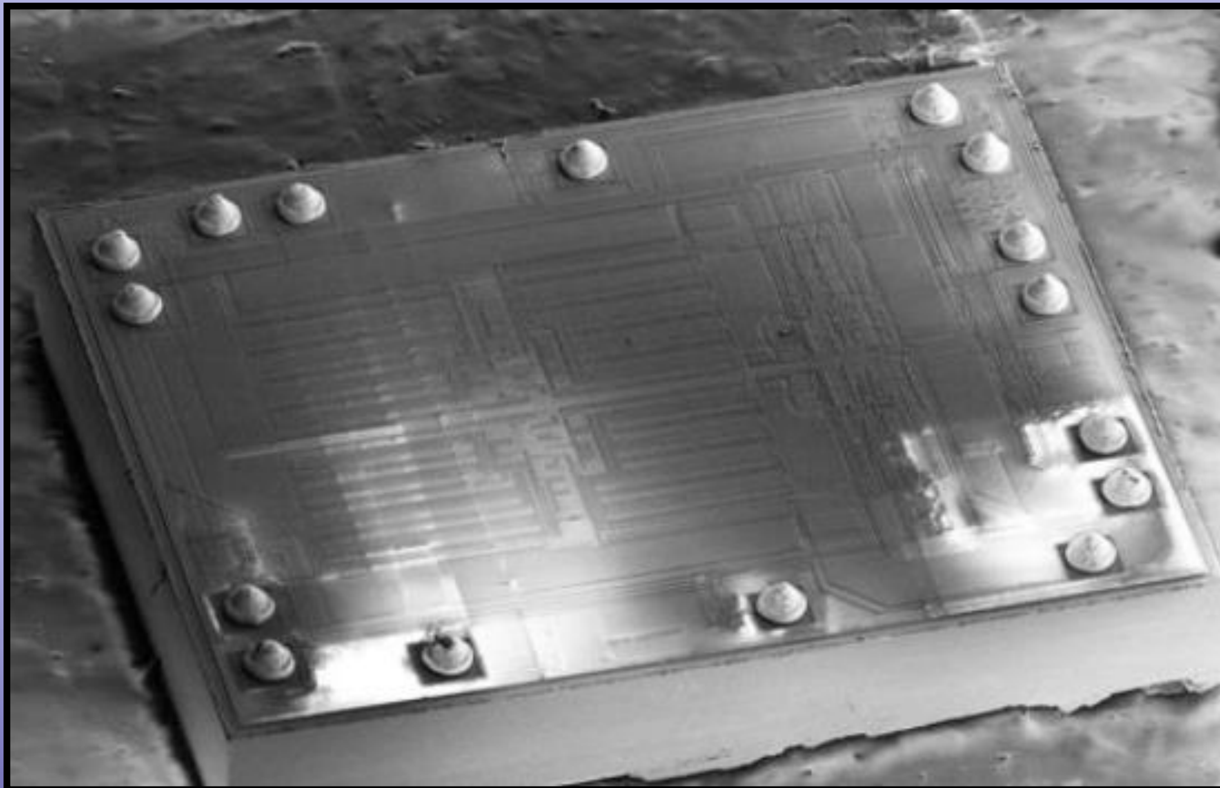
3. **Pad Re-Conditioning**:
   - **Gold Ball removal, Aluminum Pad cleaning, followed by Nickle/Au pad build up and re-plate**



GLOBAL CIRCUIT INNOVATIONS

Data from Global Circuit Innovations

Chip Recovery: Bond Pad Re-bonding



Chip Recovery Die ready for re-bonding

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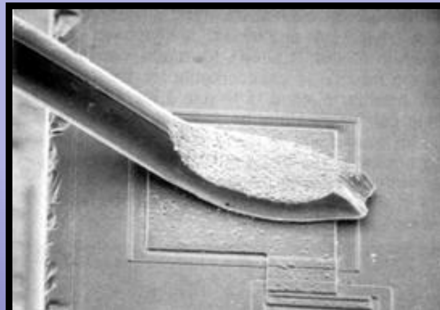
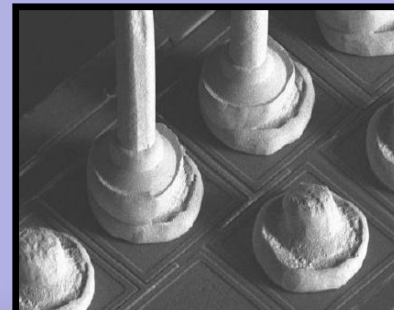
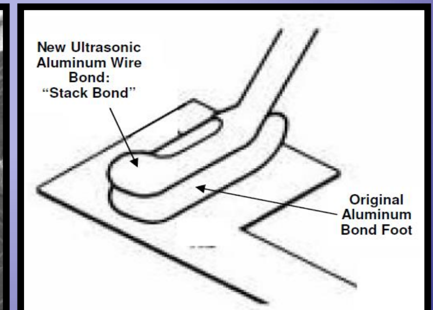
Chip Recovery: Bond Pad Re-bonding

- **Wire Bonding**
  - **Original Gold or Aluminum wires are mechanically removed at the top of the original bond**
  - **Clean, uncontaminated gold or aluminum surface is used for the new, high-adhesion wire connection**
  - **New bond formation is made to original pristine bond, NOT a re-bond.**



Original Gold Ball and Aluminum Wedge Bonds





Compound Gold Ball and Aluminum Wedge Bonds

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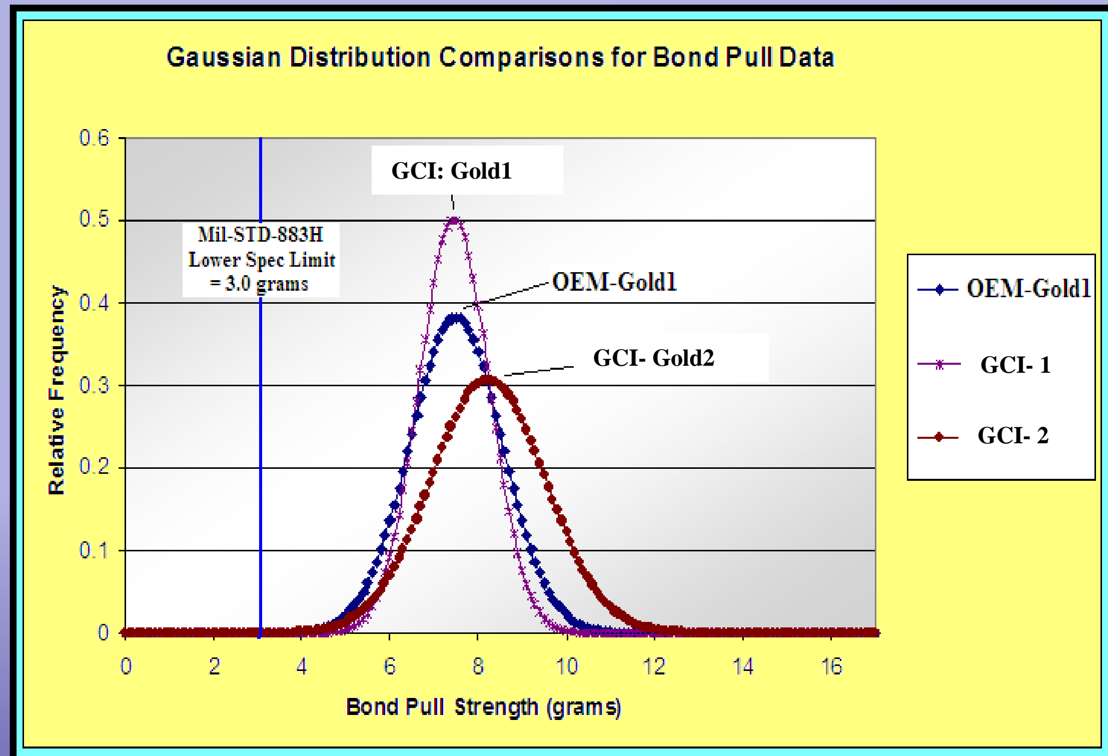
Chip Recovery: Bond Pull Data

- Bond Pull Results
  - The compound Gold on Gold Wire Connection provides identical bond pull adhesion strength to the OEM device
  - The Bond Pull Data is nearly Indistinguishable for Pre and Post Die Extraction

- Mean: 3 Sigma
  - OEM Gold1 = 4.374 g
  - GCI Gold1 = 5.075 g
  - GCI Gold2 = 4.342 g

- MIL-STD-883H
  - Spec Limit = 3.0 g



Data from Global Circuit Innovations

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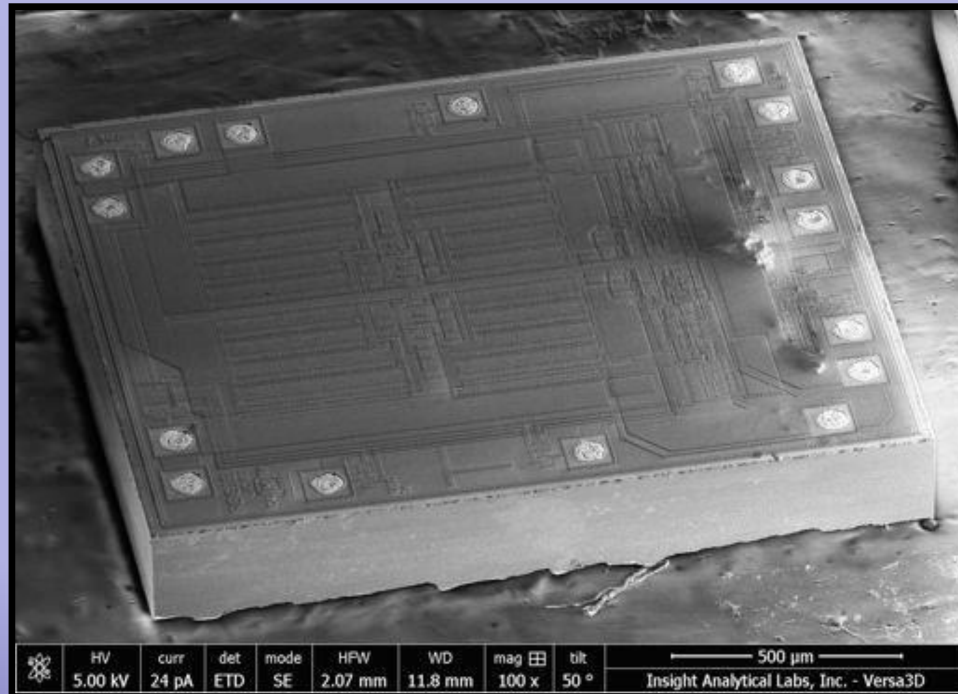
Chip Recovery: Bond Pad Cleaning



Chip Recovery Die with Remnant Bond Wires Removed and Pads Cleaned

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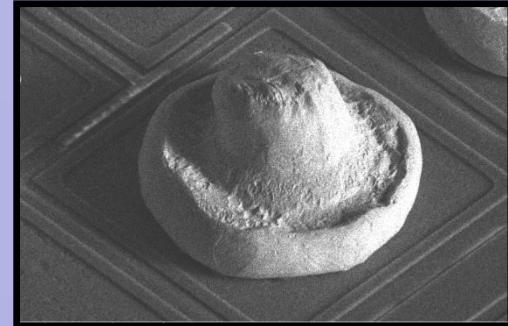
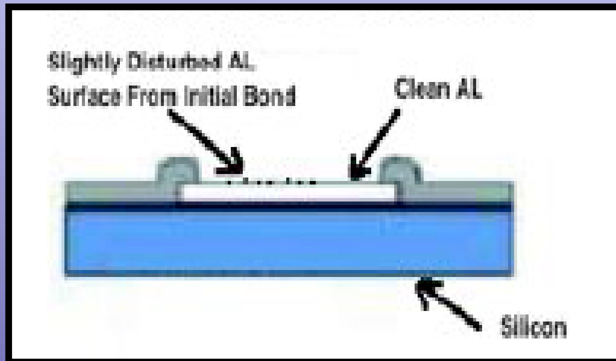
Chip Recovery: Bond Pad Cleaning

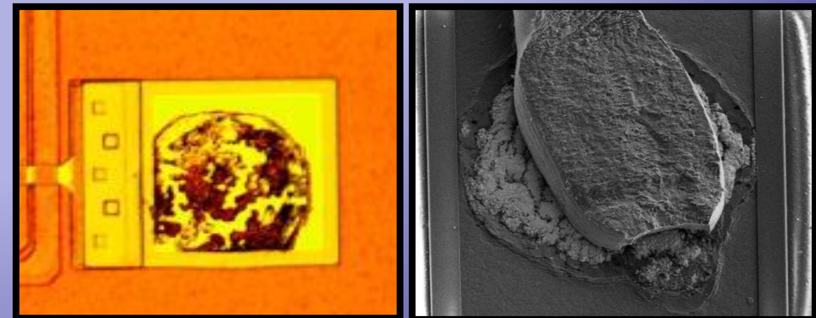
1. Original Gold Ball bond





2. After removal of Gold Ball bond

3. New bonding area ready for new Gold Ball or Aluminum Wedge bonding



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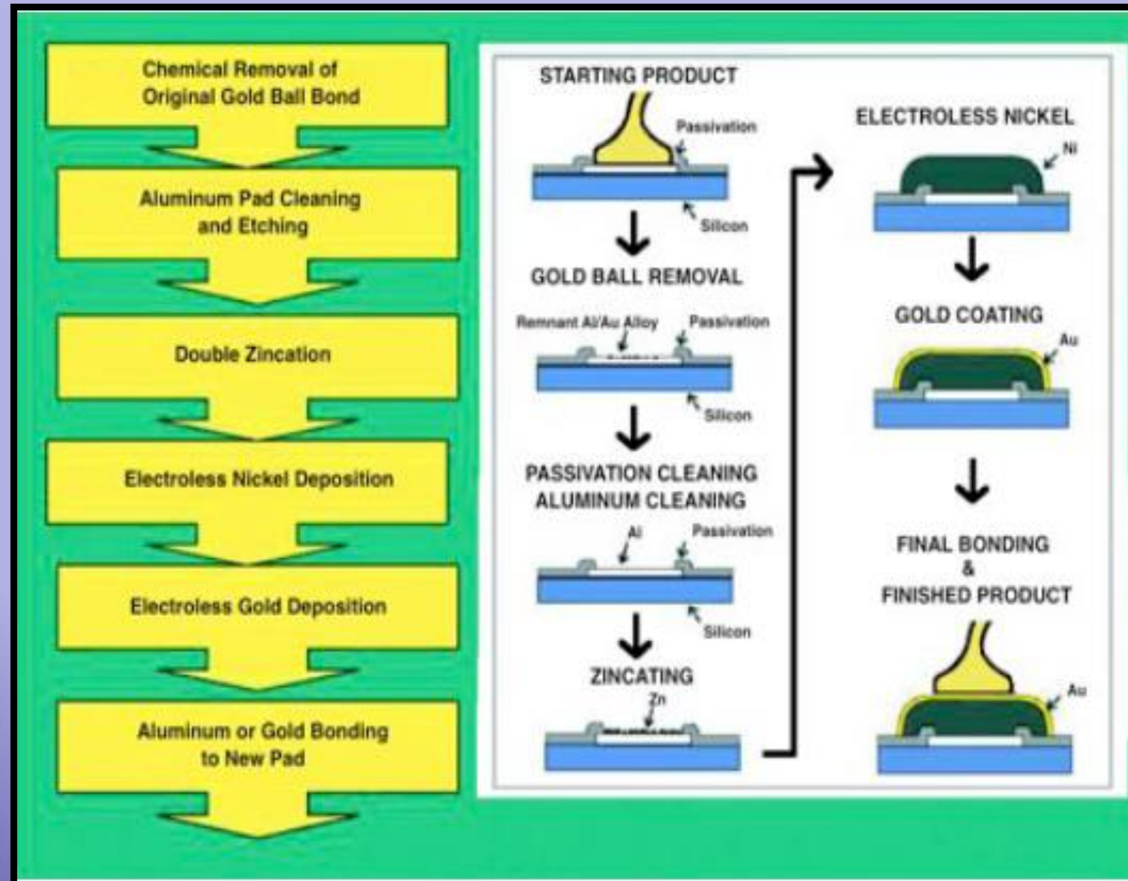
Chip Recovery: Bond Pad Reconditioning



Nickle/Au Metallization UBM (Under-Bump Metal) Process

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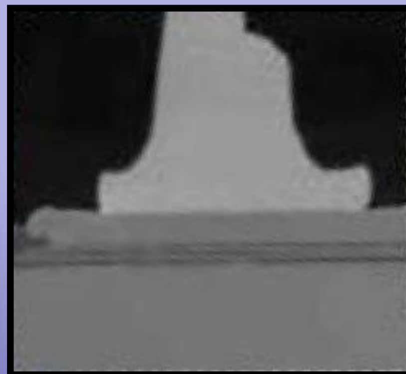
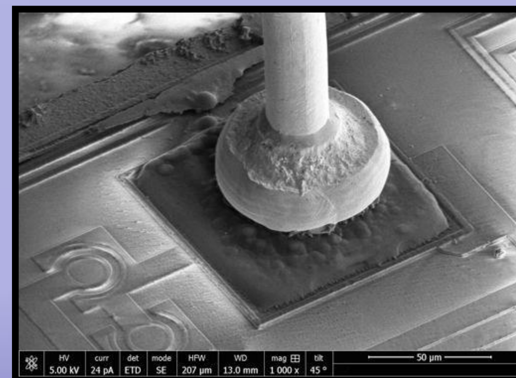
Chip Recovery: Bond Pad Reconditioning

Ni/Au Metallization UBM process



Cross Section of Au Bond and new Ni/Au Pad



Gold Ball Bond on new Ni/Au Pad

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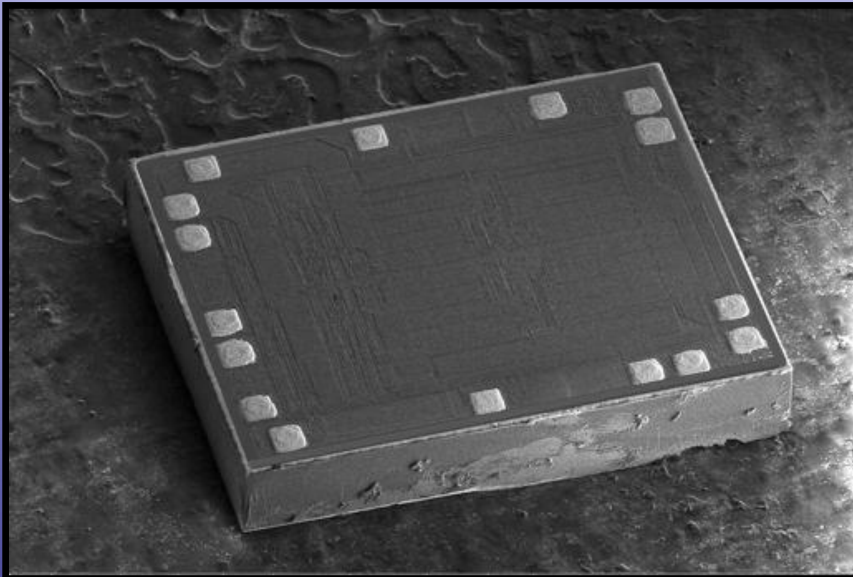
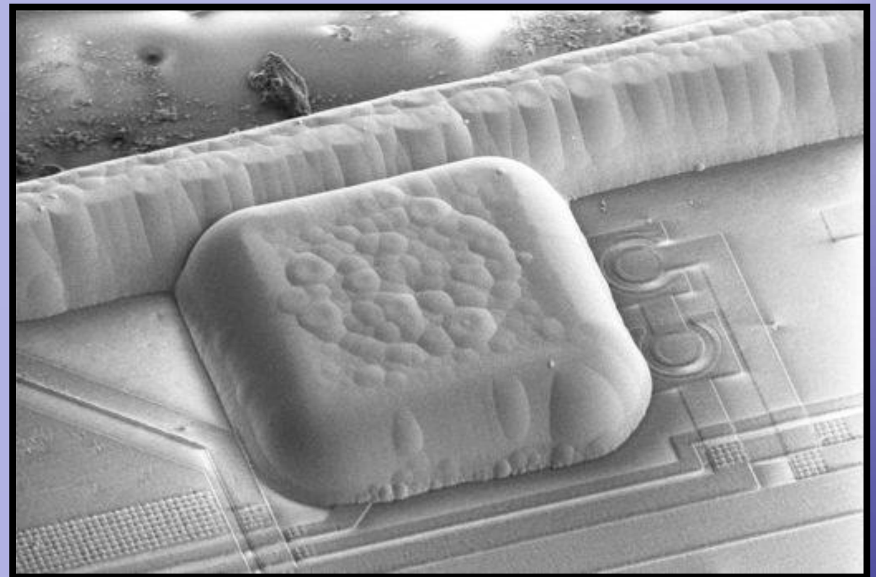
Chip Recovery: Bond Pad Reconditioning

Ni/Au Metallization UBM process





Reconditioned Bond Pads ready for Gold Ball or Aluminum Wedge Bonding

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Chip Recovery: Bond Pad Reconditioning

Ni/Au Metallization UBM process

Why consider our Gold Ball removal and Ni/Au Metallization UMB process?

- Eliminates MIL-STD compound bonding concerns and provides bare die with a consistent, predictable bonding surface.
- Proven to provide superior bond strength if original bonding has not been optimized.
  - Conventional Bond Strength: Mean 3 SD = 4.01g
  - Ni/Au Metallization UBM Process: Mean 3 SD = 8.74g
- The new Ni/Au bonding interface dramatically reduces Inter-Metallic Diffusion (Kirkendall Voiding), therefore, creating a much more robust bonding process relative to high temperature (>175C) exposures.
- Provides new metallization compatible with High Reliability and small pitch Gold Ball bonding requirements.

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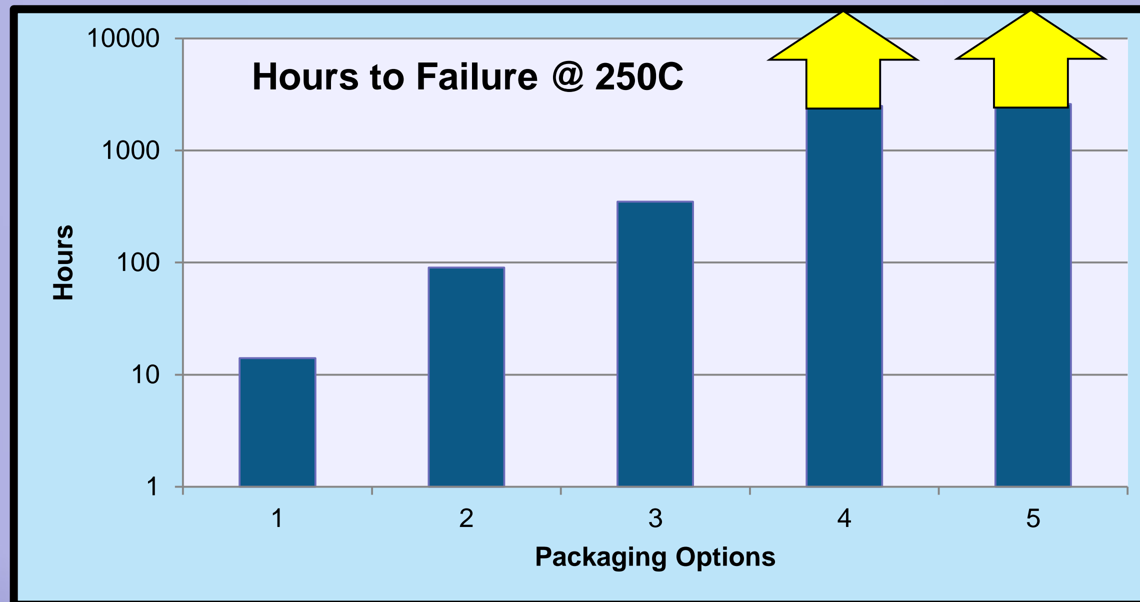
Chip Recovery: Bond Pad Reconditioning

Ni/Au Metallization UBM process



Packaging Option Key

1. Standard Plastic Packaged Product
2. Die Recovery, Standard Ceramic Assembly
3. Die Recovery, High-Temp Ceramic Assembly
4. Die Recovery with Ni/Au Reconditioned bond pads, High-Temp Ceramic Assembly
5. Die Recovery with Ni/Au Reconditioned bond pads, Standard Ceramic Assembly

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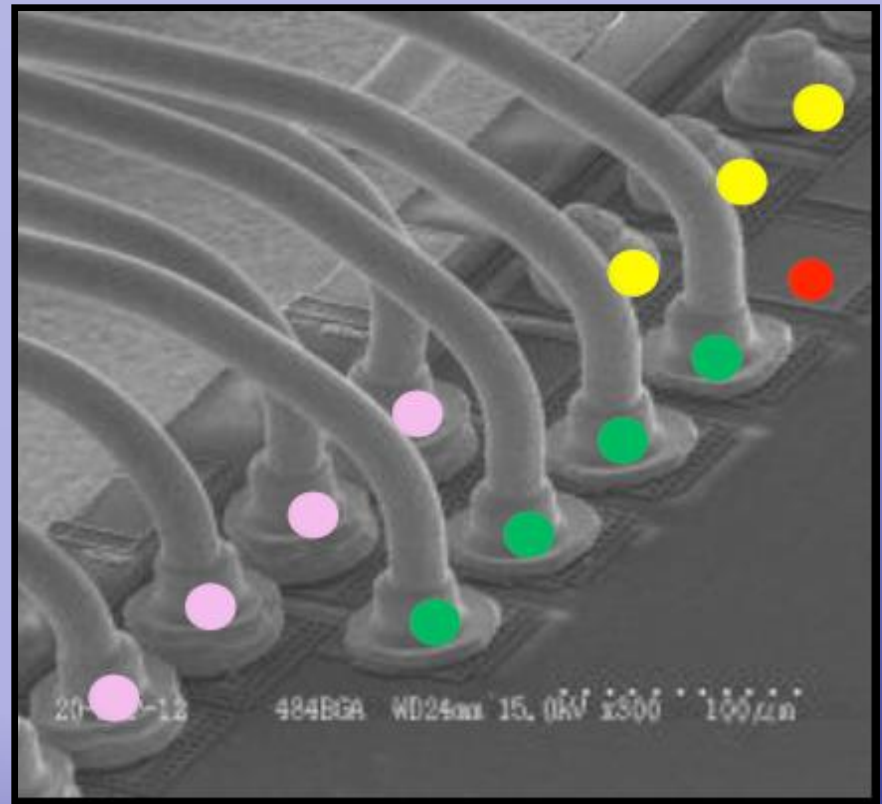
Chip Recovery: Bond Remapping and Reassembly Options

Multiple Device configurations for the same ship can be achieved with remapping optional bond outs.

- **Memory Devices: Bond options for x4, x8, x16 devices from the same chip**
- **FPGA's: Reconfigure to create multiple devices from a single chip**

Examples of Remapping Options

- **Original non-bonded pad, still not bonded**
- **Original non-bonded pad, now bonded**
- **Previously bonded pad, now not bonded**
- **Previously bonded pad, re-bonded with new compound bond.**



Global Circuit Innovations

Data from Global Circuit Innovations

*Chip Recovery "C*hi*PR"* Product

- **Benefits of *Chip Recovery***
  - ***Chip Recovery* and re-assembly is an excellent solution to IC Component Obsolescence – Solves DMSMS problems.**
  - **Die can be removed from virtually ANY plastic or ceramic package without damaging the die, while maintaining FULL functionality.**
  - ***Chip Recovery* allows fully functional die to be re-assembled into ANY plastic or ceramic package, MCM, or hybrid module**
  - **Die Shear and Bond Pull data are identical to or exceed original OCM product.**
  - **Allows access to original OCM die stock, while avoiding costly minimum order die or wafer purchases.**
  - **Offers a direct replacement for the original OCM product**

Chip Recovery "C*hi*PR"

"Breathing New Life into Obsolescence"

Any Questions?

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