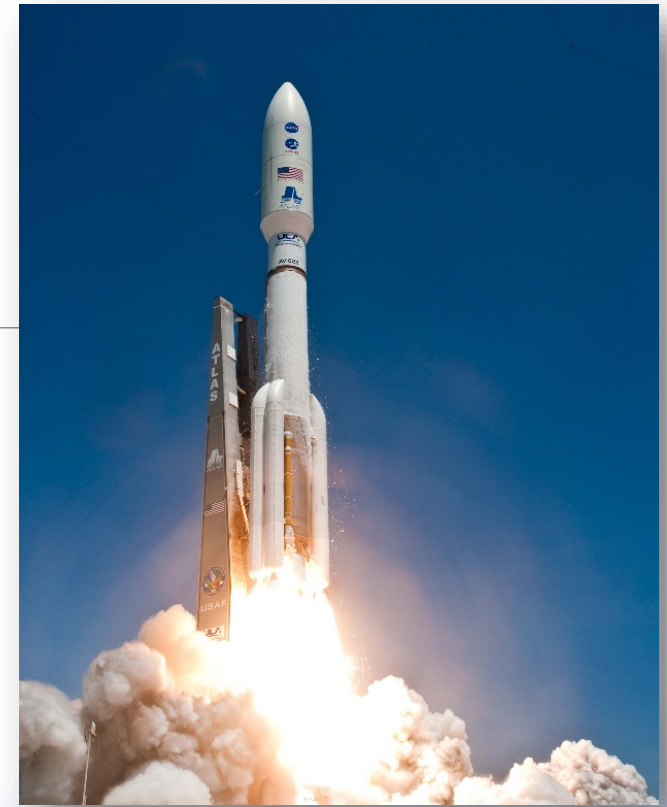




NASA Counterfeit Parts Awareness and Inspection



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Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not constitute or imply its endorsement by the United States Government or the Jet Propulsion Laboratory, California Institute of Technology.



Training Course Objectives

- **This course provides a high-level overview of suspect counterfeit external visual inspection related to government and industry best practices.**
 - Learn hands-on verification and inspection processes for the detection of suspect parts
 - Learn the limitations of visual inspection



Section 1 – External Visual Inspection



Assessing Incoming Parts

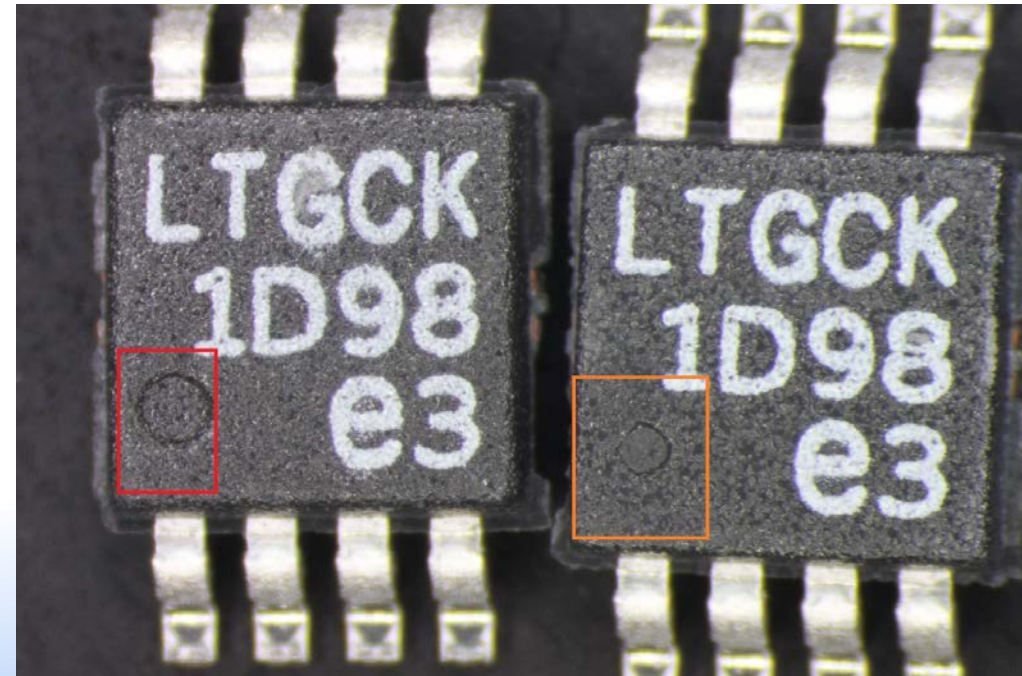
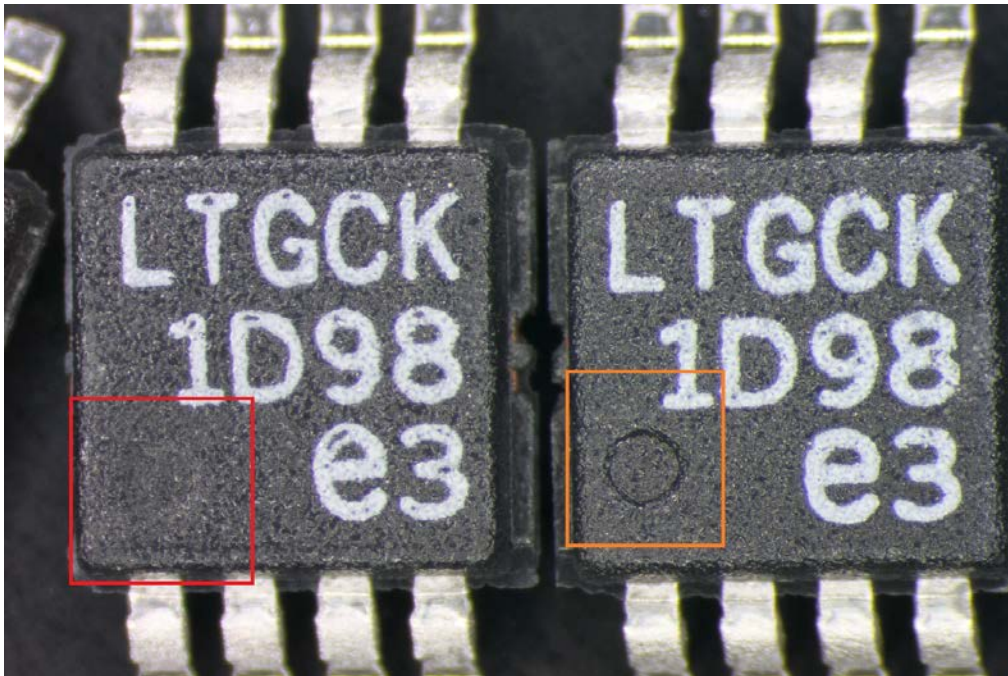


Is this part suspect or counterfeit?

- The part is **suspect**.
- Determining if a part is counterfeit depends upon the subsequent investigation.



Assessing Incoming Parts



Parts are suspect, but are they counterfeit?



Assessing Incoming Parts

1. External visual
 - a) Physical mold features
 - b) Part surface
 - c) Part markings
 - d) Indents
 - e) Pins



Suspect-Part markings

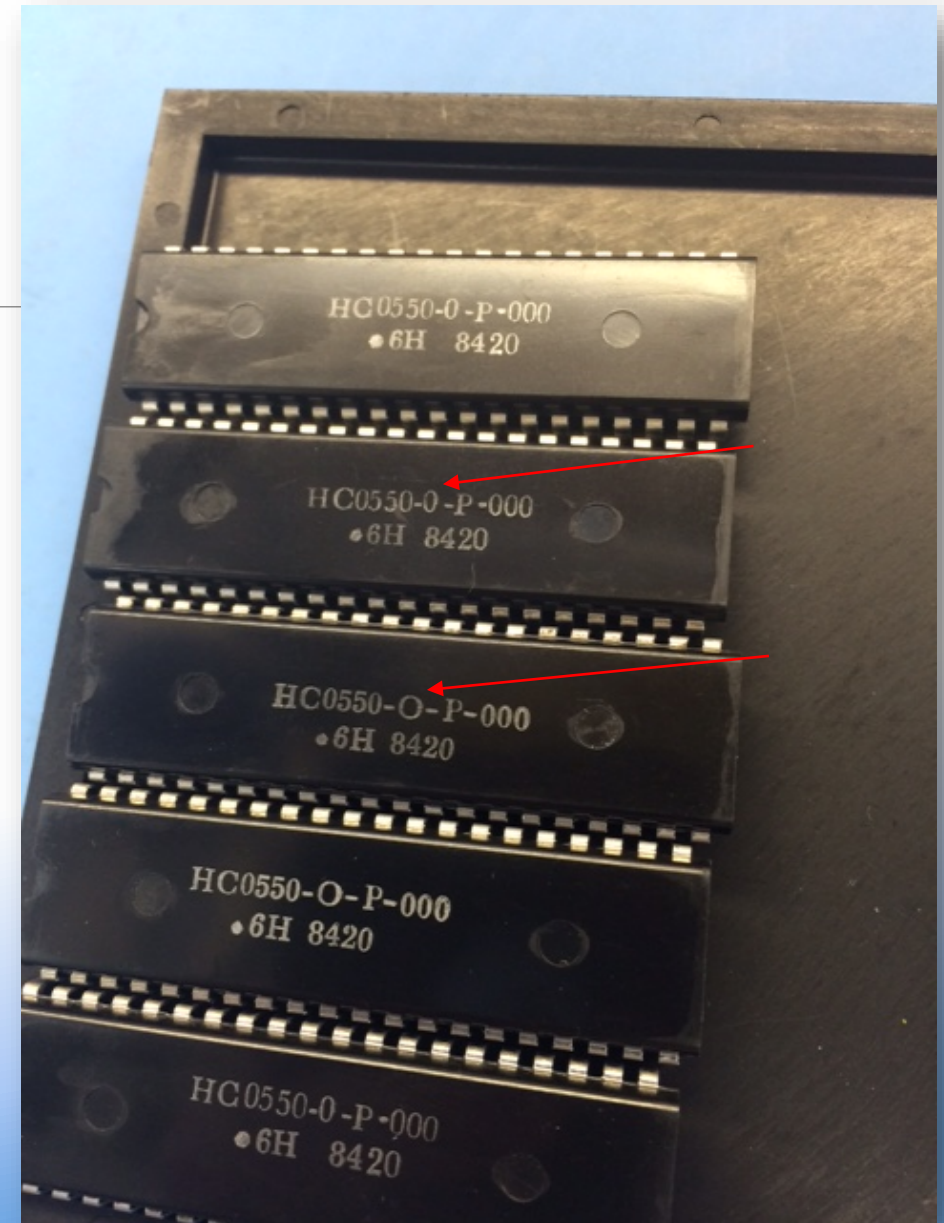
- OCMs follow quality standards and major imperfections are uncommon
 - P/N will be in a certain location on the part
 - P/N will not be misaligned, crooked, or misspelled
 - Manufacturer logos do not vary from part to part
 - Part markings designed to withstand rigors of testing



- Part on right has laser burn markings
- Markings missed the part on the left side
- Part on right belongs to batch that had markings in a slightly different location on each part

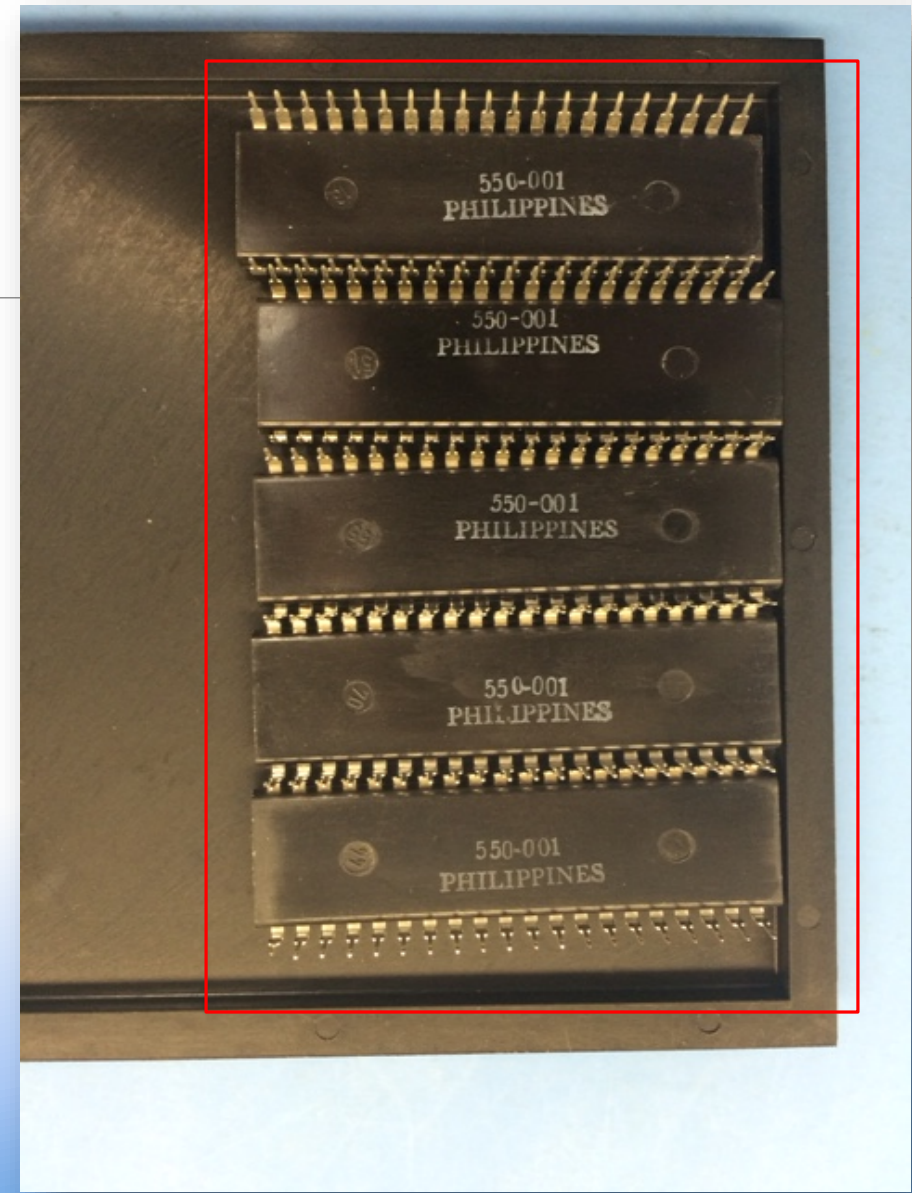
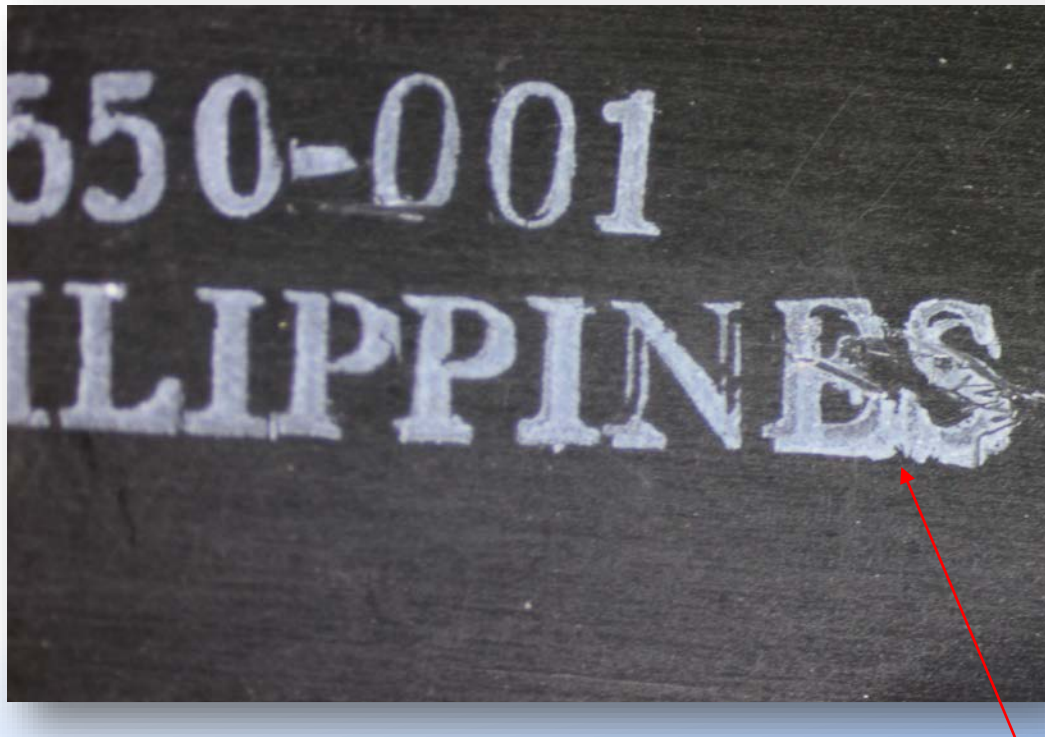


Suspect-Part markings





Suspect-Part markings



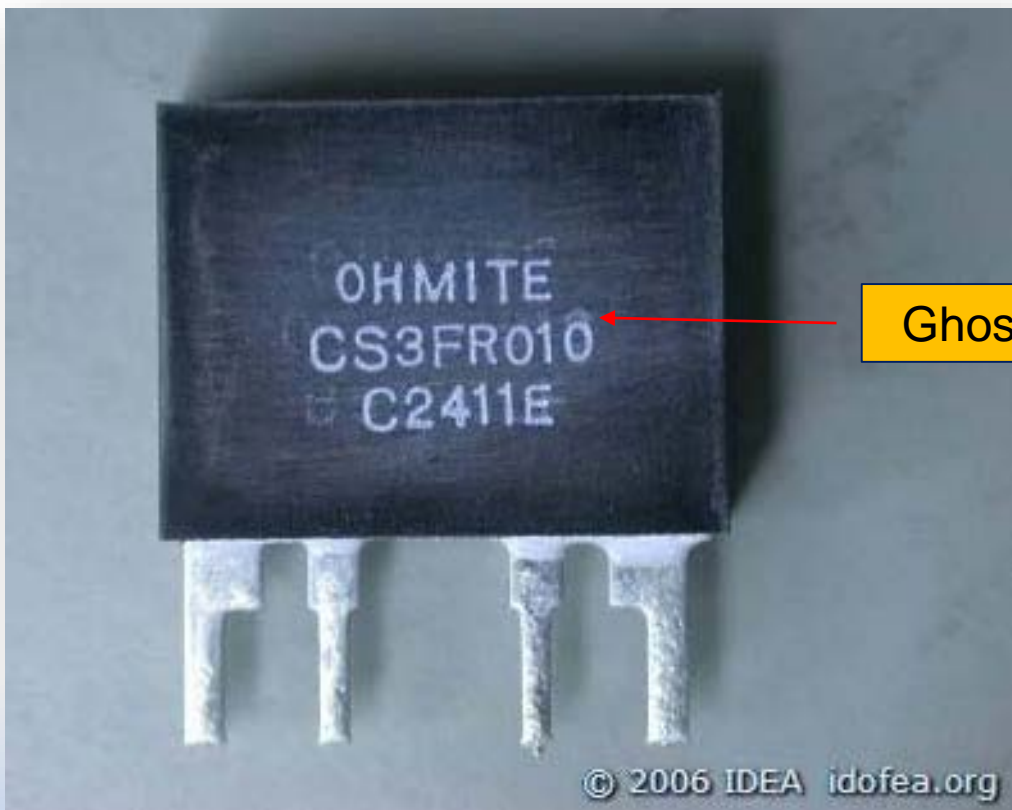


Suspect-Part markings





Suspect-Part markings



Ghost markings



Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market



Suspect-Part markings





Assessing Incoming Parts

1. External visual
 - a) Part markings
 - b) **Part surface**
 - c) Indents
 - d) Physical mold features
 - e) Pins



Suspect-part surface



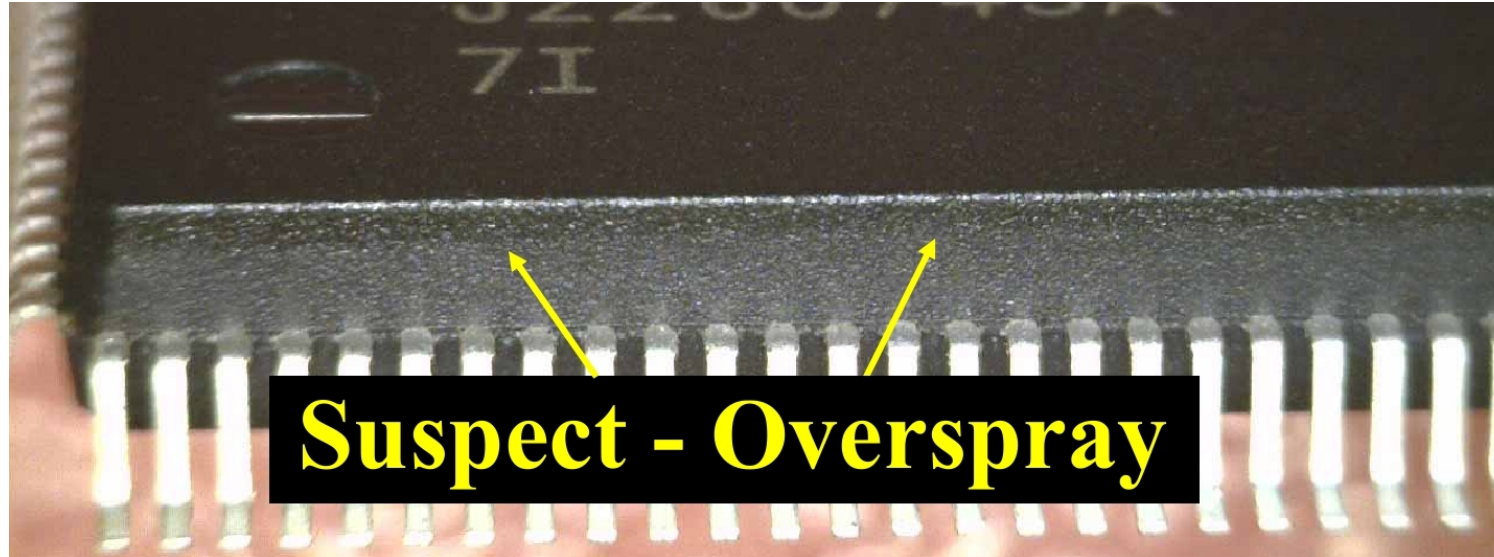
Directional sanding markings

Uneven thickness resulting from sanding





Suspect-part surface



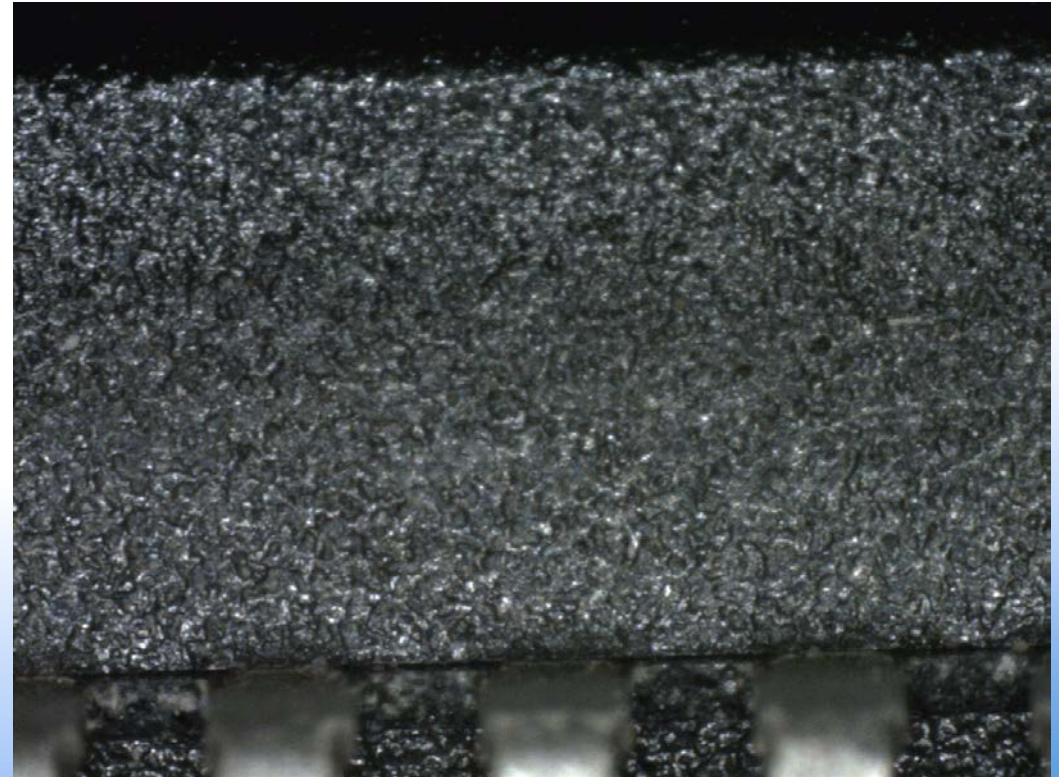
Blacktopping: resurfacing of a component so it can be re-marked



Blacktopping



Authentic

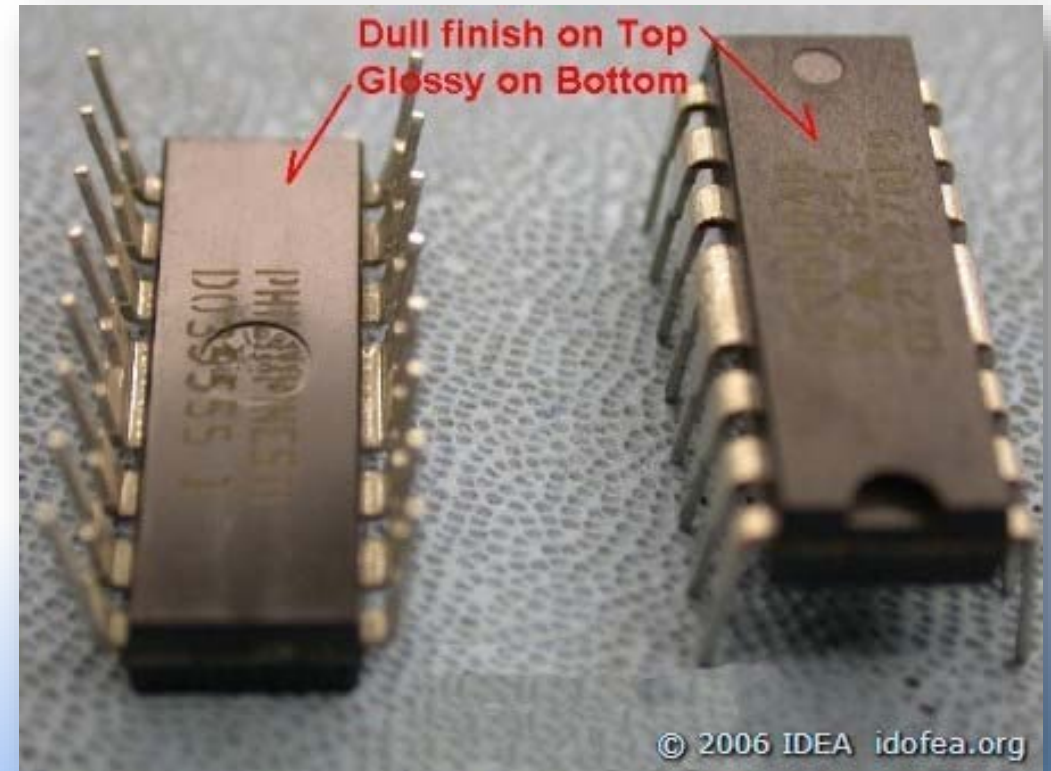
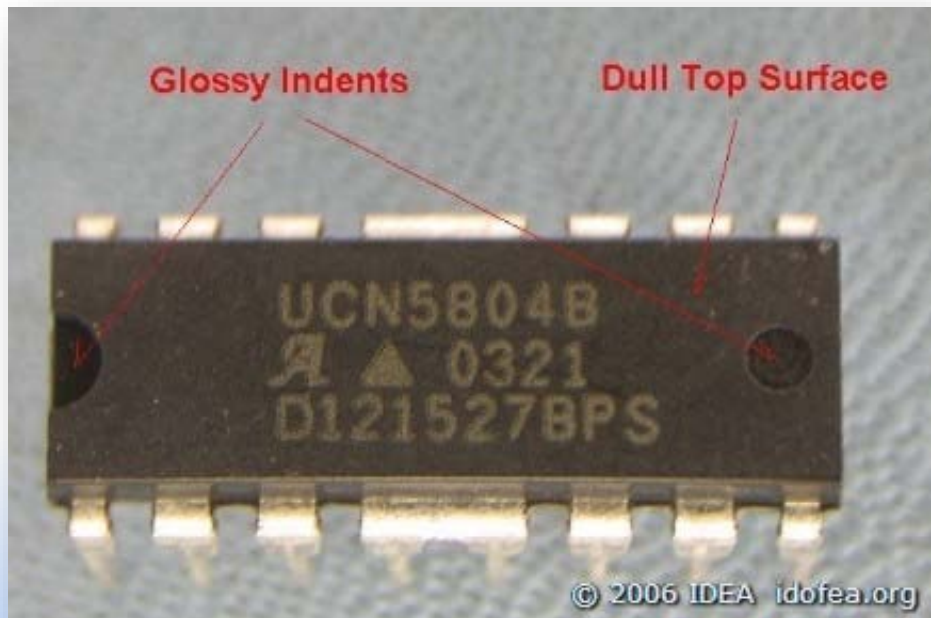


Suspect



Suspect part surface

- Different textures can be indicative of remarking
- Top and bottom of part should have same texture



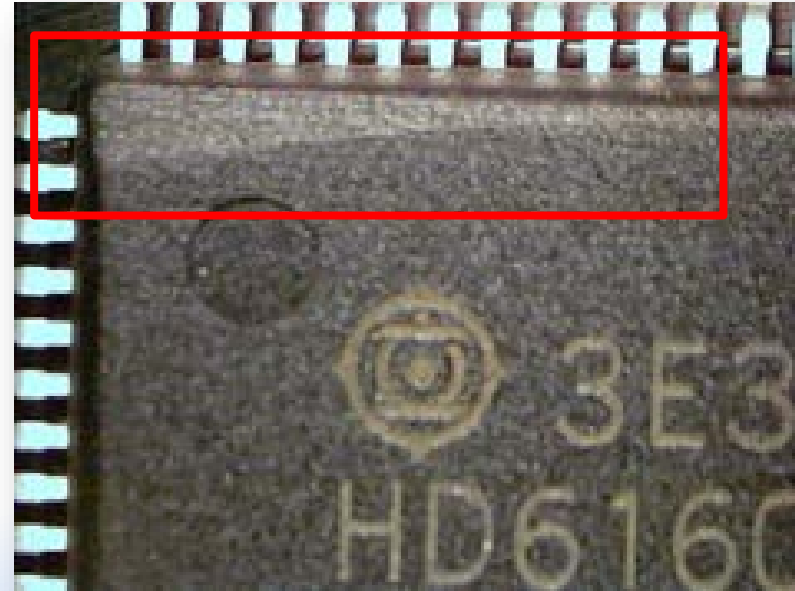
- Top and bottom of the same part have two different textures: rough vs. smooth



Suspect-part surface



Over-sanding



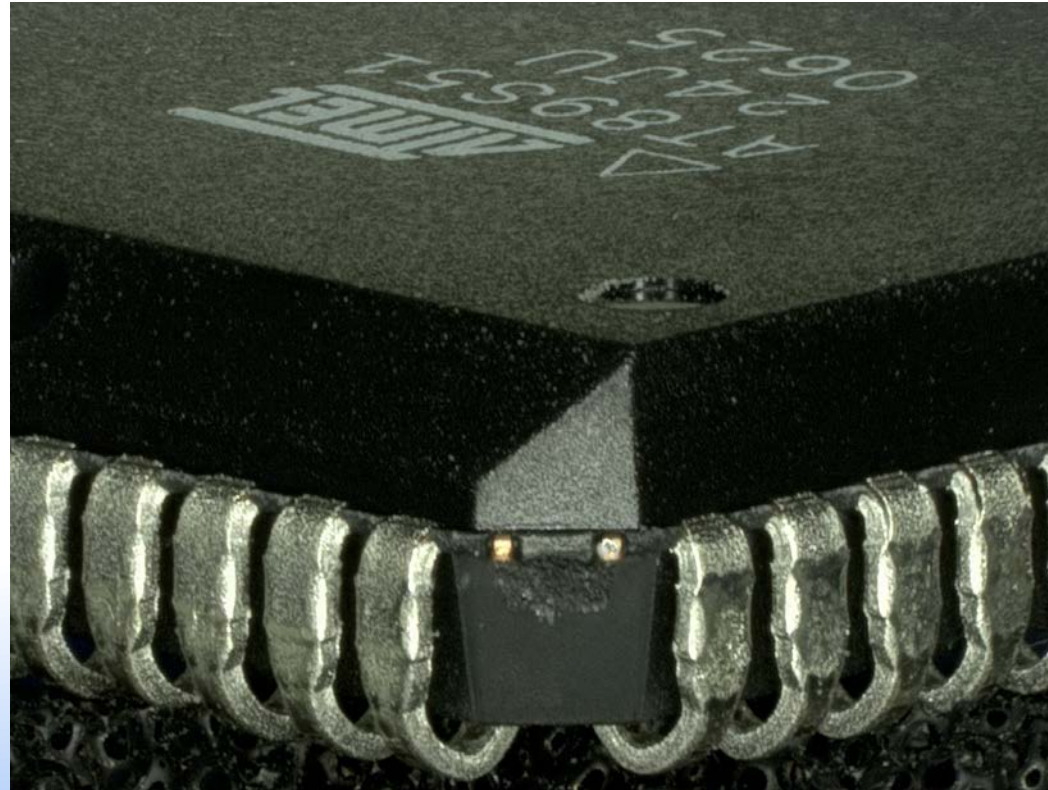
- Blacktopped surface was shiny and smooth but with an unnatural orange peel finish
- Scraping the top layer revealed the Altera logo underneath



Suspect-part surface

Plastic leaded chip carrier (PLCC) package

Nice try! Counterfeiter blacktopped not only the top surface, but the sides and bottom. Just didn't get this one corner well enough.





Suspect-part surface



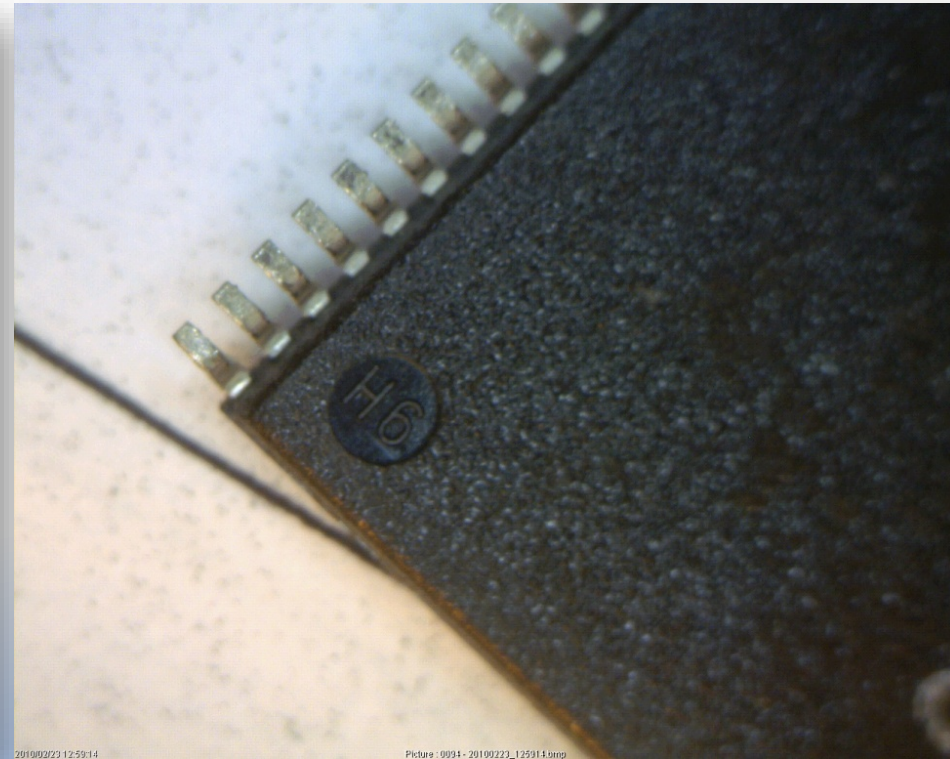
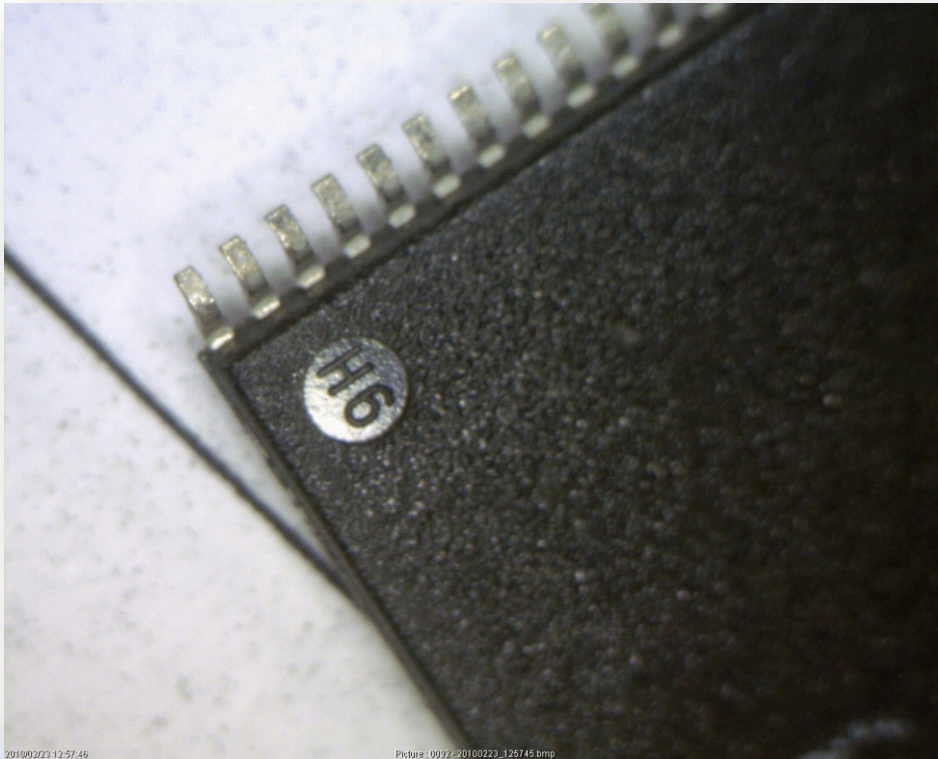


Assessing Incoming Parts

1. External visual
 - a) Part markings
 - b) Part surface
 - c) **Indents**
 - d) Physical mold features
 - e) Pins



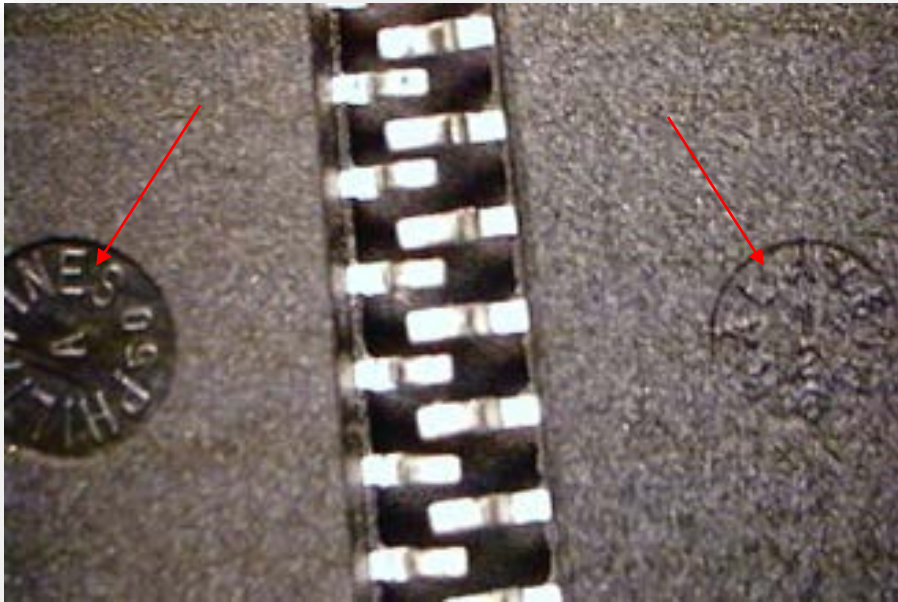
Good-Part indents



- Example: clean indents on good parts under two different lighting scenarios



Suspect-Part indents



- Identical part markings
- Parts on the left is marked Philippines, part on the right is Malaysia



- Indent is half-filled with black top
- Letters have rough texture



Suspect-Part indents



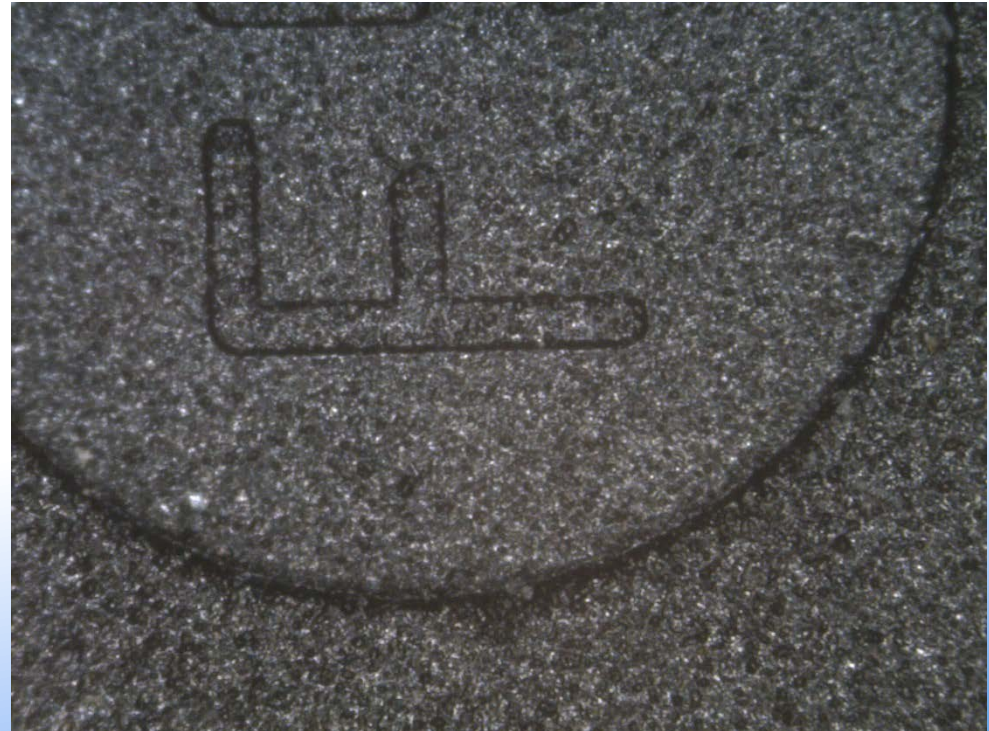
- Indent has been filled in with blacktopping material
- **Original indents should always be clean**



Blacktopping



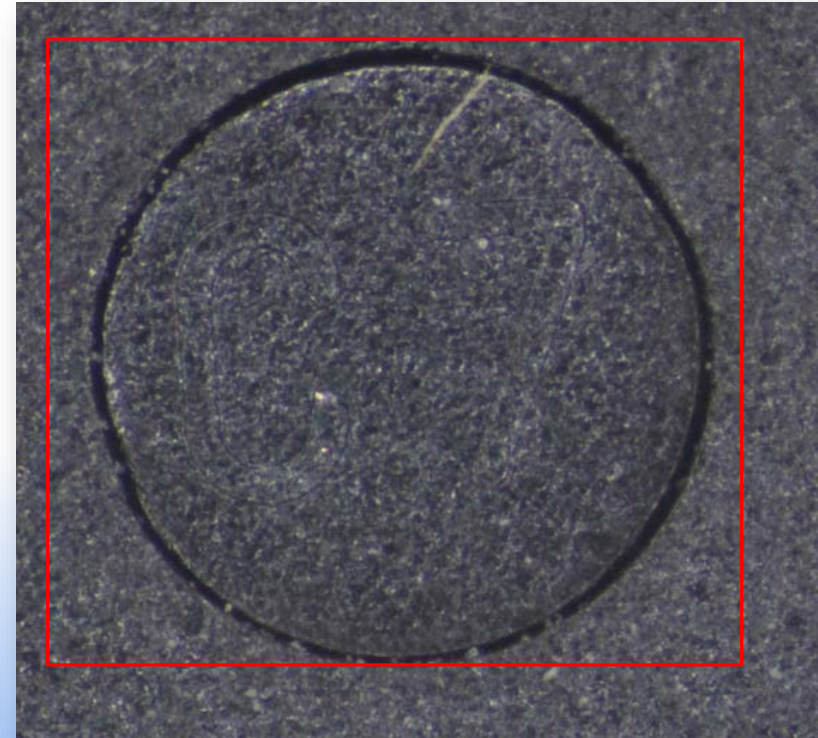
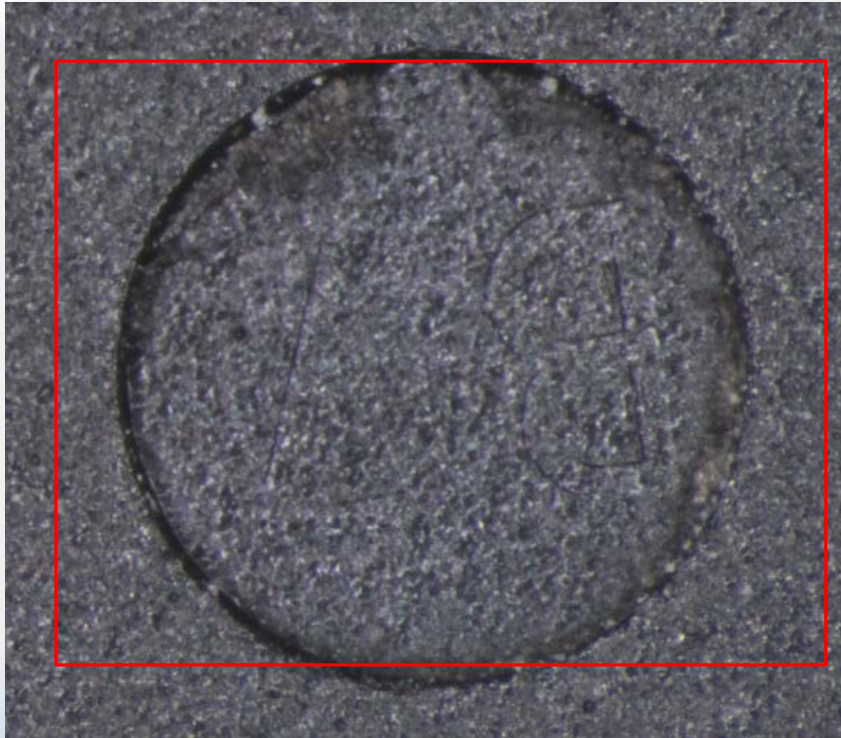
Authentic



Suspect

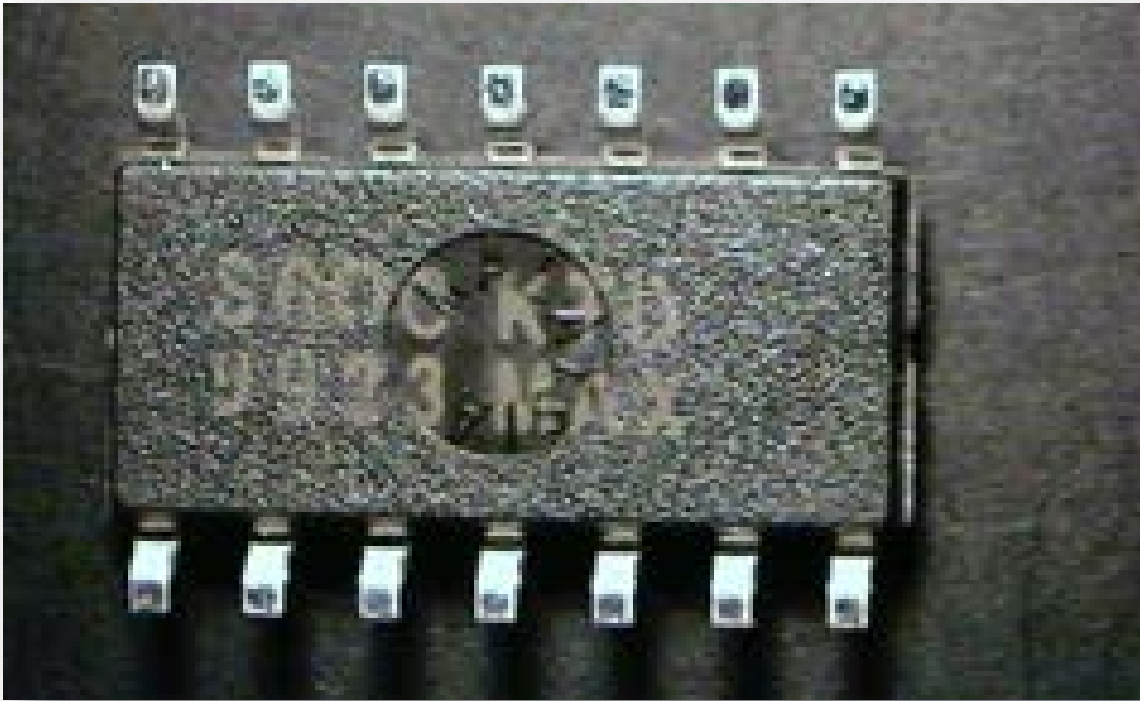


Suspect-Part indents

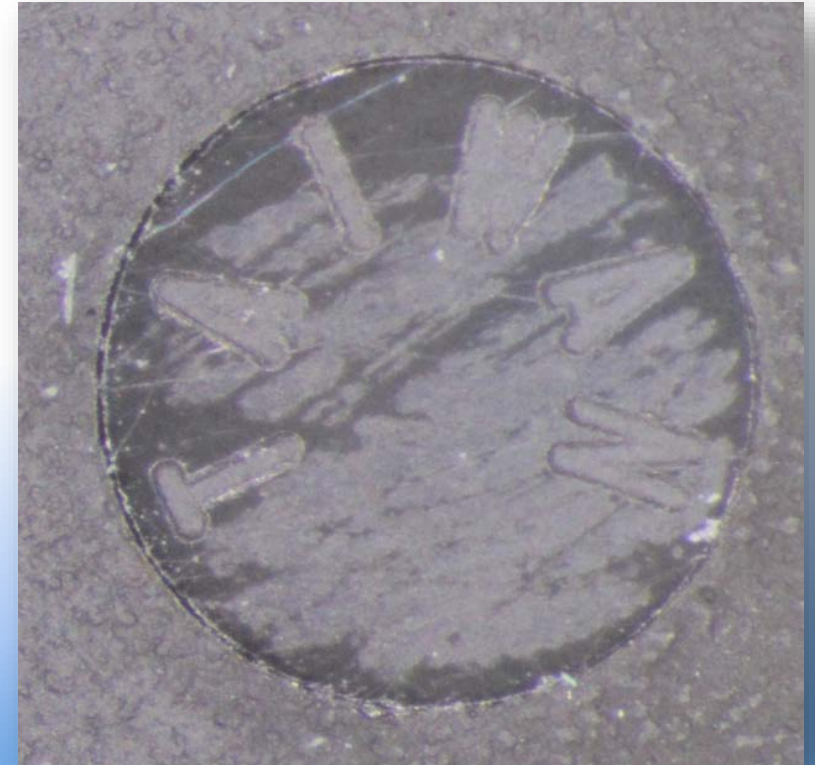




Suspect-Part indents



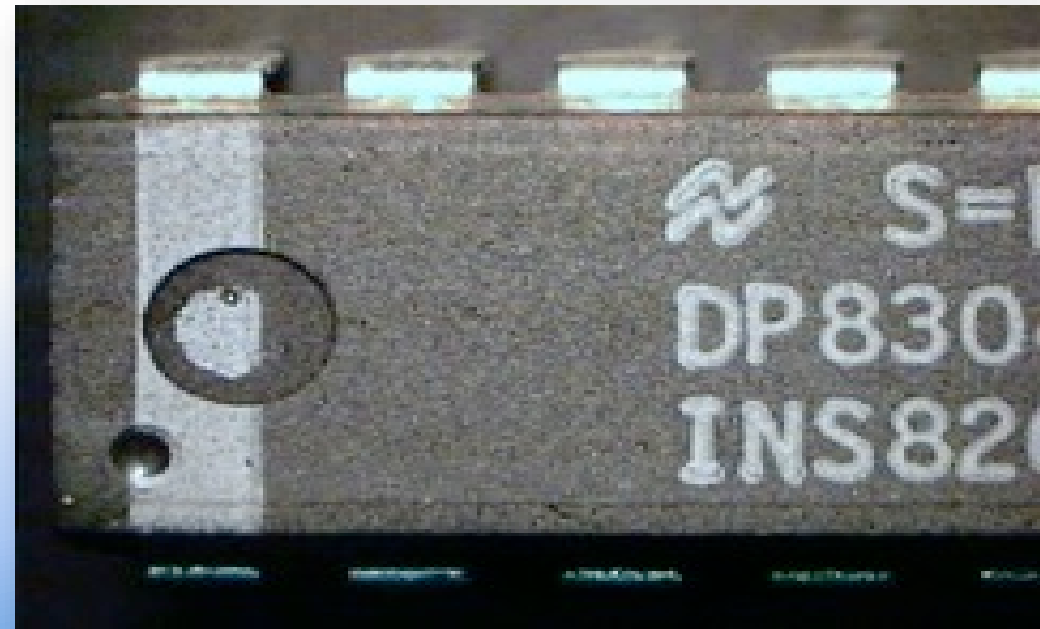
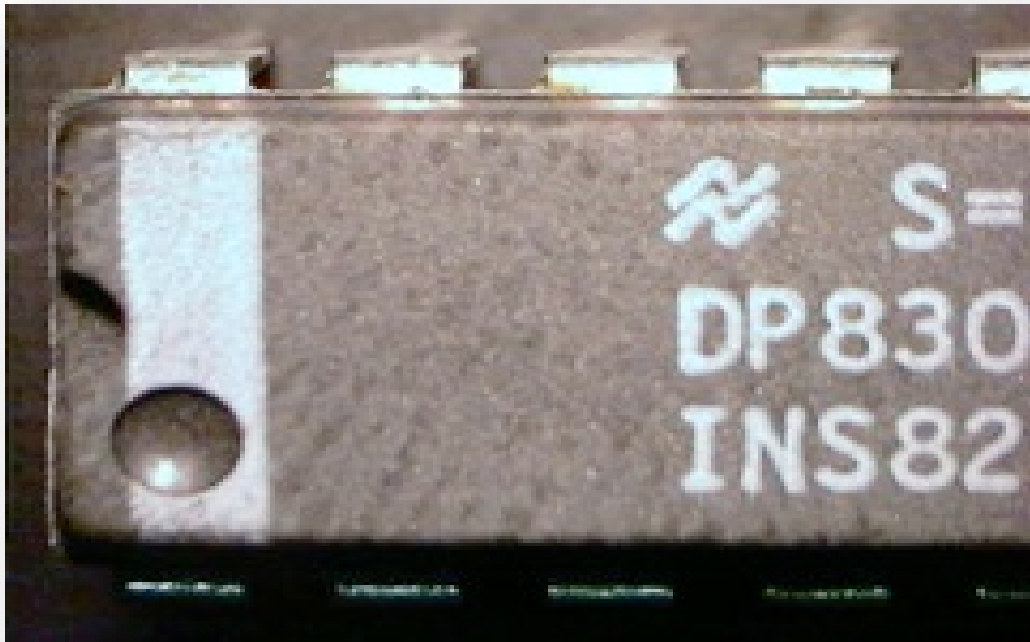
- Part has marking inside indent
- **Indents with markings can signify a suspect part**





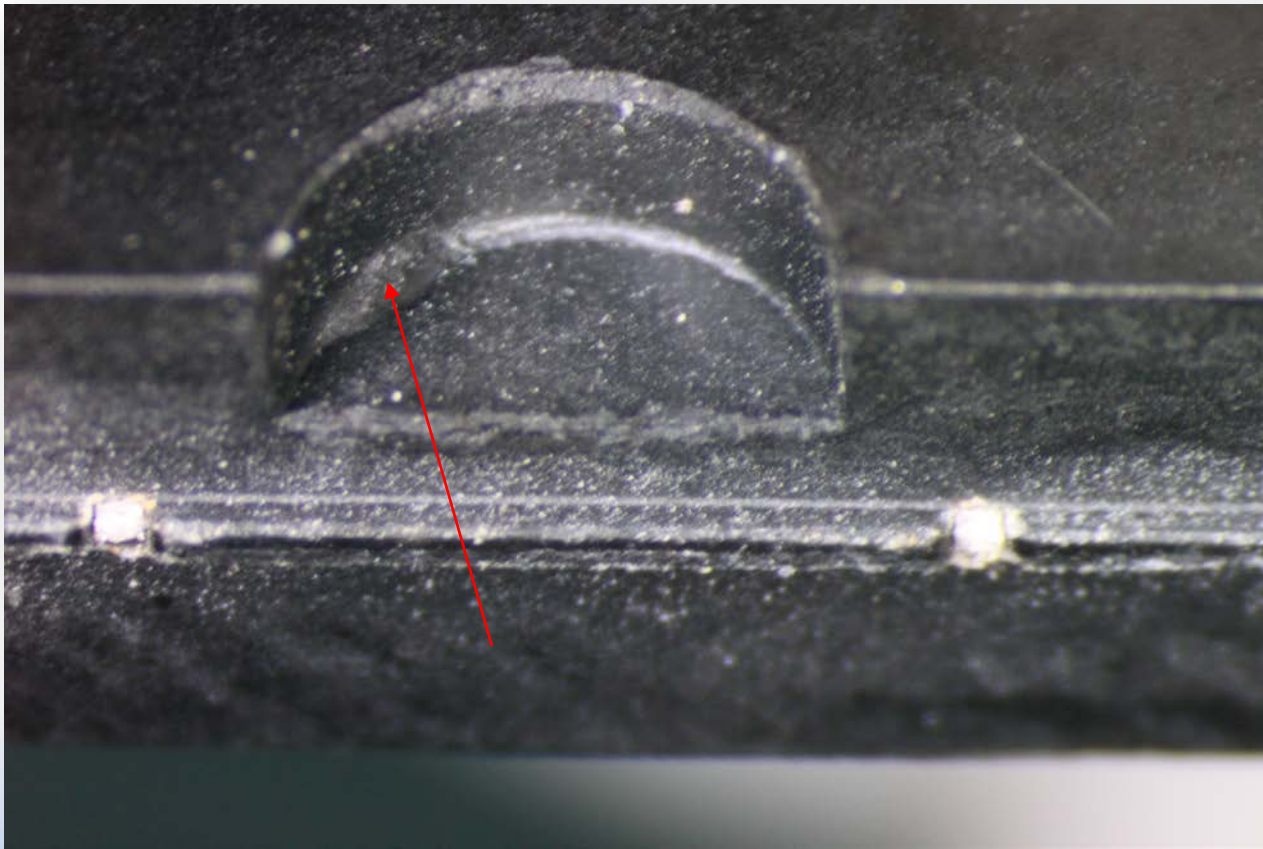
Suspect-Part indents

- Identical part number markings
- Indents between the two parts are not identical





Suspect-Part indents





Assessing Incoming Parts

1. External visual
 - a) Part markings
 - b) Part surface
 - c) Indents
 - d) **Physical mold features**
 - e) Pins

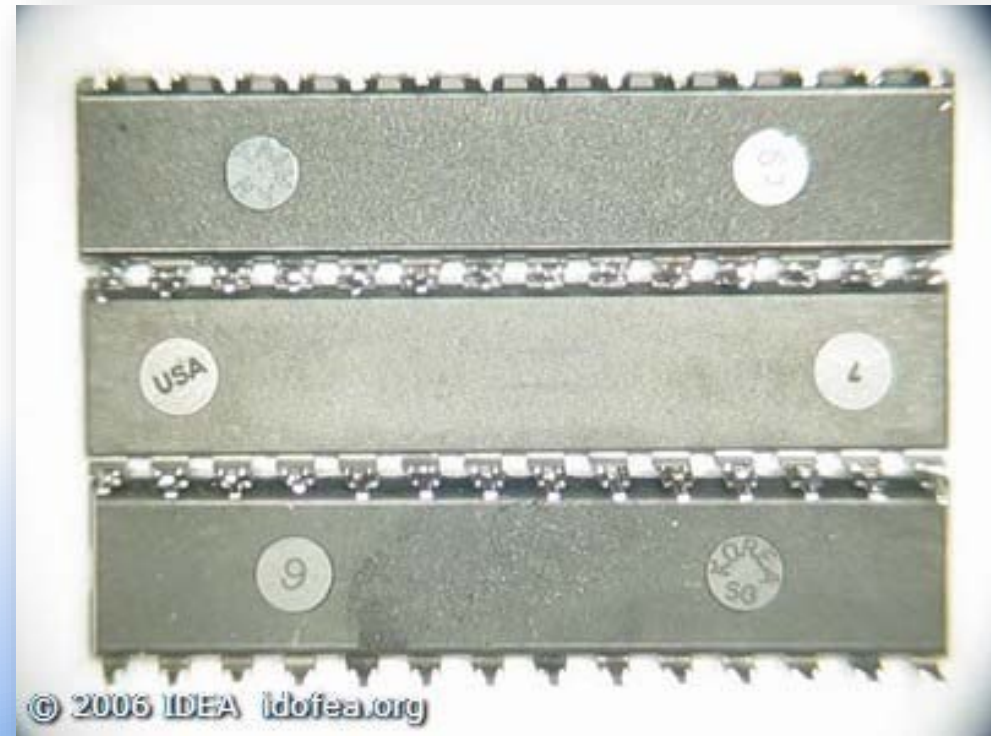


Suspect-mold features

Top of Parts



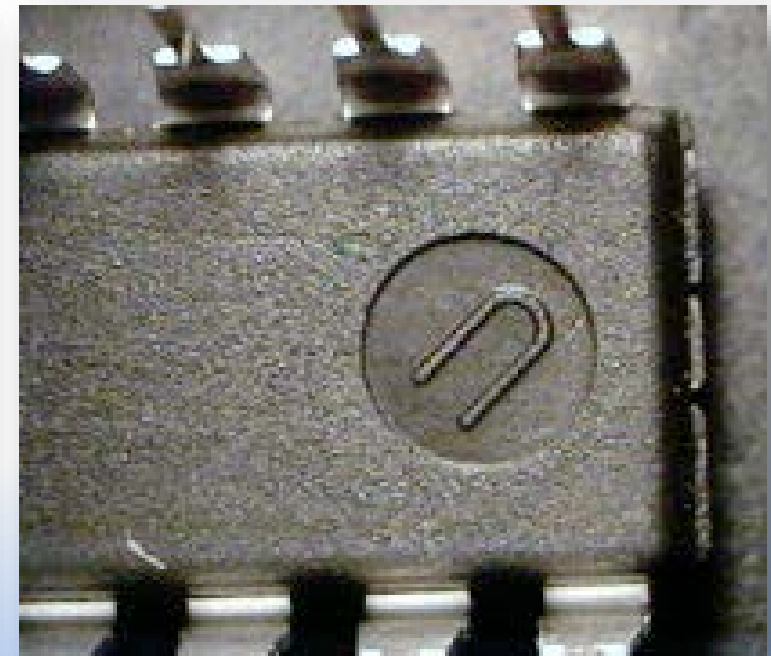
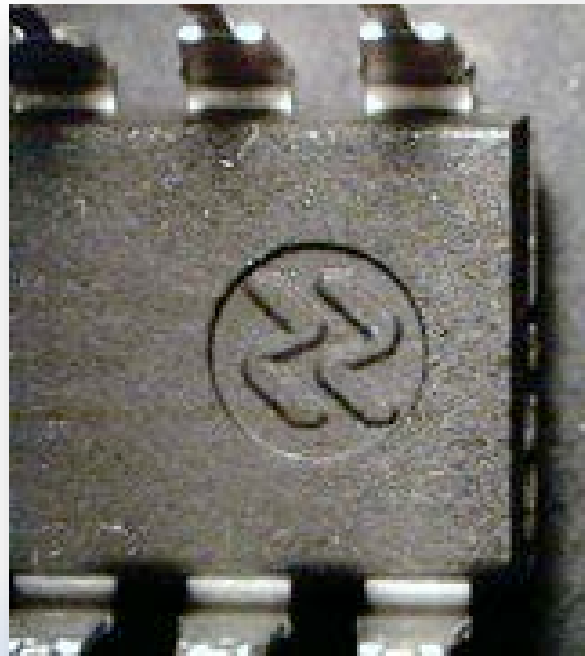
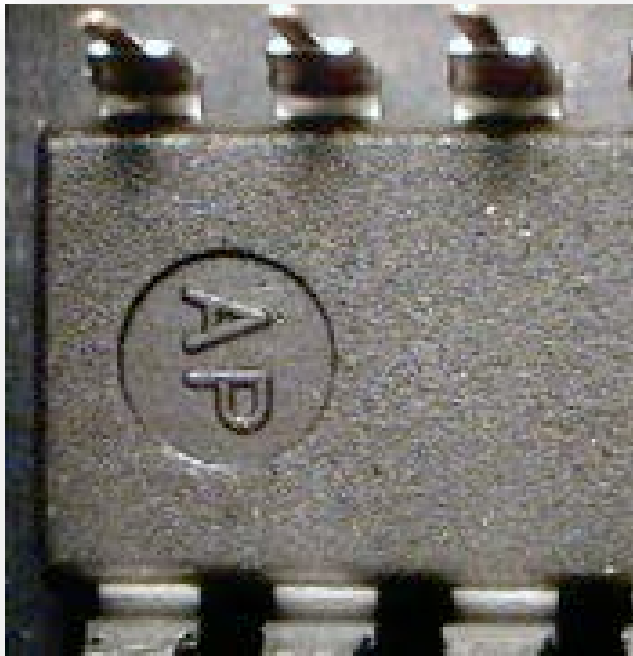
Bottom of Parts



Same P/N, manufacturer, D/C but three different moldings!



Suspect-mold features



- Top surface: Identical part markings
- Bottom surface: **three completely different markings**

Courtesy: AERI.com

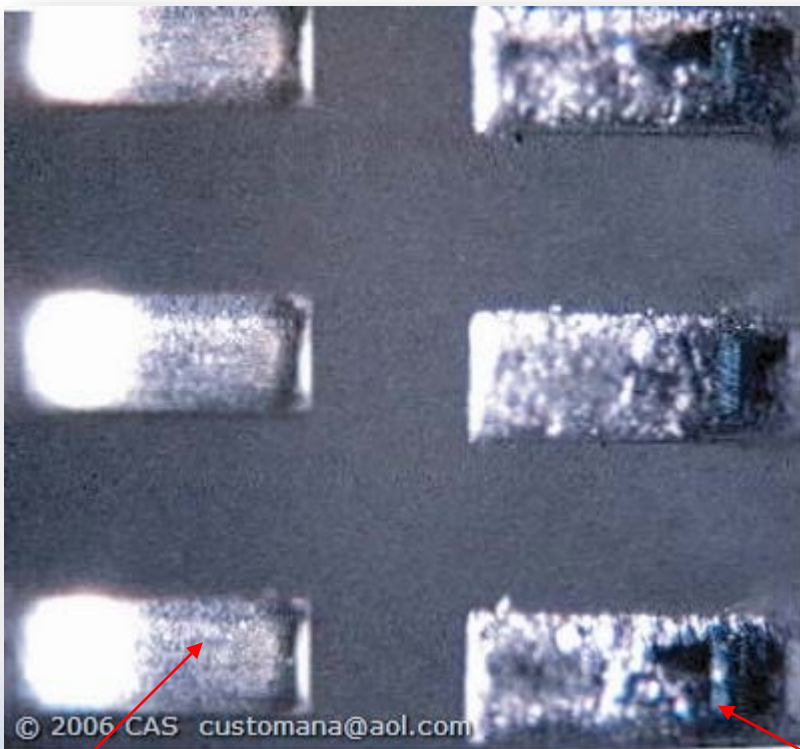


Assessing Incoming Parts

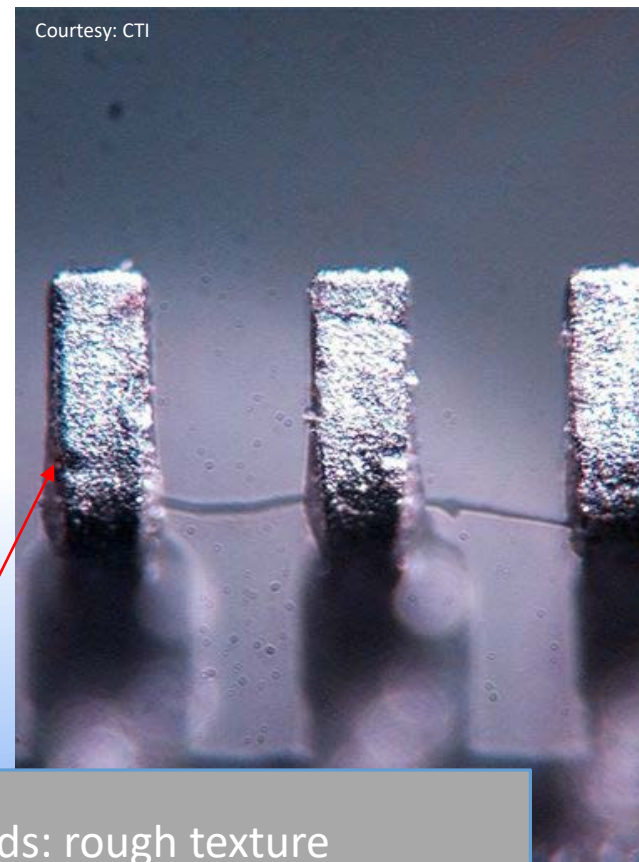
1. External visual
 - a) Physical mold features
 - b) Part surface
 - c) Part markings
 - d) Indents
 - e) Pins



New vs. Suspect Part Leads



New leads: uniform, consistent finish and shape



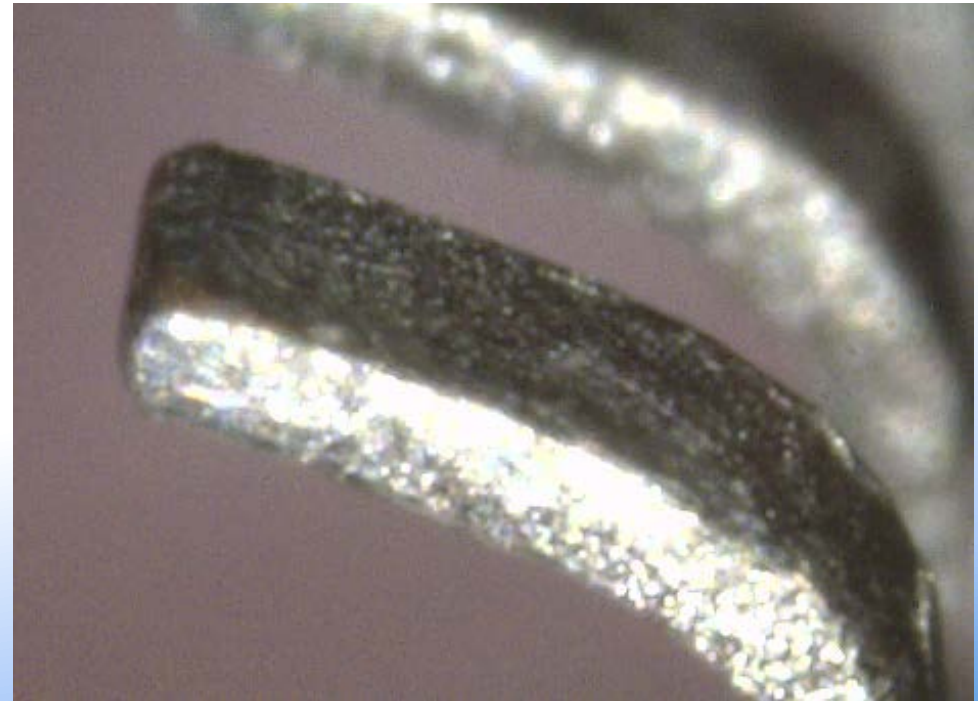
Used leads: rough texture



Lead Pads



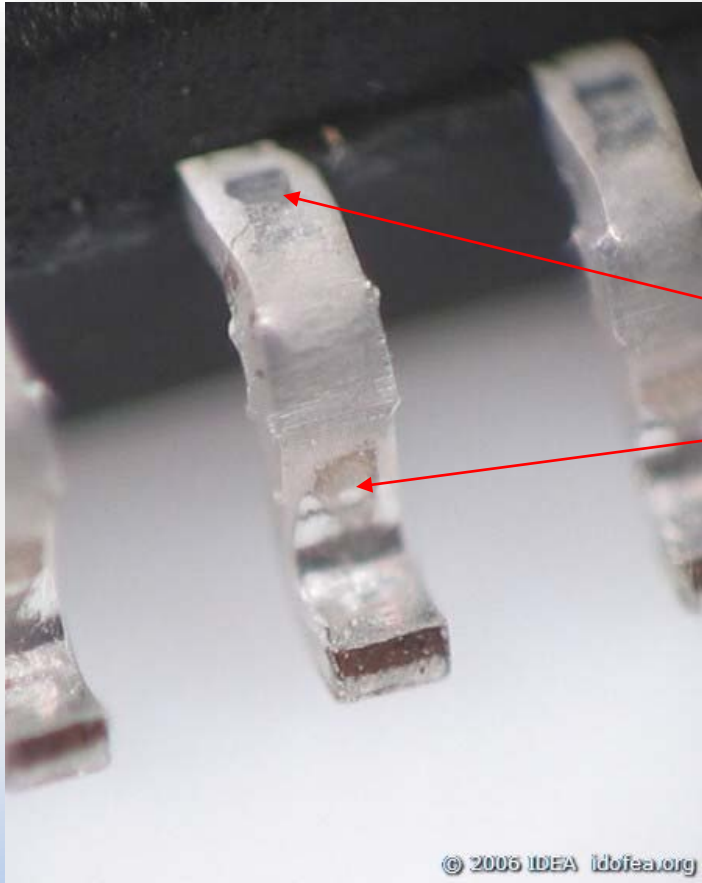
Authentic



Suspect



Good-Part leads

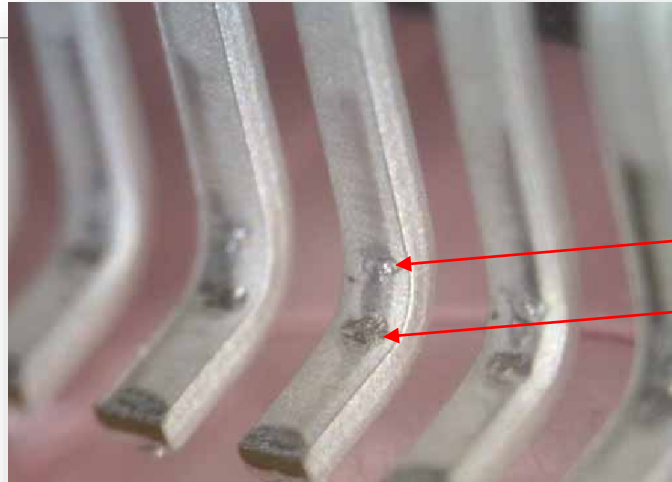


Tooling marks: result of lead formation or “bending” of leads to meet specification

Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market



New vs. re-tinned leads



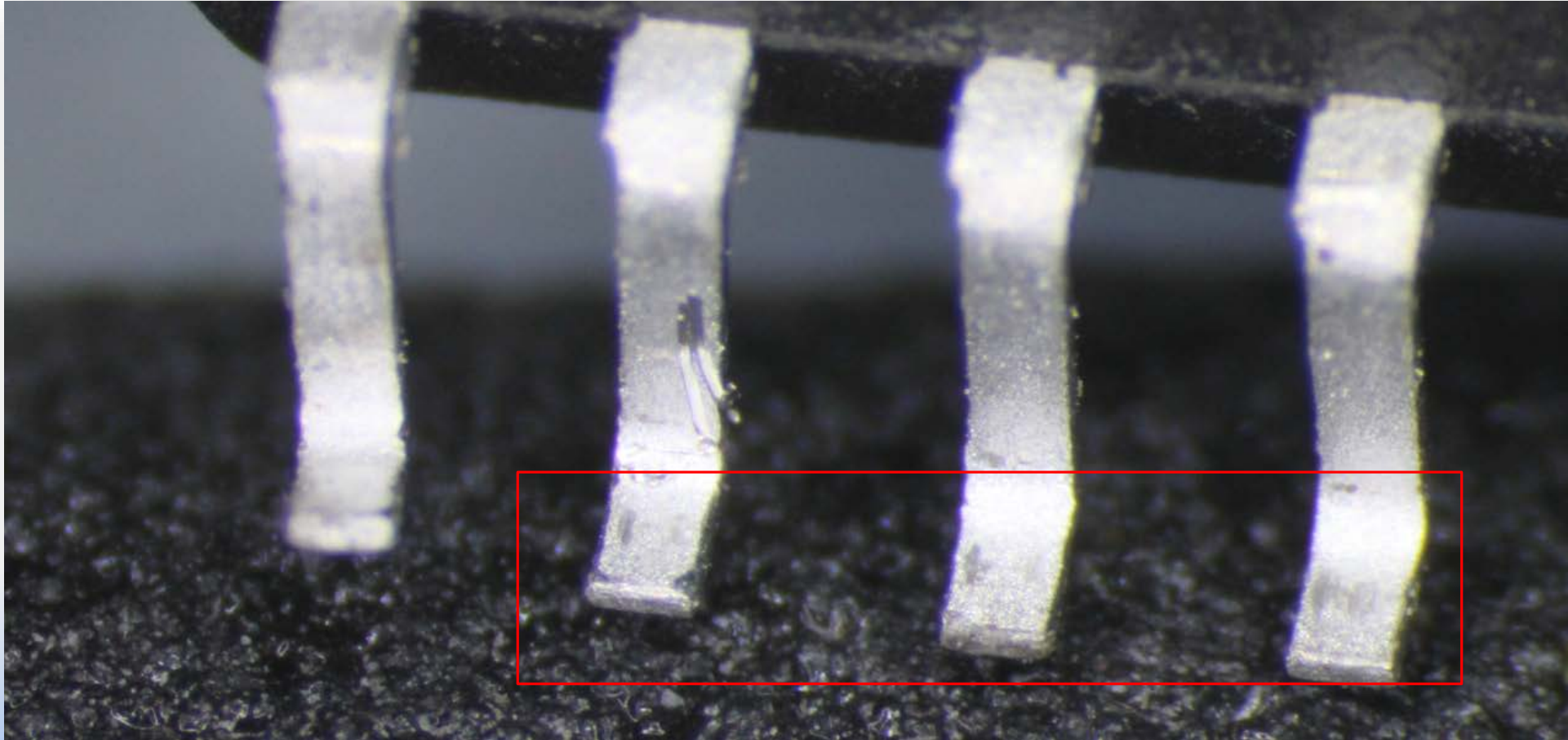
Leads with obvious witness marks



Same part re-tinned, witness marks are hidden

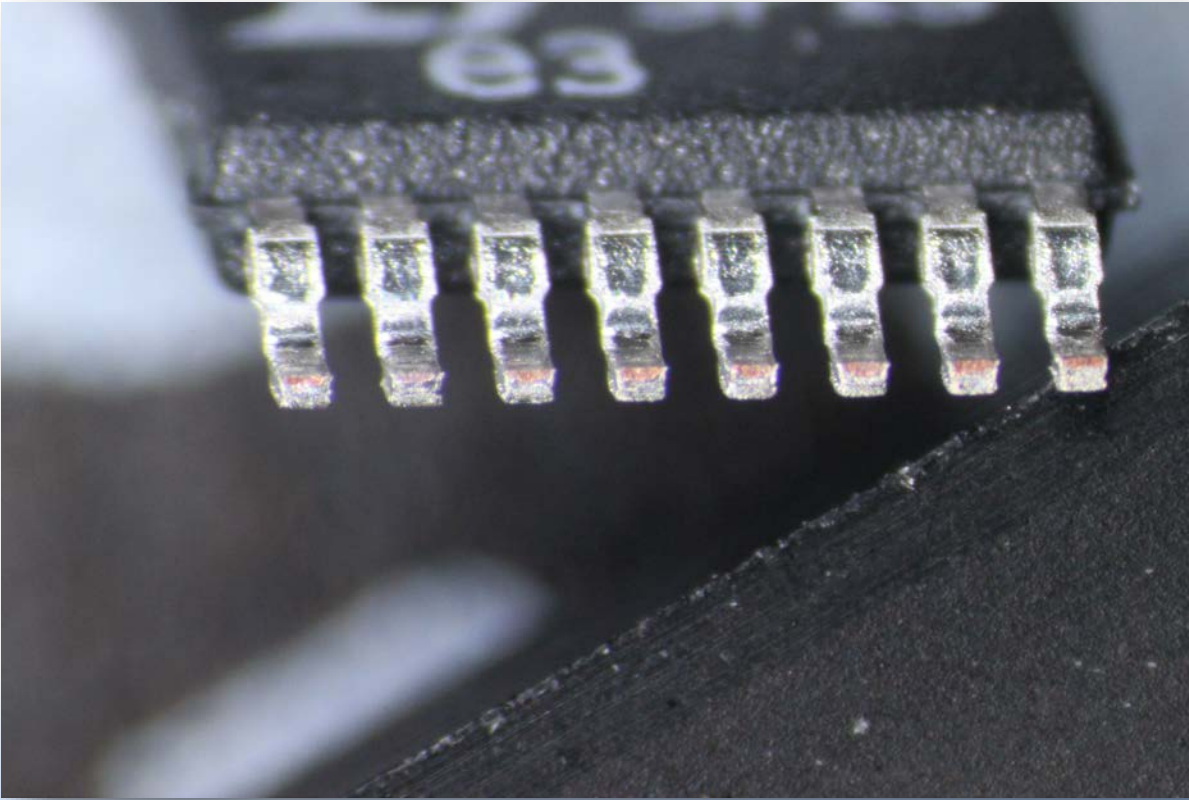


Tooling marks absent

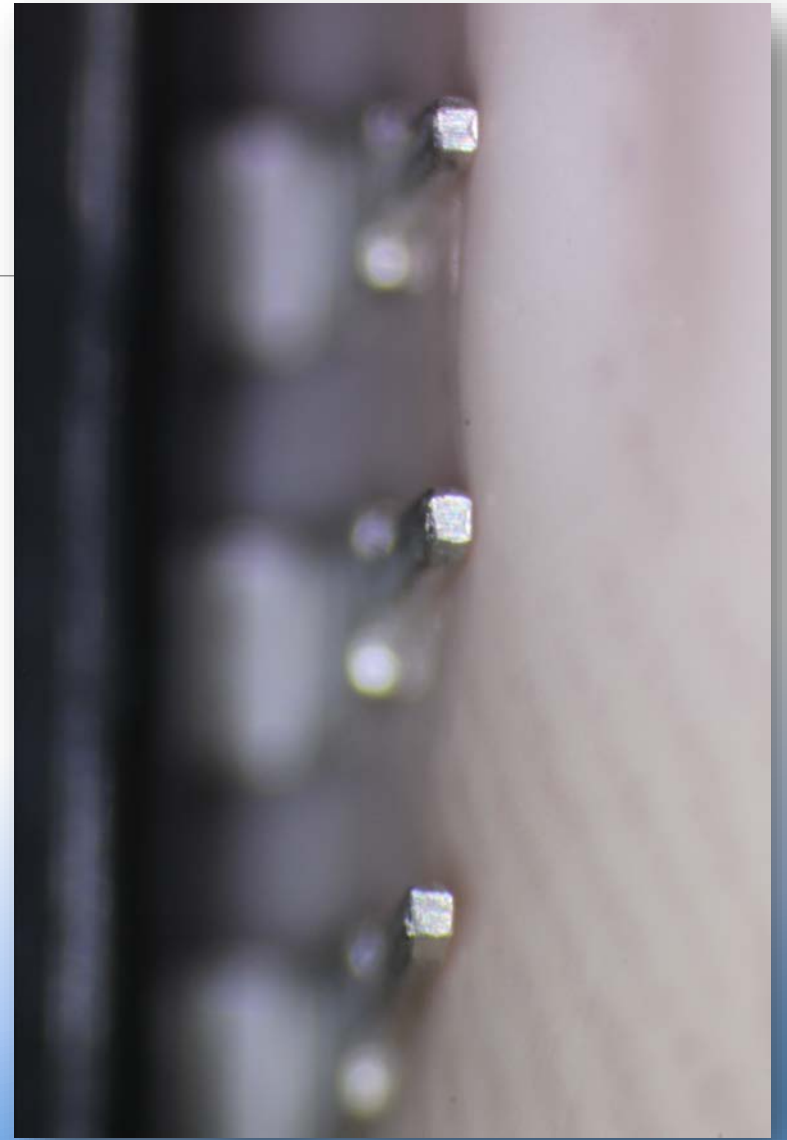




Exposed copper



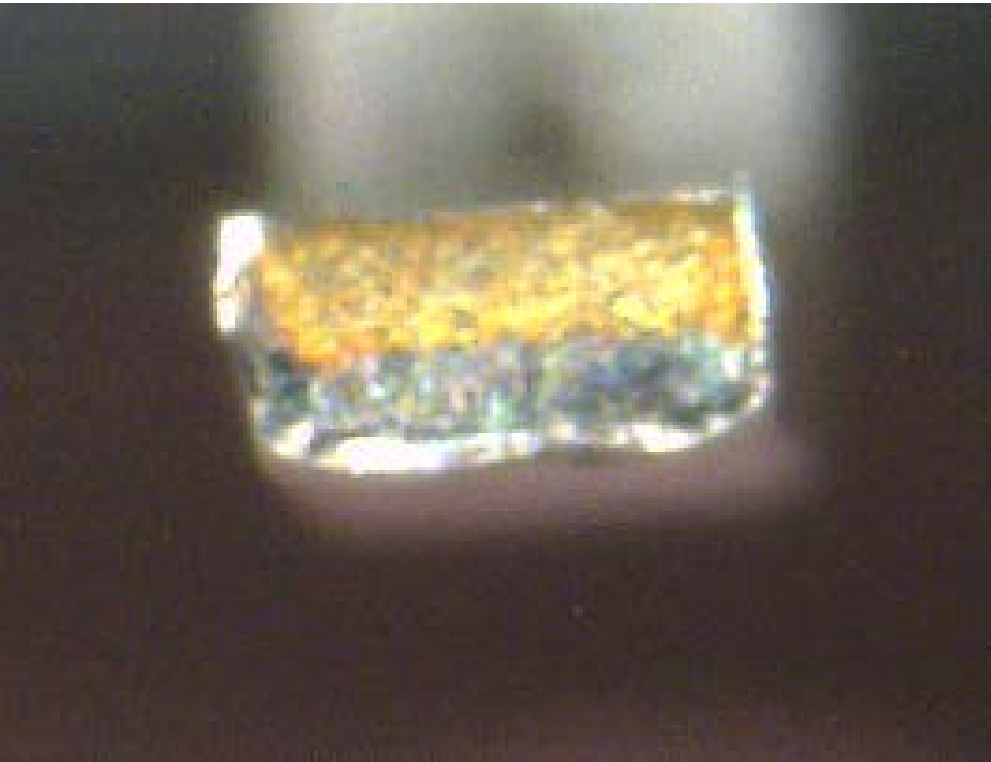
Authentic



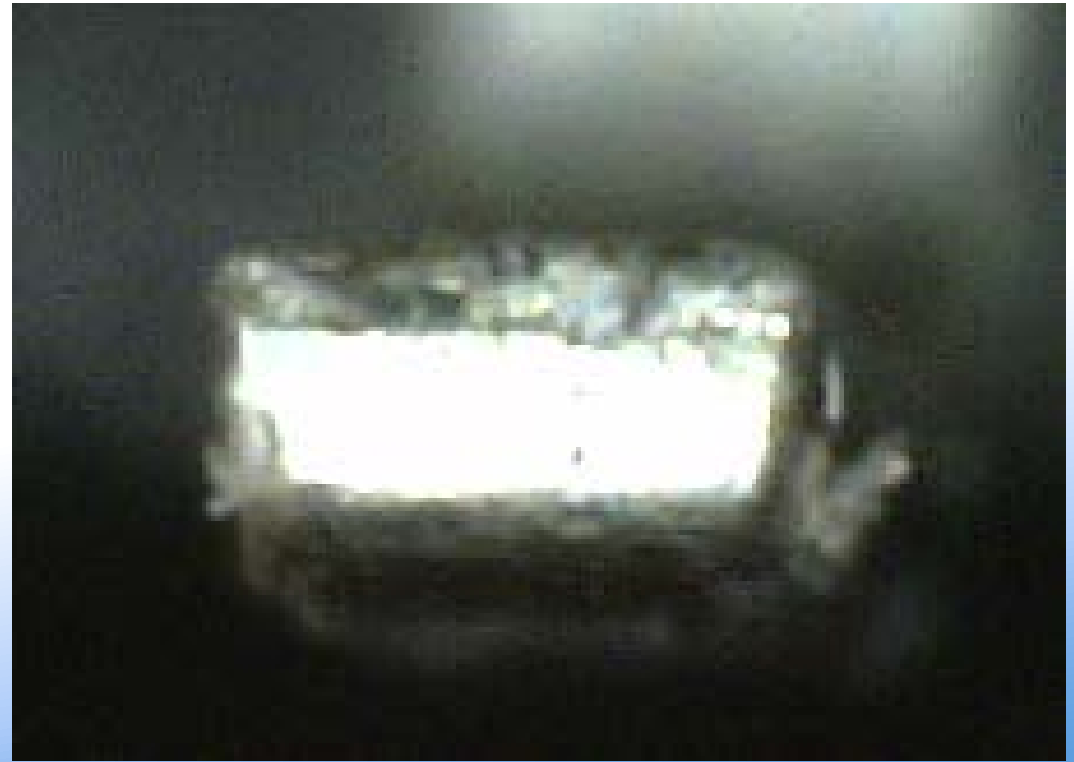
Suspect



Exposed copper



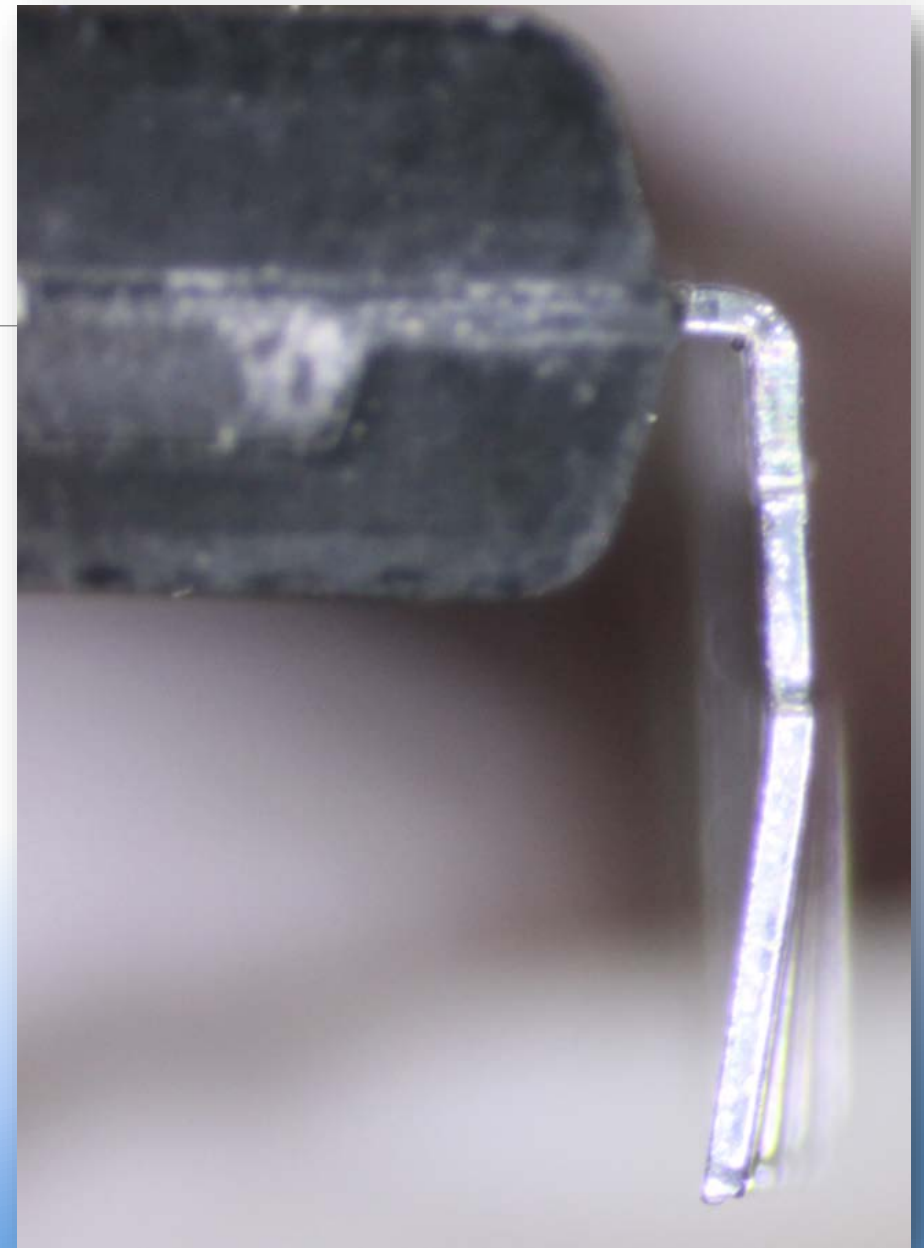
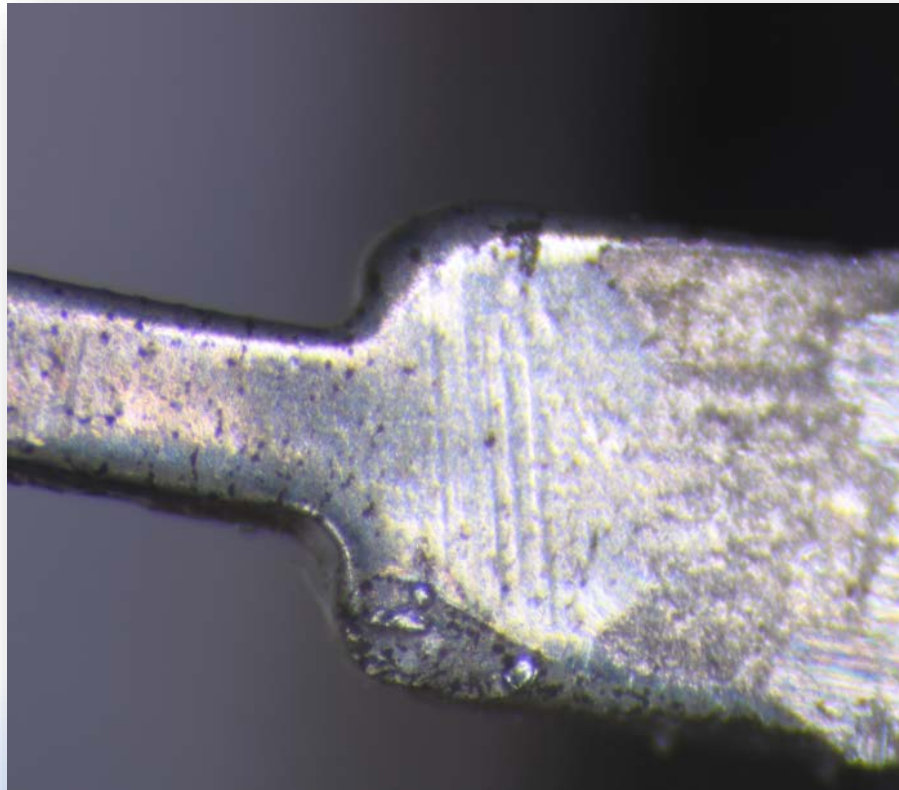
Authentic



Suspect

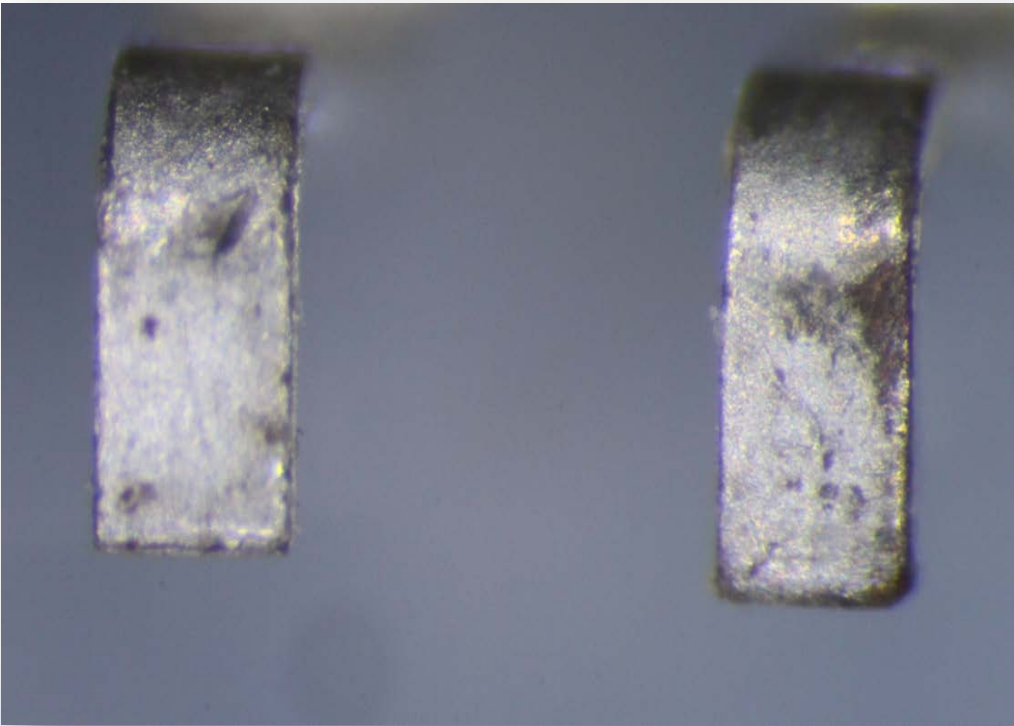


Suspect-Part leads



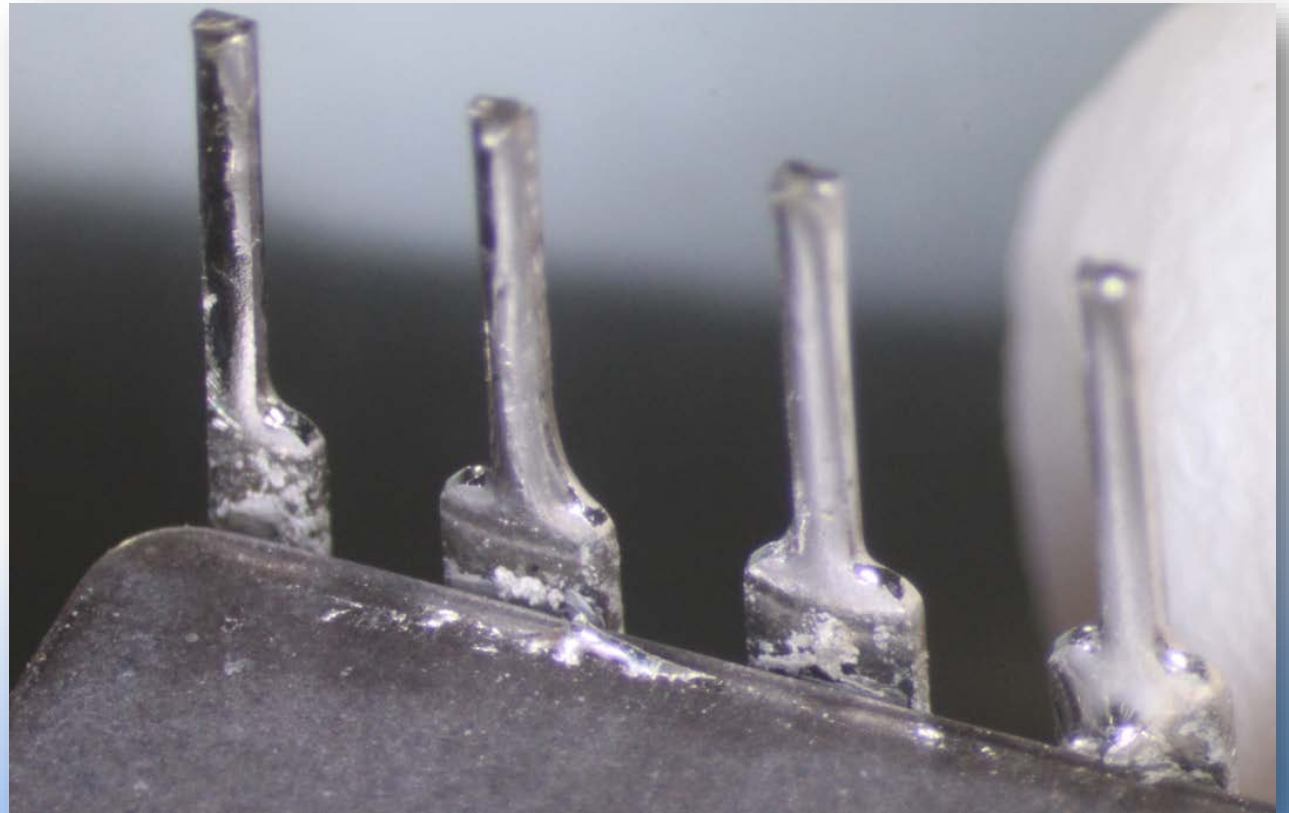
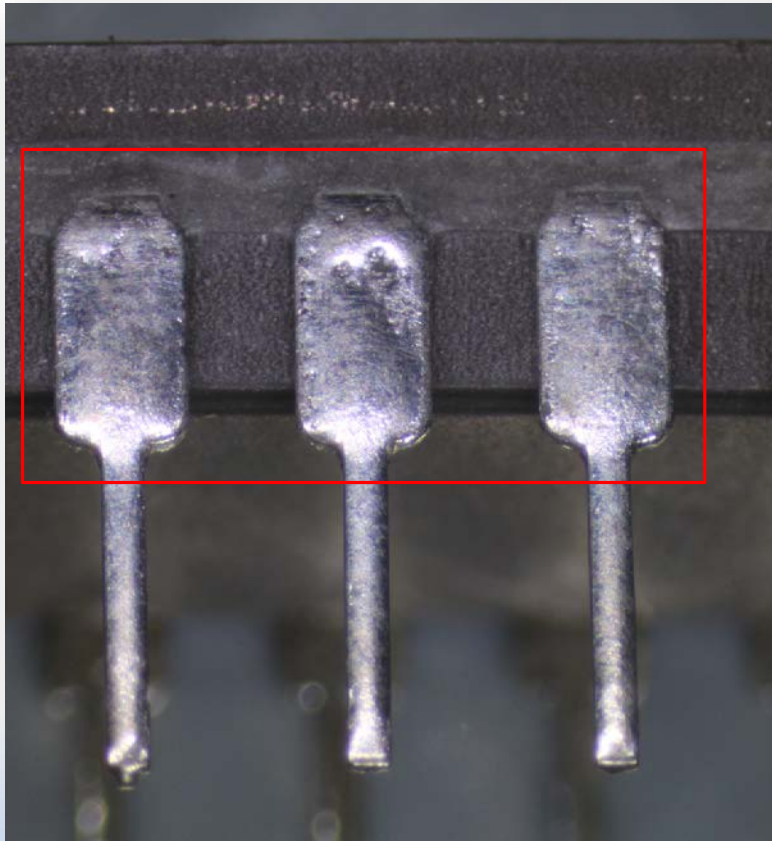


Suspect-Part leads





Suspect-Part leads



Courtesy: IDEA-STD-1010-A: Acceptability of Electronic Components Distributed in the Open Market



Section 2 – Advanced Testing Procedures



Marking Permanency: Solvents Testing

- Inspection for Re-marking or Resurfacing
 - Standard “resistance to solvents” test methods can be effective, but more aggressive methods may be necessary to remove coatings applied to disguise sanding marks, and to reveal other indications that the original device marking has been removed.
 - Scrape surface of part with a razor blade
 - Dilute acetone 3:1 with water & swab with Q-Tip
 - 3:1 mineral spirits:alcohol
 - Heated acetone
 - DynaSolve





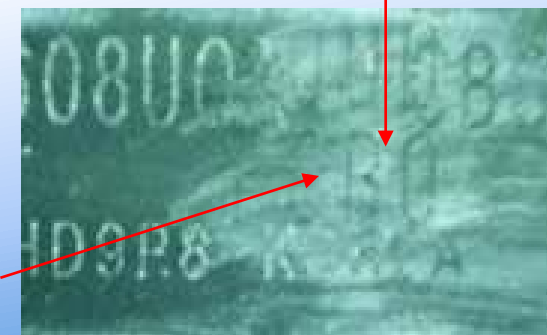
Marking Permanency: Solvents Testing



Scraping from razor removed fake "top"



Ghost markings





Marking Permanency: Solvents Testing



Courtesy: GIDEP

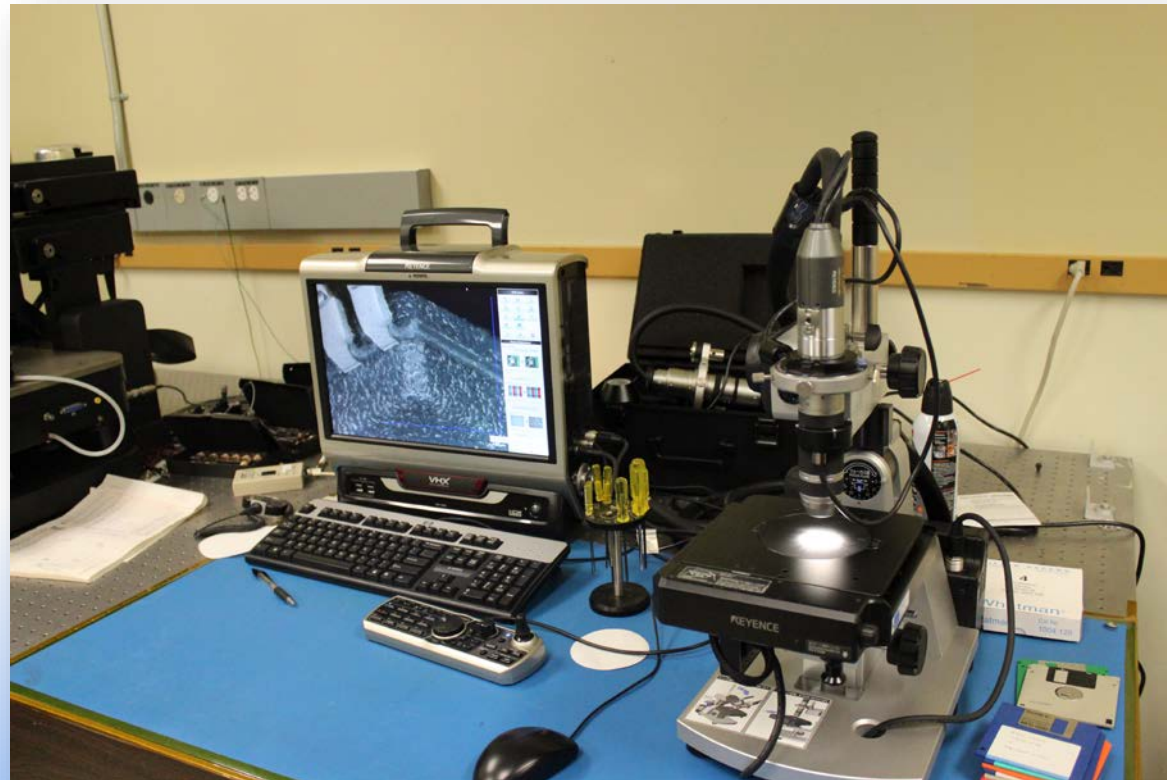


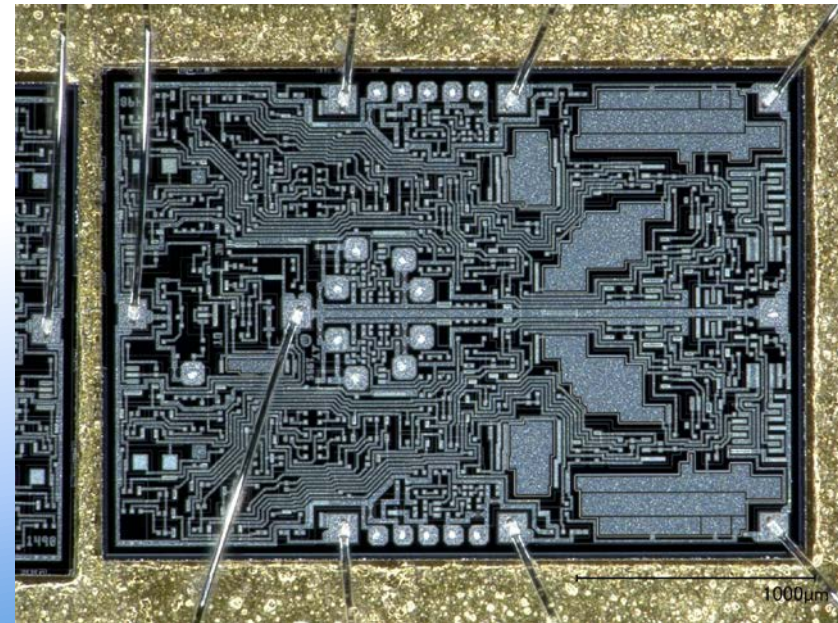
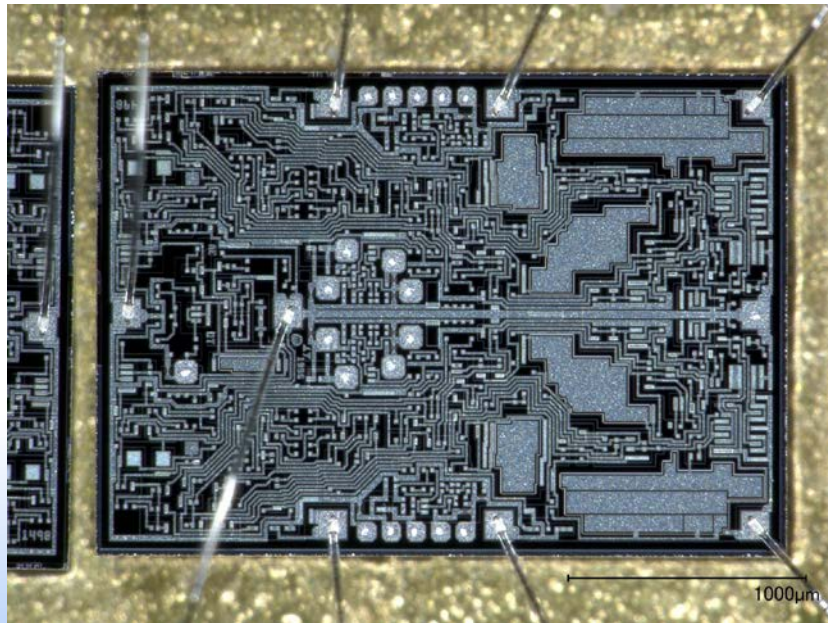
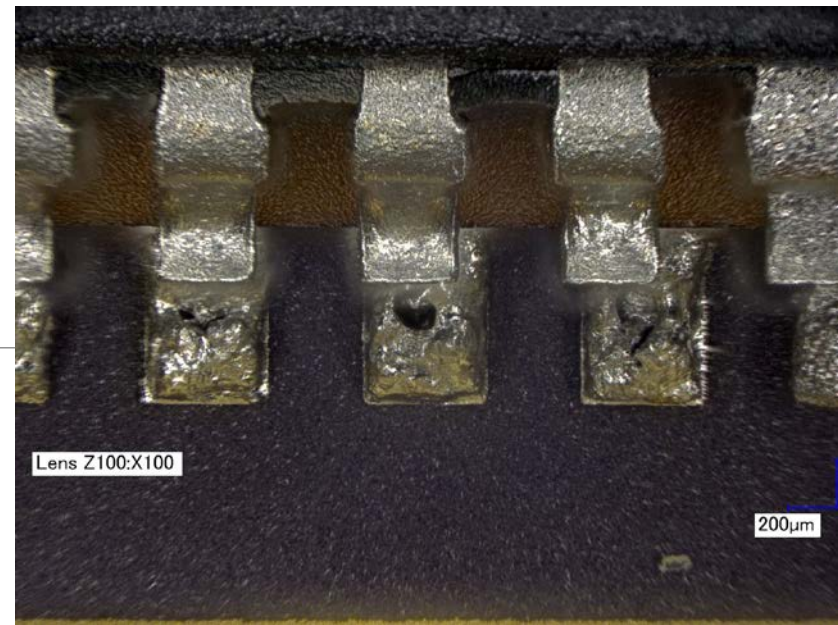
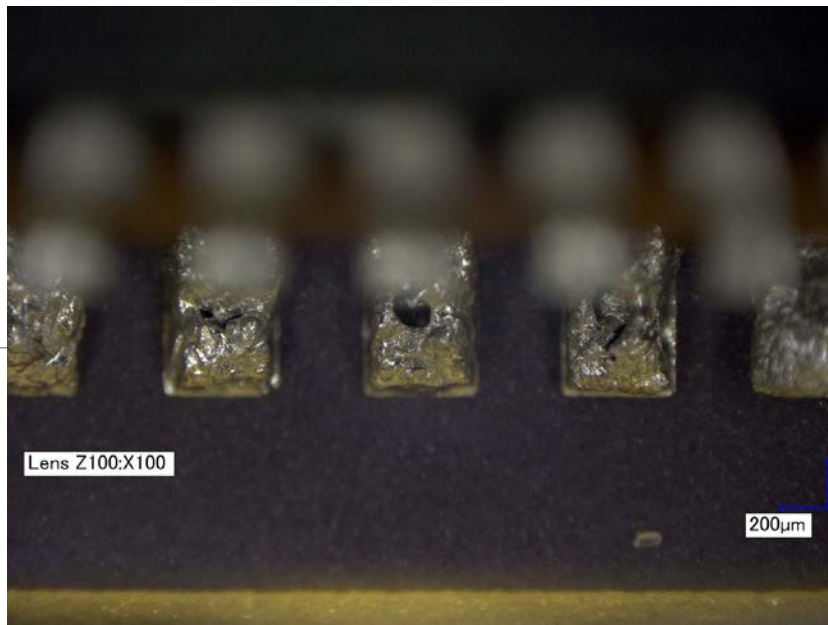
Acetone removes black from surface of part



Microscopy

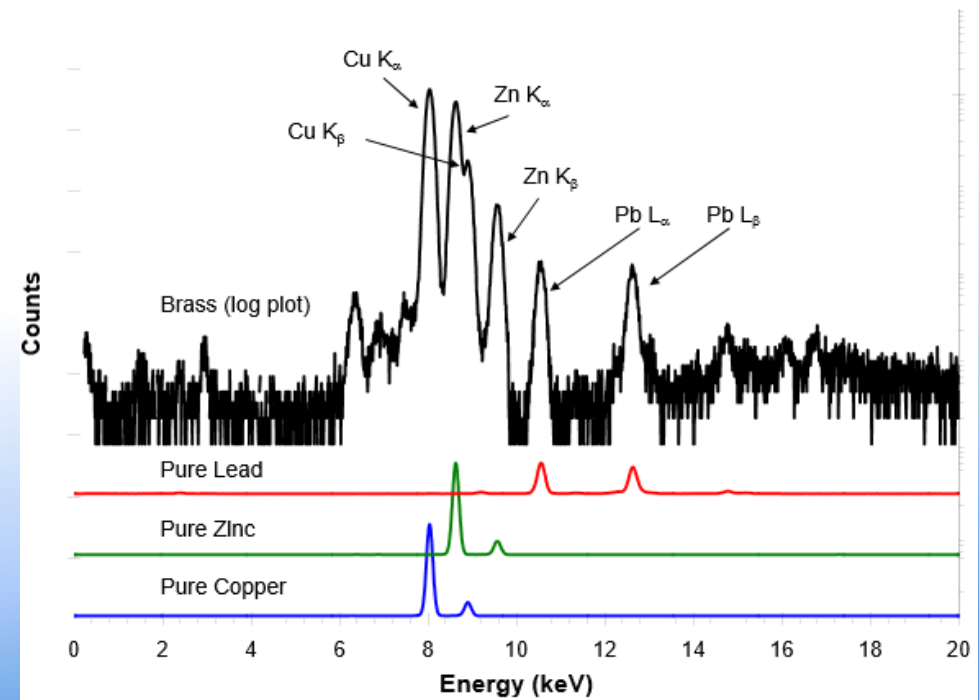
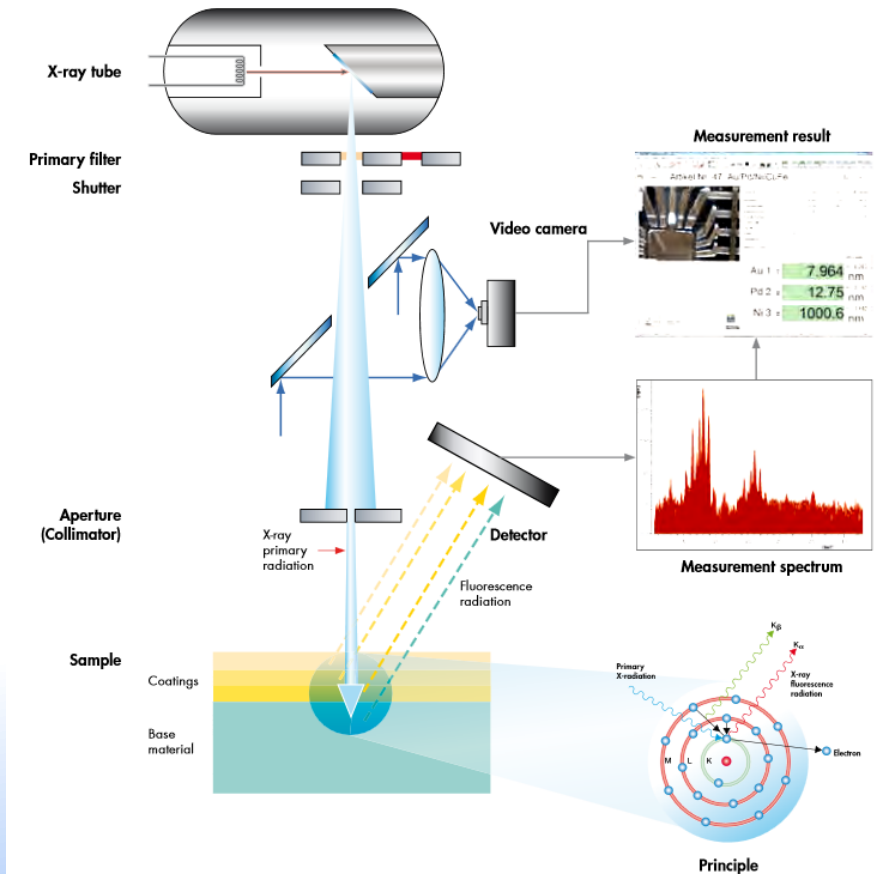
- High magnification
 - 20x-1000x
 - Confocal capabilities







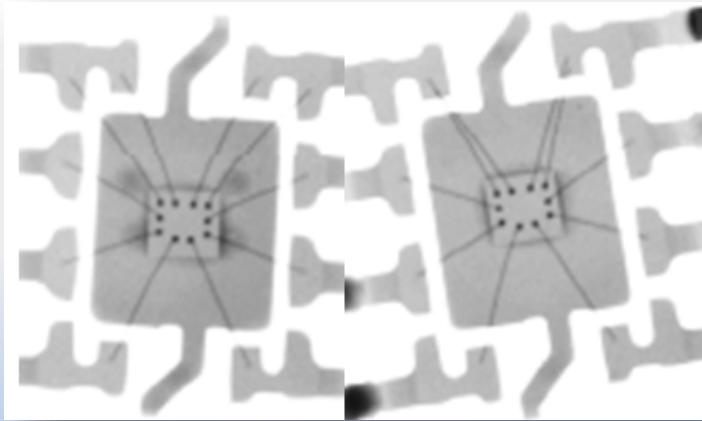
X-Ray Fluorescence (XRF)





Real-time X-ray

- Provides internal inspection of IC while being able to manipulate sample
 - Nondestructive technique
 - High magnification and resolution
- Inspect die attach, wire bonding, lid seals, etc.

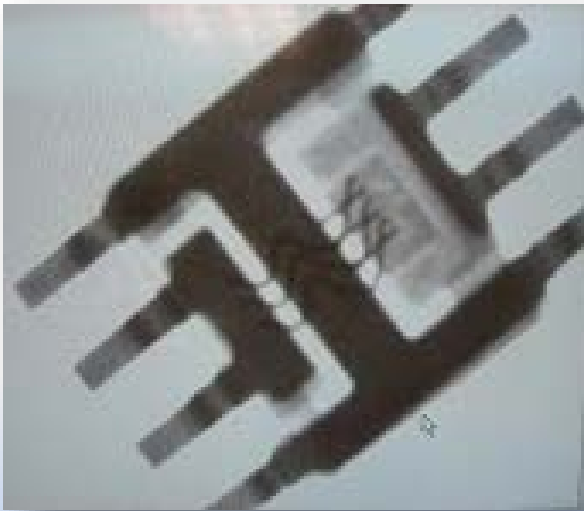




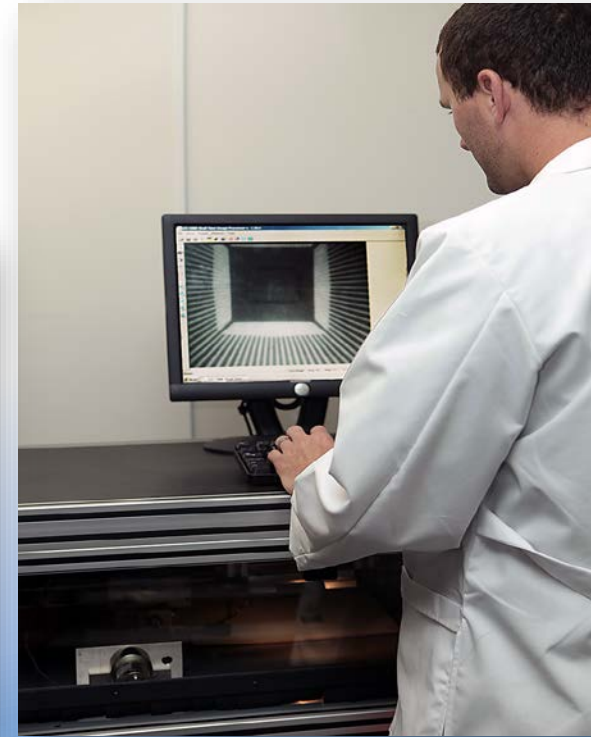
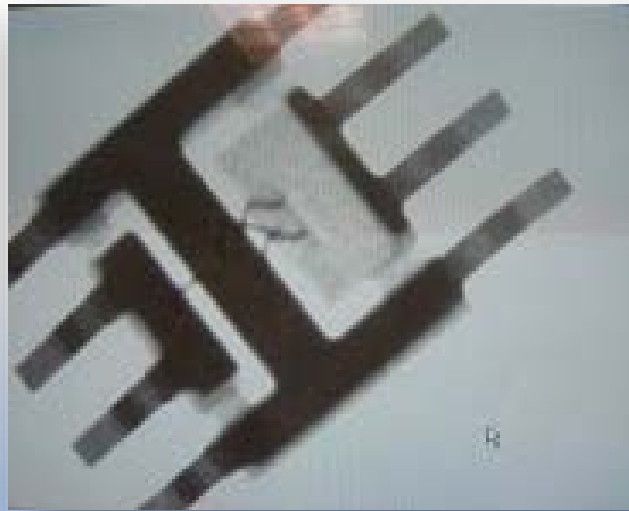
Detecting a repackaged part: X-ray

- Effective to look for manufacturing differences in die size, lead frame, bond wire patterns and voids. In some cases there have been no bond wires.

Bond wires present

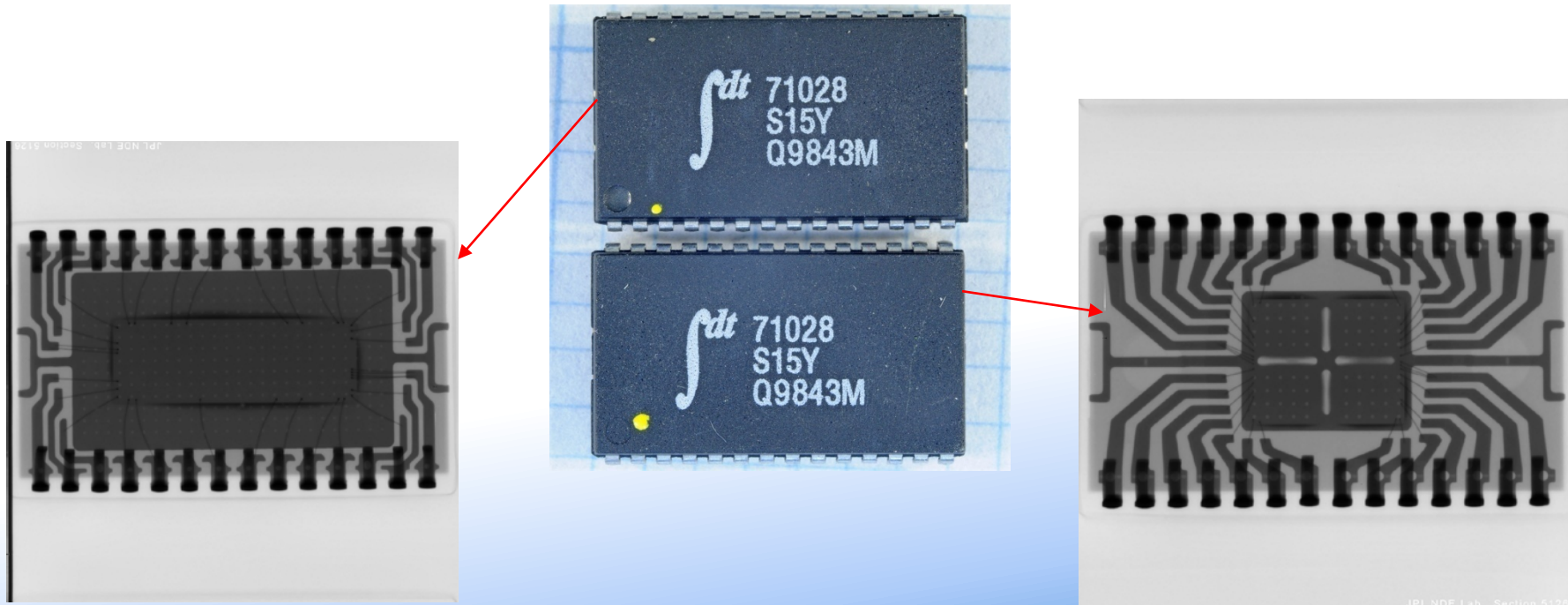


Some bond wires missing



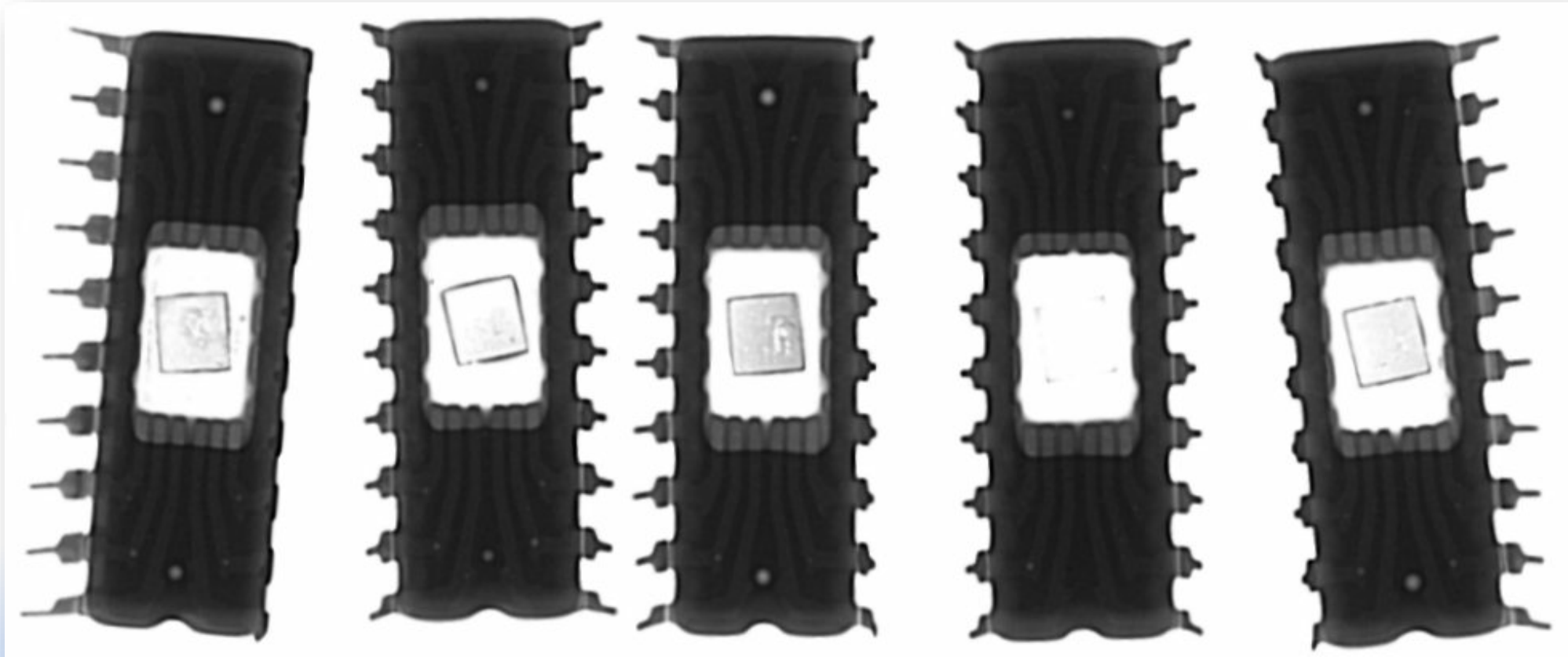


Detecting a repackaged part: X-ray





Detecting a repackaged part: X-ray





Other package styles: Transistor outline (TO) cans

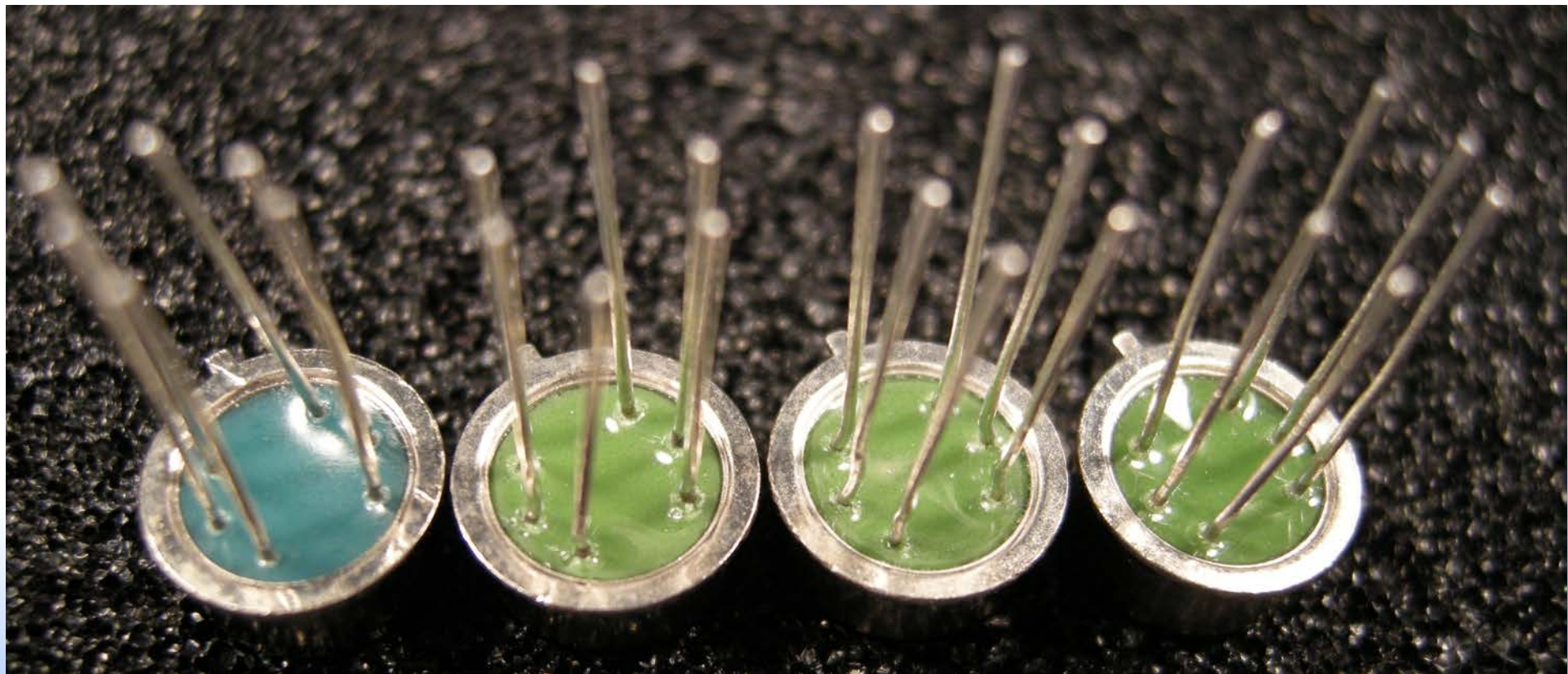
How do these TI 4N23 optocouplers look?





Other package styles: TO cans

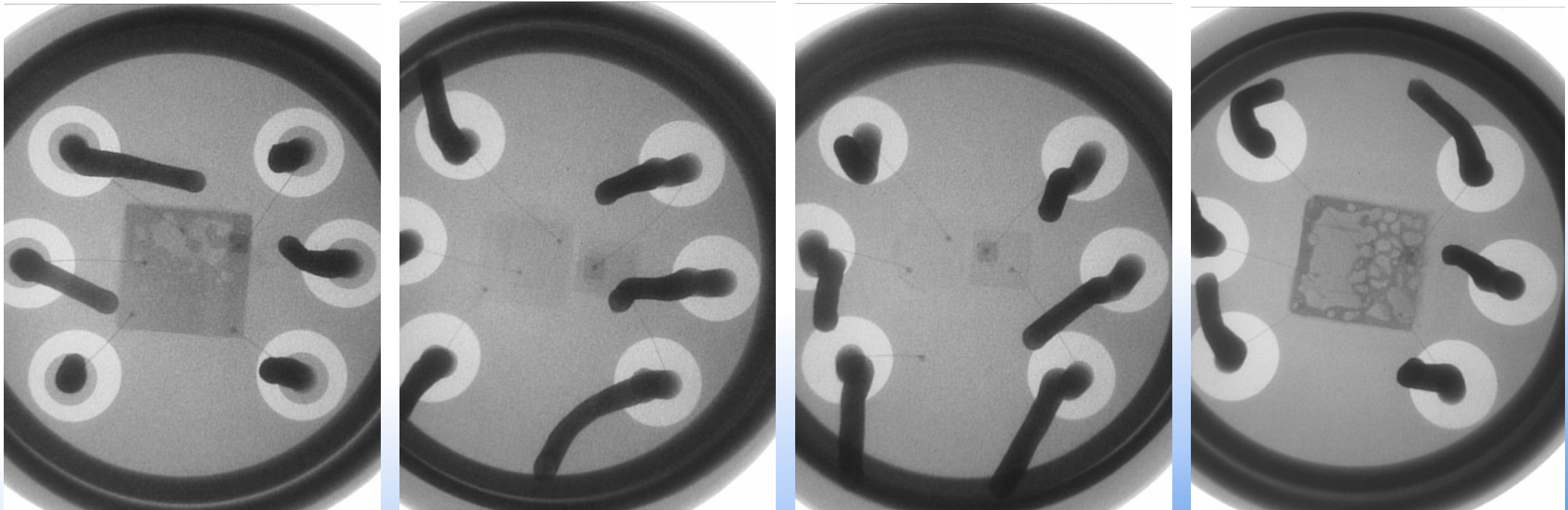
How do these TI 4N23 optocouplers look now?





Other package styles: T0 cans

How do these TI 4N23 optocouplers look in x-ray?





Other package styles: TO cans

How do these TI 4N23 optocouplers look internally?





Other package styles: TO cans

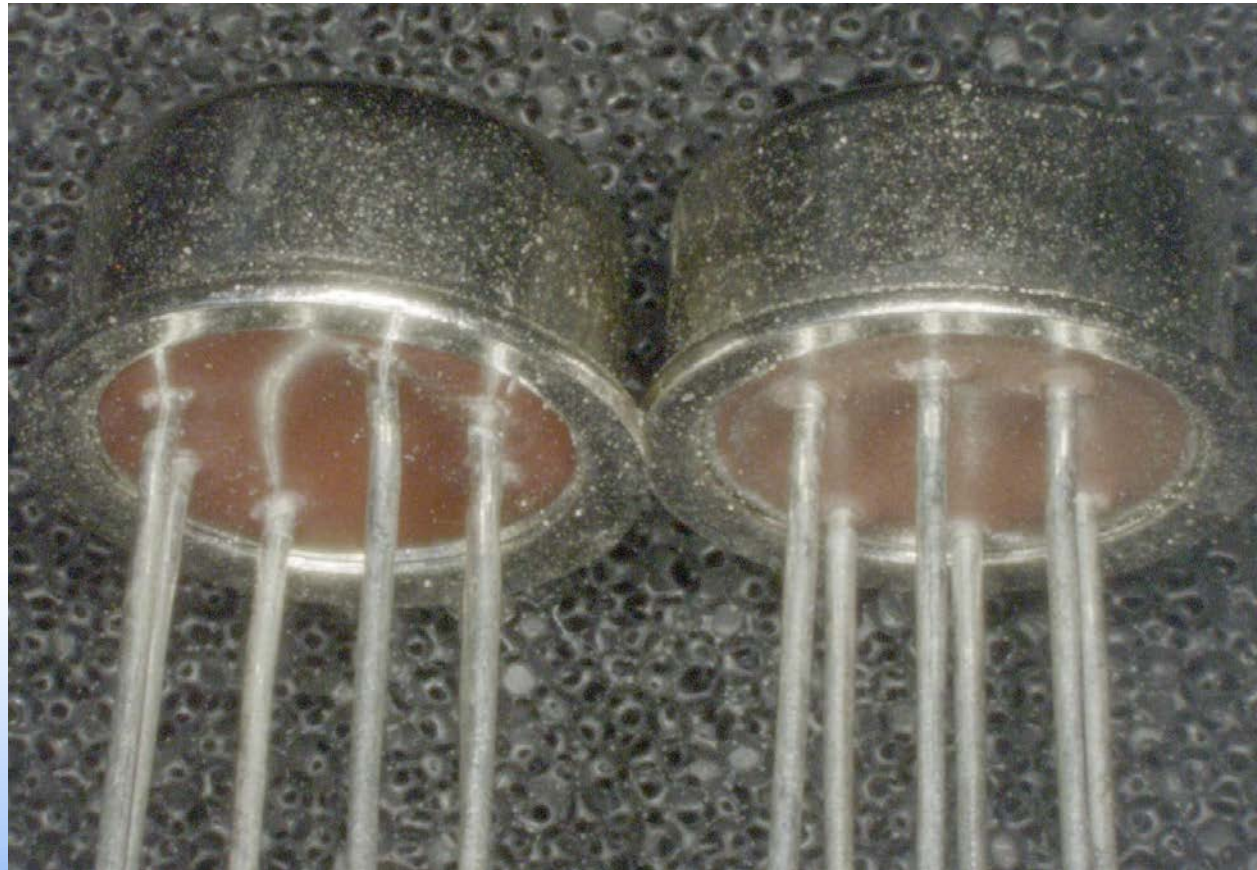
How do these Motorola 4N24A optocouplers look?





Other package styles: TO cans

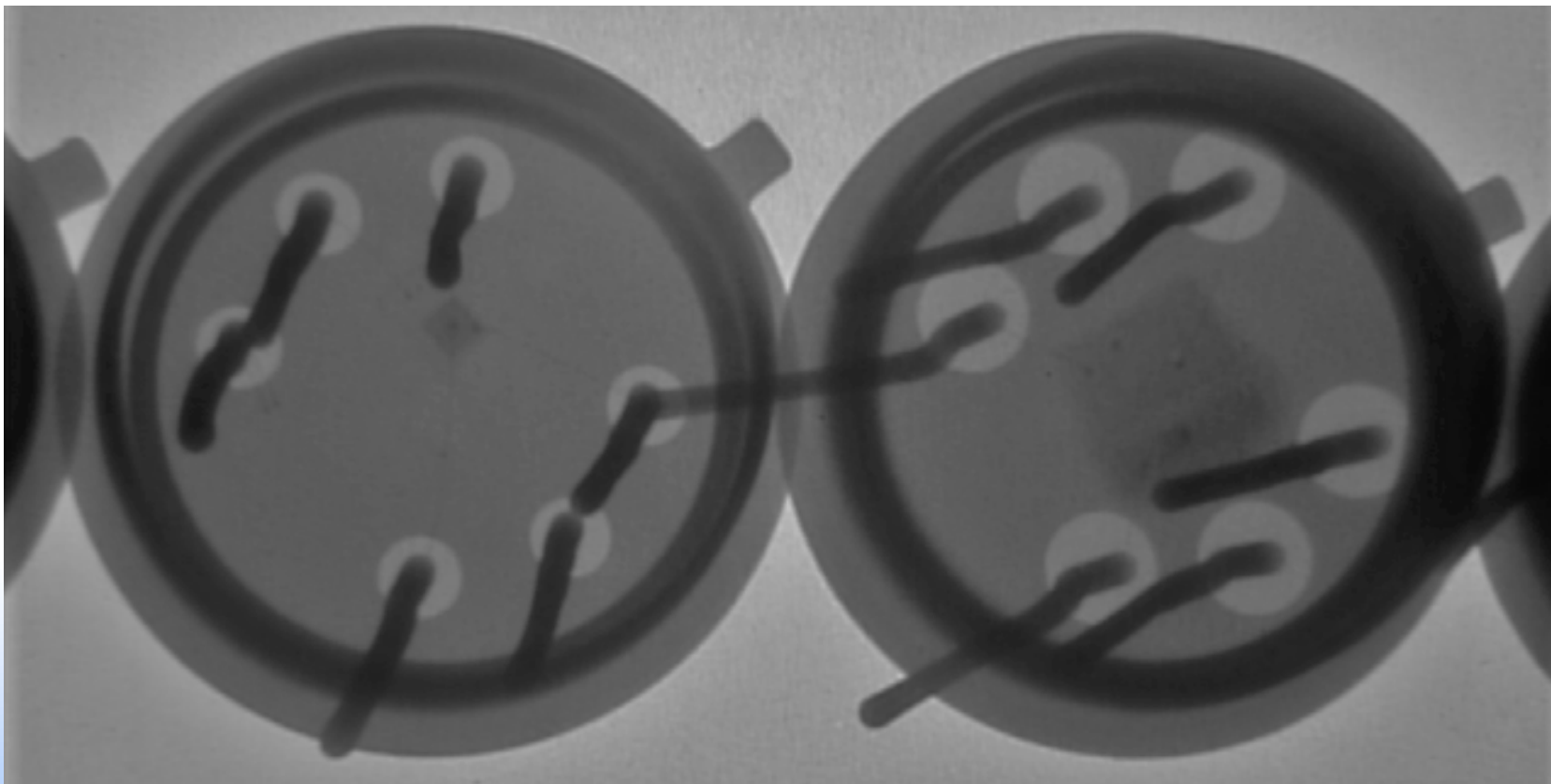
How do these Motorola 4N24A optocouplers look now?





Other package styles: TO cans

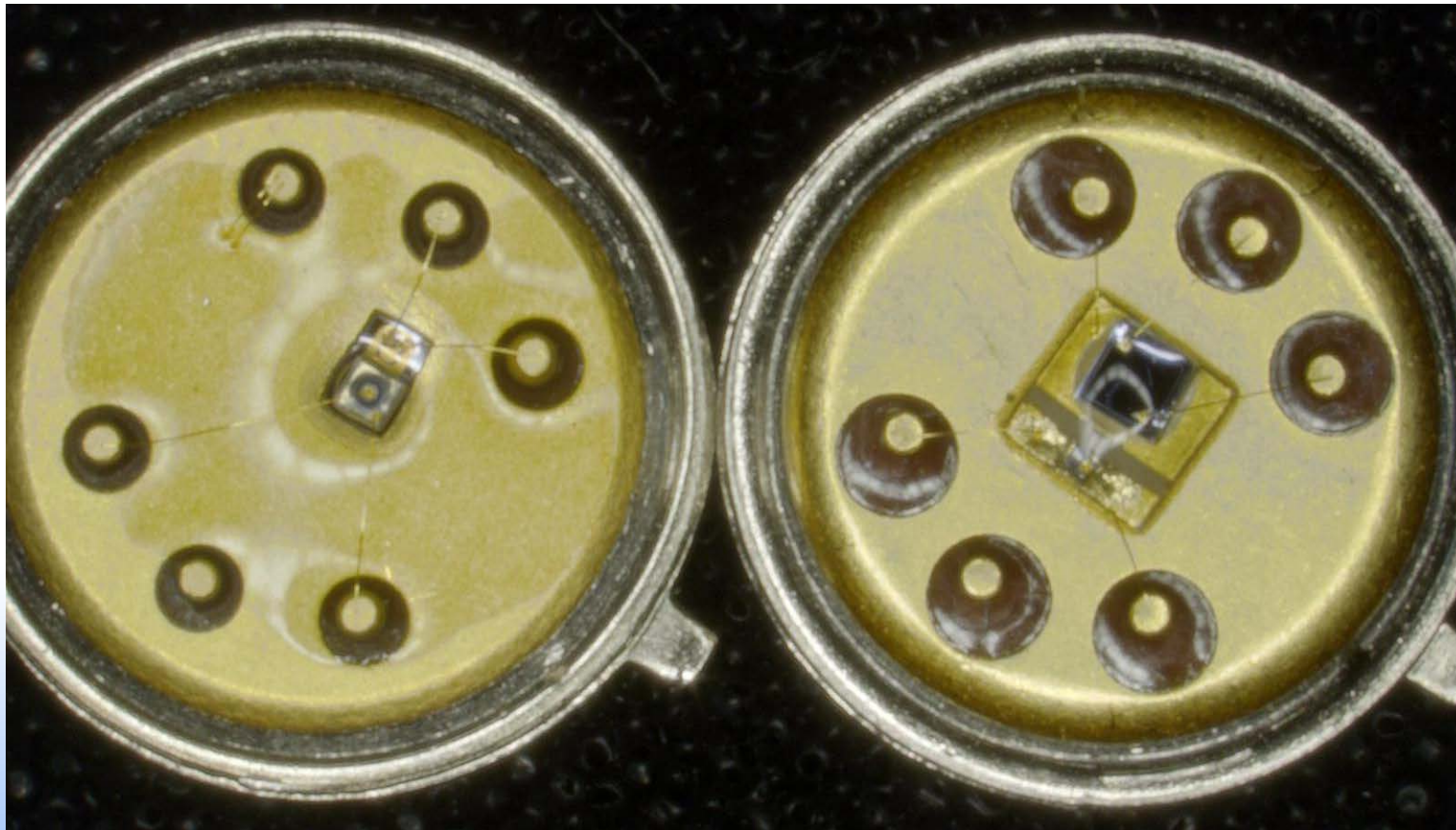
How do these Motorola 4N24A optocouplers look in x-ray?





Other package styles: TO cans

How do these Motorola 4N24A optocouplers look internally?

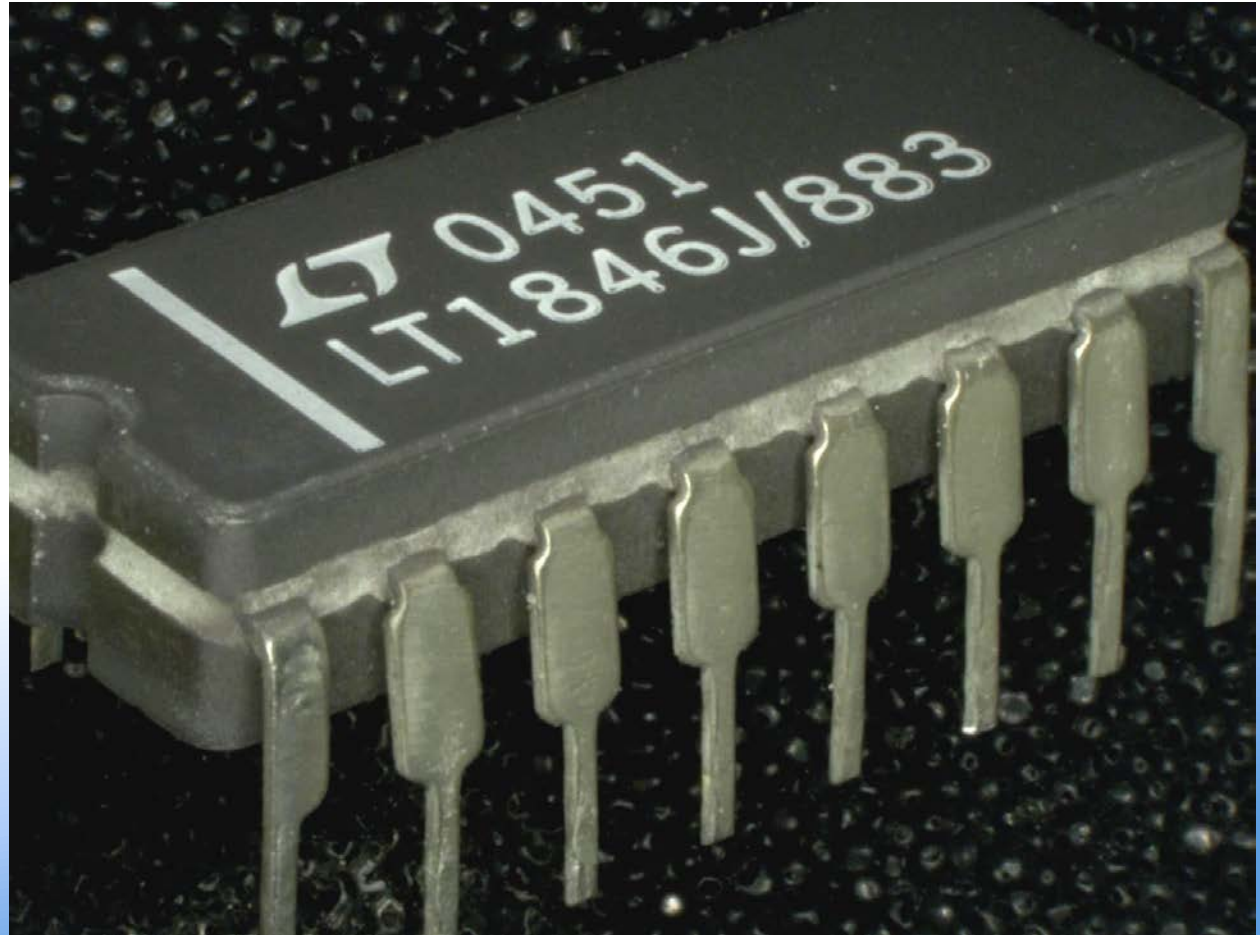




Other package styles: ceramic DIP

Ceramic dual in-line package

Linear Technology LT1846J/883
Switching controller, MIL-spec





Other package styles: ceramic DIP

Ceramic dual in-line package

Linear Technology LT1846J/883
Switching controller, MIL-spec

...with sanded (refurbished) leads





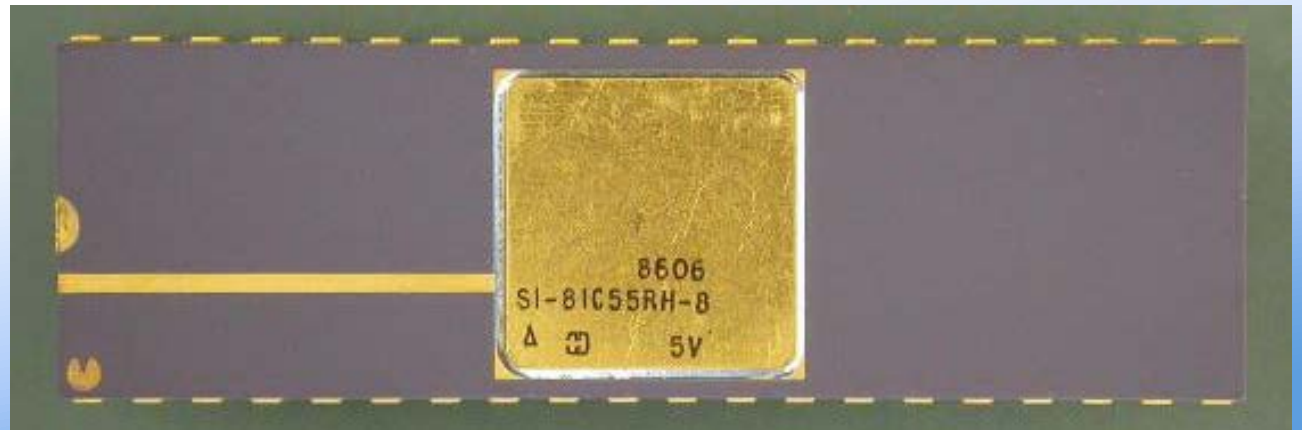
Other package styles: cermet DIP

Obsolete Harris integrated circuit,
ceramic package with metal lid,
HS1-81C55RH-8:

Unknown origin, D/C 9232A



Known good, D/C 8606

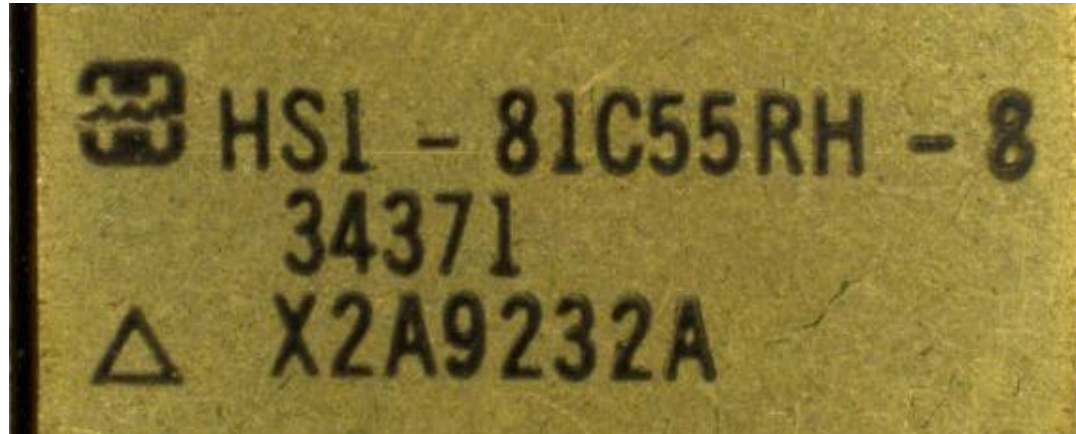




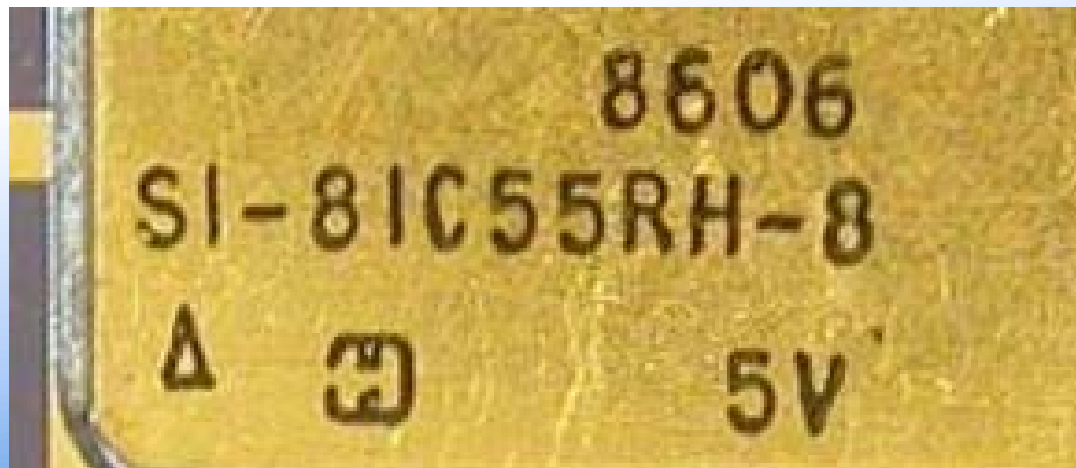
Other package styles: cermet DIP

Obsolete Harris integrated circuit,
ceramic package with metal lid,
HS1-81C55RH-8:

Unknown origin, D/C 9232A



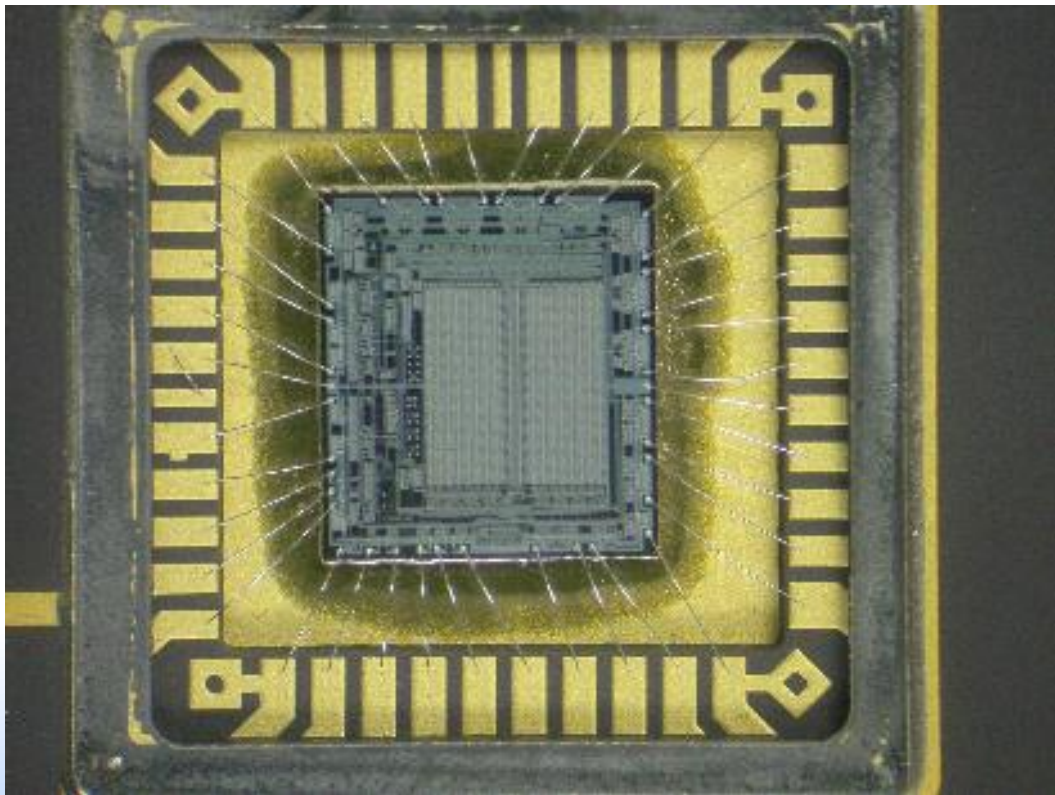
Known good, D/C 8606



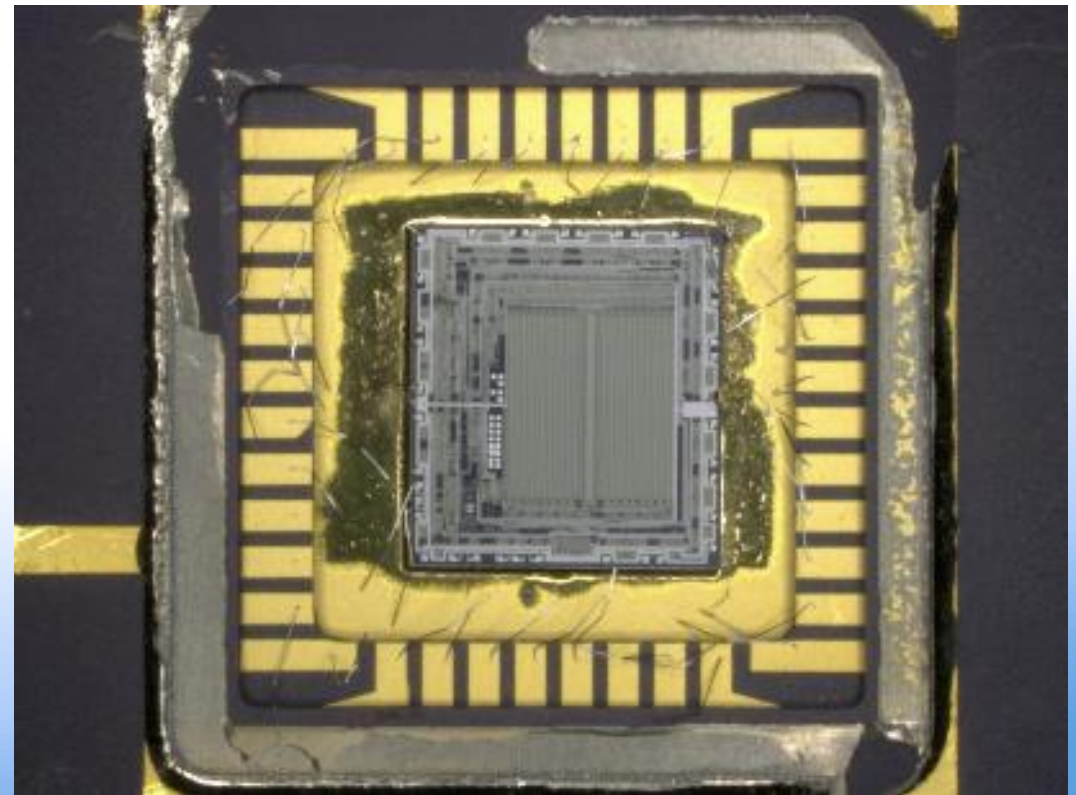


Other package styles: cermet DIP

Obsolete Harris integrated circuit, ceramic package with metal lid, HS1-81C55RH-8:



Unknown origin, D/C 9232A

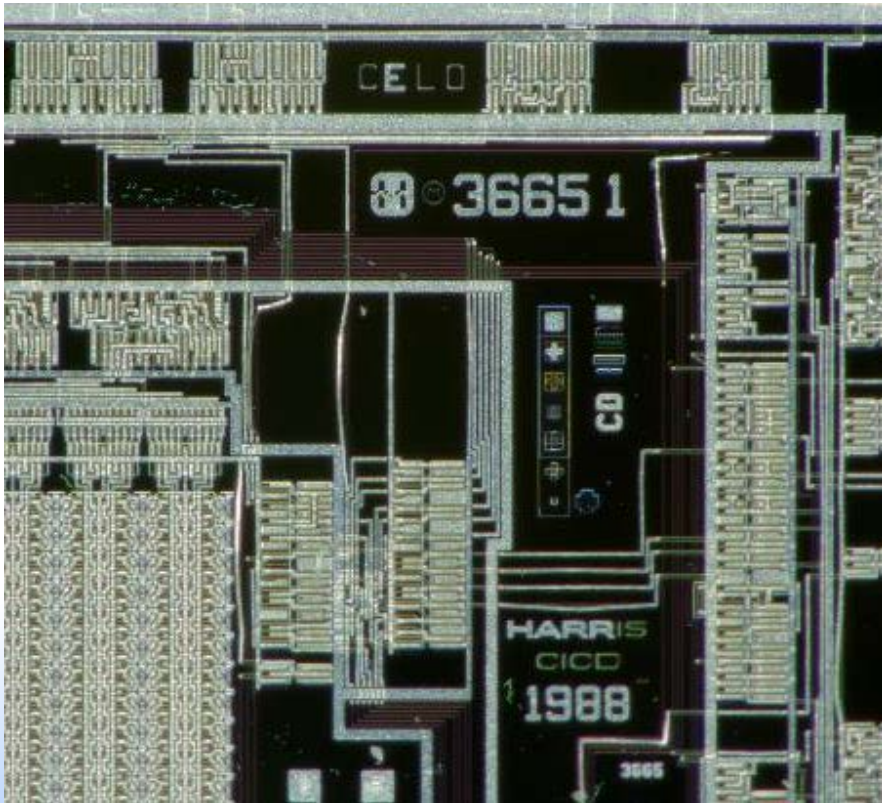


Known good, D/C 8606

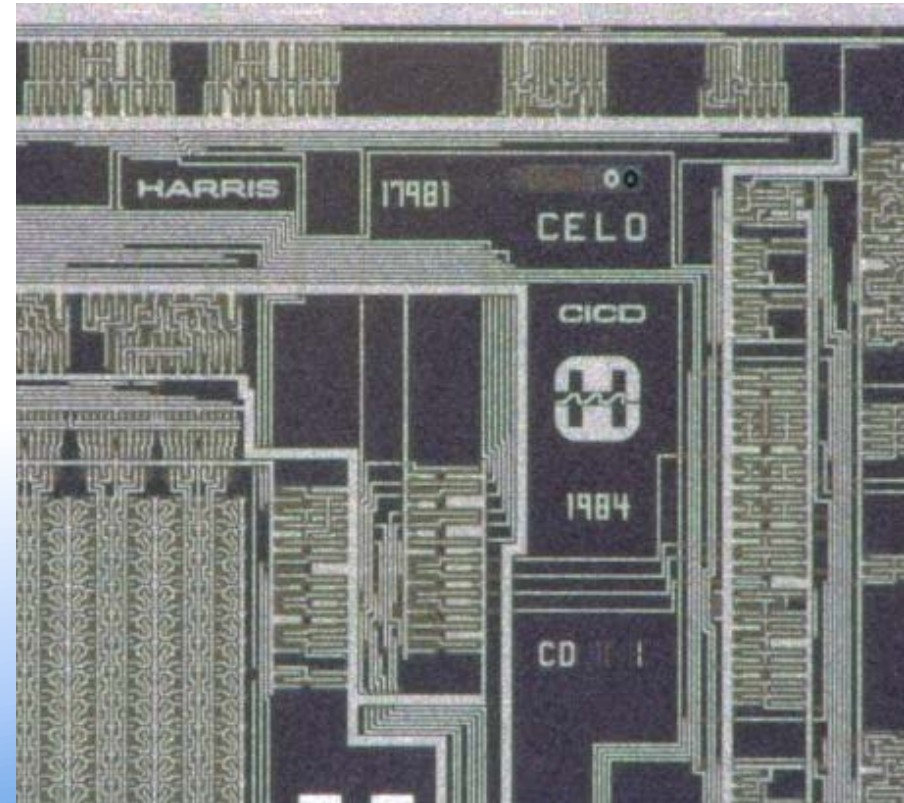


Other package styles: cermet DIP

Obsolete Harris integrated circuit, ceramic package with metal lid, HS1-81C55RH-8:



Unknown origin, D/C 9232A



Known good, D/C 8606



Other package styles: cermet DIP

Obsolete Harris integrated circuit,
ceramic package with metal lid,
5962R9570801QJC:

Unknown origin, D/C 9501A



Unknown origin, D/C 9844

Manufacturer was bought many
years ago, new owner says they no
longer have golden part or die mask
marking information

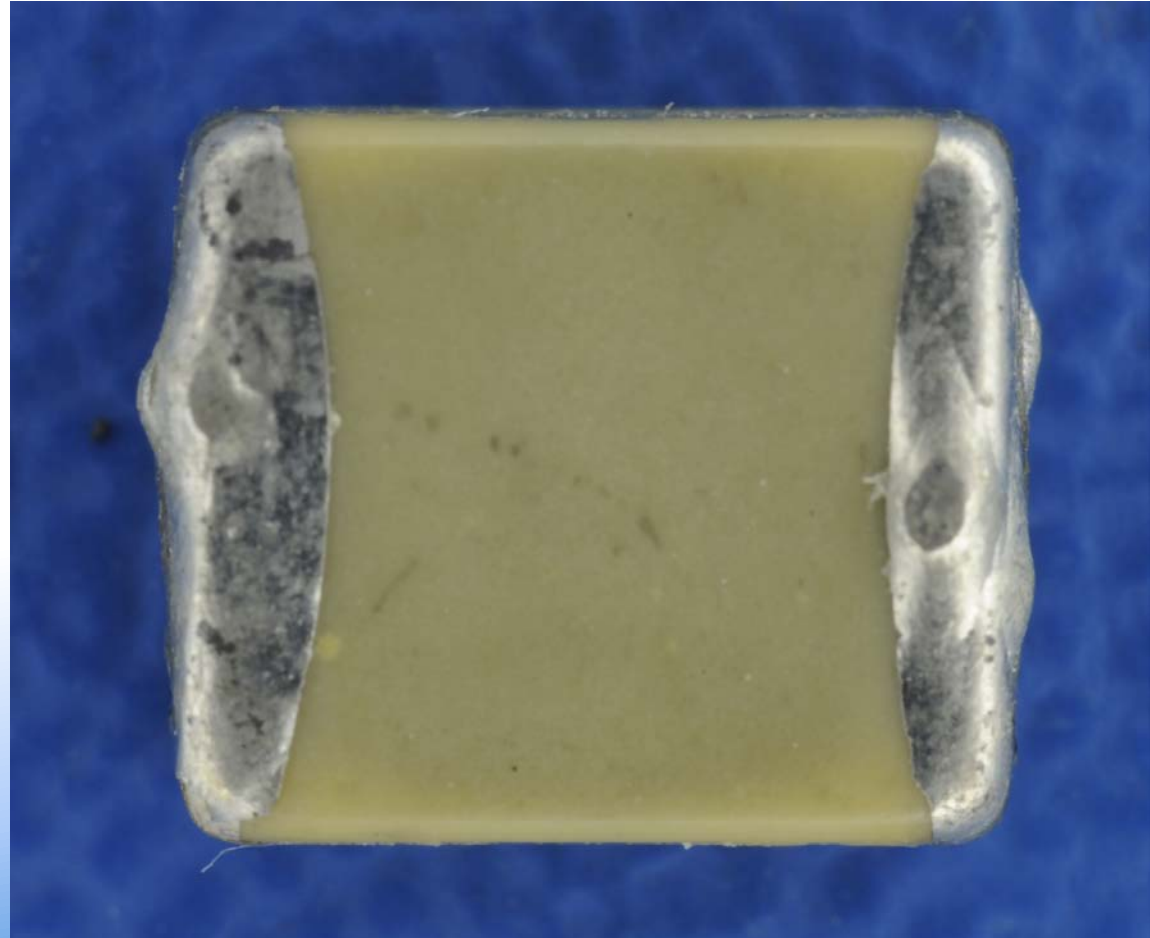




Other part and package styles: Passive parts—ceramic capacitors

TDK C5750Y5V1H226Z capacitor:

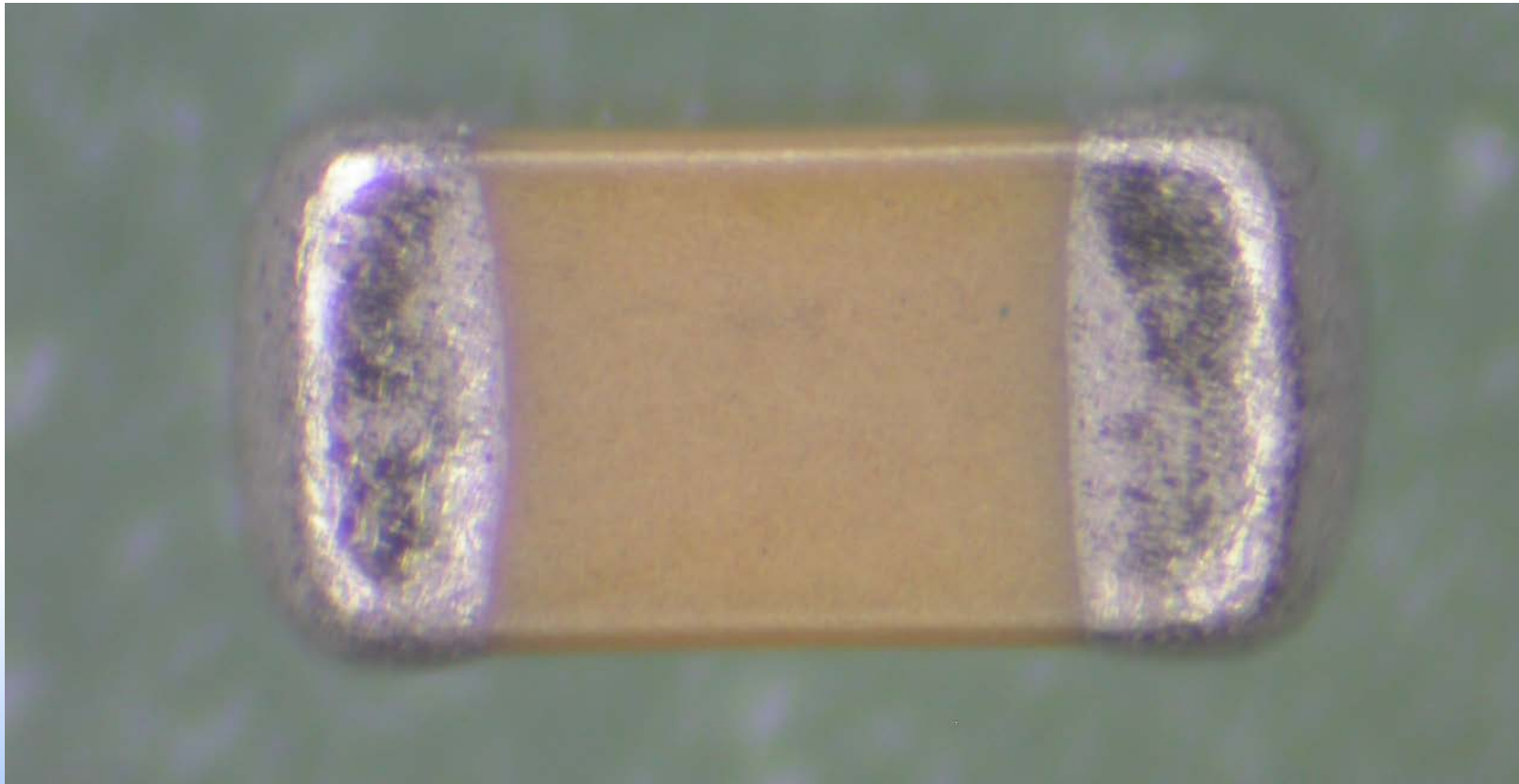
real or counterfeit?





Other part and package styles: Passive parts—ceramic capacitors

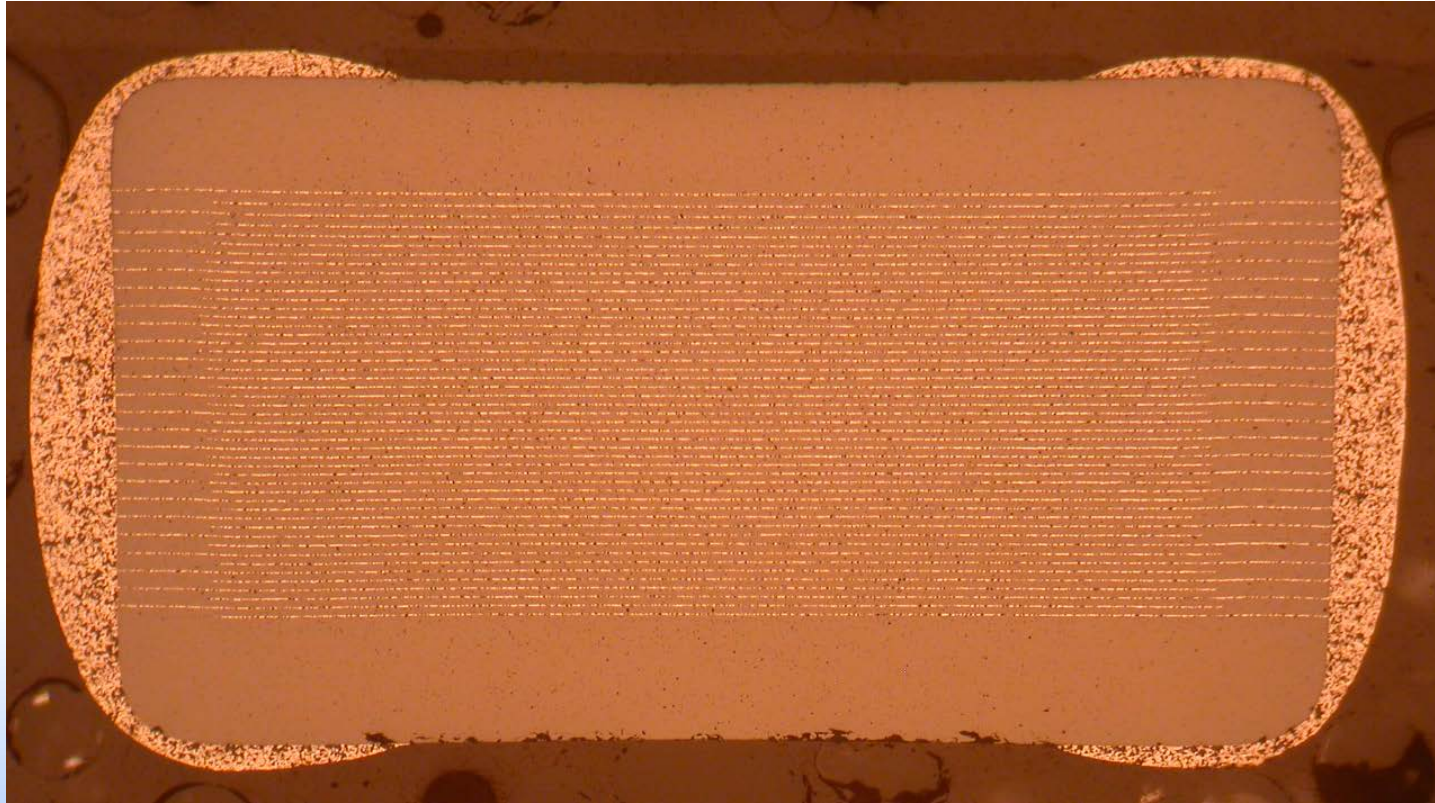
AVX capacitor: real or counterfeit?





Other part and package styles: Passive parts—ceramic capacitors

AVX capacitor: real or counterfeit?



A cross section may be the only way to know—*if* you have a known genuine part for comparison



Additional References

- SAE Aerospace Standard AS5553: Counterfeit Electronic Components; Avoidance, Detection, Mitigation, and Disposition
- SAE Aerospace Standard AS6174: Counterfeit Materiel; Assuring Acquisition of Authentic and Conforming Materiel
- <http://www.analog.com/en/other-products/sampletrack-and-hold-amplifiers/ad585/products/product.html>
- SMT Corp. – Miscellaneous charts and images on sample counterfeit parts
- IDEA-STD-1010-B: Acceptability of Electronic Components Distributed in the Open Market
- Pecht, Humphrey , “Addressing Obsolescence – The Upgrading Option,” IEEE Transactions on Components and Packaging Technologies, V31, No. 3, September 2008
- <http://counterfeitparts.wordpress.com>
- <http://www.acq.osd.mil/dpap/index.html>
- <http://www.integra-tech.com/>
- “Reliability Concerns for COTS Microelectronics in Space & Military Applications.” M. Sandor & S. Agarwal, EEE Parts Microelectronics Reliability and Qualification Workshop, 1998