Missile Defense Agency Copper Wire Bond Overview

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Bottom Line Up Front

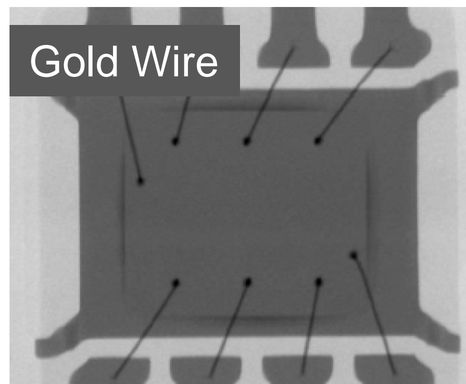
- The Department of Defense is continuing to identify and assess the risks associated with using copper bond wire parts in defense systems
- Screening processes should be in place to identify all use of plastic encapsulated microcircuits (PEM) with copper wire bonds in each system
- Test and evaluation processes for PEMs must be updated to account for the differences between gold and copper bonding processes
- Destructive Physical Analysis (DPA) is an effective method for detecting manufacturing process indicators and defects

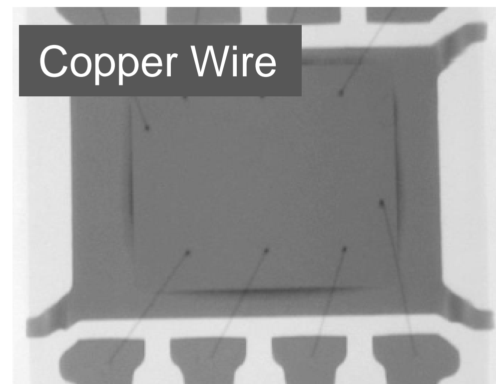
AEC-Q006 Appendix 1 Best Practices

- Inert environment around Cu wire
  - During wire storage
  - During free air ball formation
  - (Pd) Plated Cu wire
- Tighter controls/limits for wire pull/shear metrics
  - USL/UCL and LSL/LCL
  - Ball shear and wire pull near/over stitch
  - Production monitor using unmolded parts
  - Pull/shear after stress testing and careful decapsulation
- Capillary
  - More frequent replacement/maintenance
  - Designed specifically for Cu wire
- Thermosonic Bonding
  - Tighter parameters for frequency, temperature, force
  - Reliability data collection at bond recipe corners of Force and Frequency

Methods for Identifying Copper Wire Bond Parts

- Screening processes are necessary to properly identify manufacturer's transition to copper wire bonds
  - Product change notifications
    - Assembly Material Change
    - Assembly Process Change
    - Manufacturing Location Change
  - Material declaration review
    - Most manufacturers call out the wire bond material
  - DPA
  - X-ray inspection
    - Experienced operators can distinguish the difference between Au and Cu wire bonds





Summary of Issues from PCNs

- PCN implementation dates
  - No PCN was issued if the part started as copper
  - Line delays and use of existing supplies
- Multiple Assembly Locations
  - Qualification
    - By Location
    - "Additional" assembly sets
      - ✓ Transition between gold and copper parts
  - Materials vary across assembly locations
- Retracted PCNs
  - Early identification
  - Continual monitoring
    - PCNs
    - Incoming devices

Copper Wire Identification Discrepancies

- Assembly site variations in bond wire
  - Four different assembly sites:
    - Two assembly sites only use gold bond wire
    - One assembly site uses only copper bond wire
    - One assembly site uses gold or copper bond wire
      - ✓ Assembly site also has three options for wire size
- Different assembly sites can use different mold compounds, die attaches, bond wires, and die designs
  - Sometimes there are variations within the same facility

Qualification and Reliability Testing

- Reliability Monitor Data
  - Currently, most copper reliability data is a mix of copper and gold
- Qualification Data
  - PCN Qualification Data
    - Most readily available, but limited to one location
  - Typically done by package type, not to a specific part number
    - AEC-Q006, Rev. A qualification testing can be used

Methods to Limit the Impact of Copper Bond Wires

- Better Part Selection
  - Avoid Commercial (if possible)
    - Ask OCM (original component manufacturer) about gold options
    - "Old Gold"
      - ✓ Known gold parts; date codes prior to copper implementation
  - Leveraging Automotive Options (AEC-Q006)
  - Military qualified standard parts
    - More expensive, requires less testing and screening
  - Defense Supply Center Columbus Vendor Item Drawings
    - V62 drawings are restricted to gold only
- Incoming Inspection
  - Mixed Reels
    - Review date codes & documentation
  - X-Ray

Vendor Identification Information

Altera	Letter "C" at the end of the lot number
Atmel	Adds a "C" to the orderable part number to specify copper only on sample parts. Production parts have no physical indicator
Central Semiconductor	No external visual indicator
Cypress	"C" on device packaging
Diodes Inc.	Indicator is not always available and varies according to the site of manufacture (may be a dash over the date code). Review the PCNs for additional guidance
Exar	No external visual indicator
Freescale	No external visual indicator
IDT	"Y" suffix on lot number
International Rectifier	Underscore after lot code (XXXXP_)
Intersil	"M" site code = copper, "H" site code = gold
Lattice	Numeric value in the fifth position of the Lot/Date Code (XXXX#XXX)
Marvell	No external visual indicator
Micro	Letter "C" at the end of the date code. (YYWW C)
Microsemi	No external visual indicator
Microchip Technology	No external visual indicator
National Semiconductor	No external visual indicator
NXP	Site/Year/Month (SYM) part date code format changed to Site/Year/Week (SYWW)
On Semiconductor	No external visual indicator
Texas Instruments	No external visual indicator
Vishay	No external visual indicator
Xilinx	No external visual indicator

Conclusion

- The technical risks of using copper bond wires are still under evaluation and a concern for defense applications
- Copper bond wires are an emerging issue; updating requirements and assessing the risks should be a top priority industry wide
- Screening processes need to be in place to properly identify any use of copper wire bond devices
- DPA proved to be an expedient and statistically meaningful method for detecting/screening manufacturing process indicators, defects, and changes

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