What decap really brings to quality control

Presented by:

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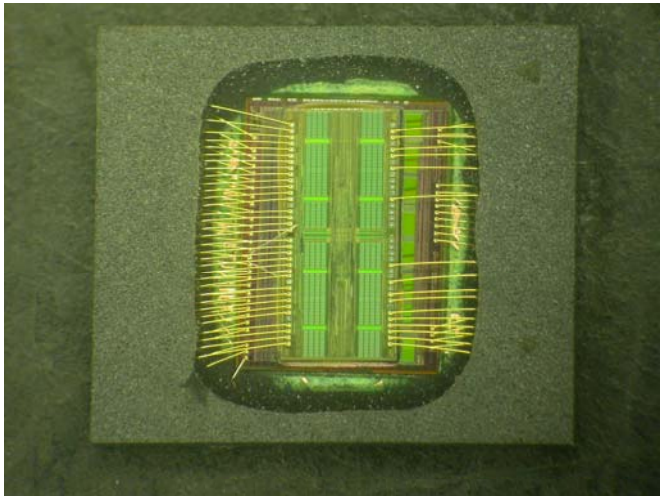
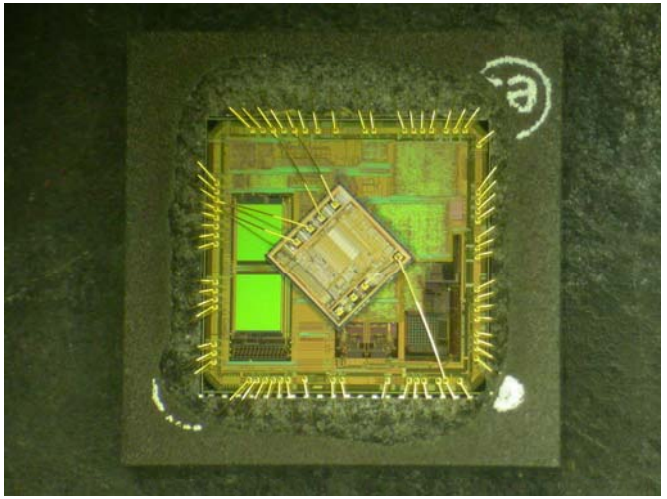
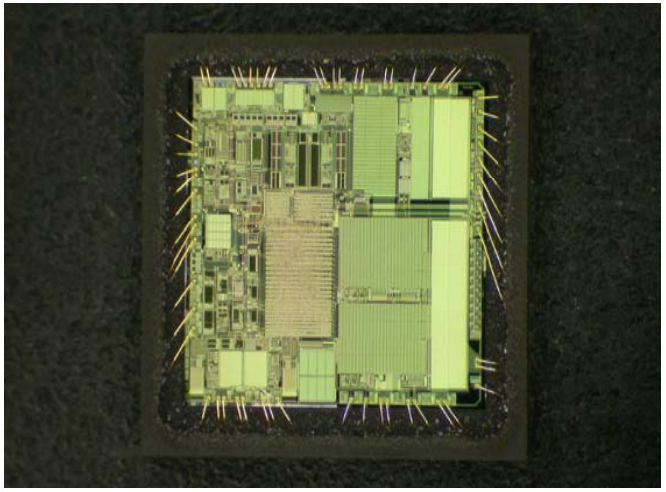
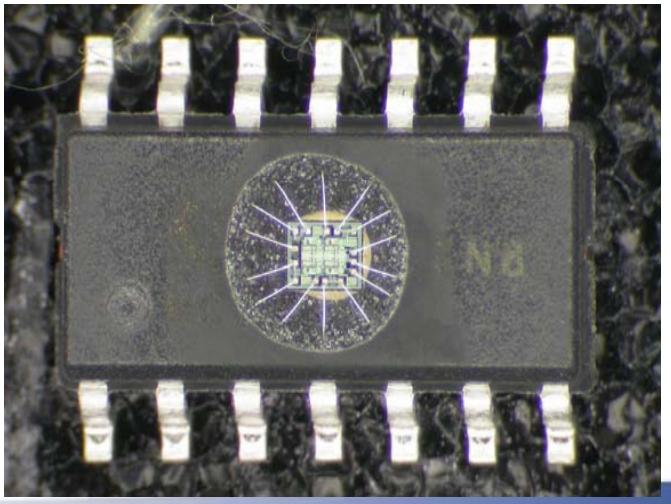


Sample Decap







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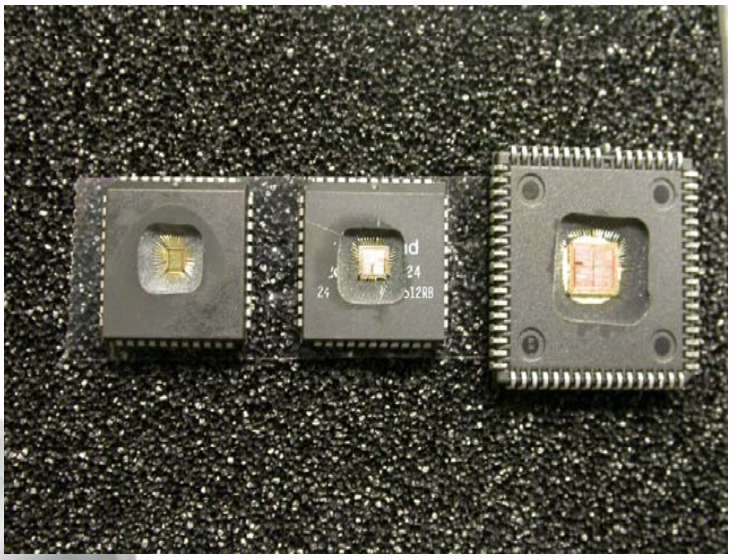
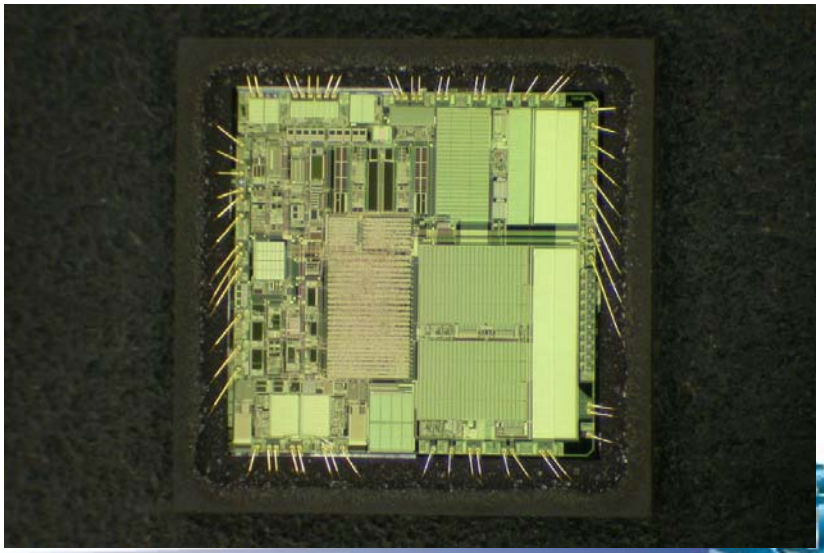
What does decap really do?

- Without inspection post decap…nothing!
- Decap itself doesn't authenticate a component
- So you have a decap system…what do you do next?





Industry Requirements Changing

- Decap is becoming required more and more
  - Industry used to be based on a “hand shake”
- In-house decap is becoming required more and more
- Paper trail of testing
- More certifications, manuals, qualifications are coming out
  - IDEA, CCAP, SAE, DoD…
- Accountability and punishment are becoming more common
- Government vendor lists are shrinking

Comparison of visual info available

- External markings test/inspection
- External lead conformance
- Surface swab test i.e. black topping

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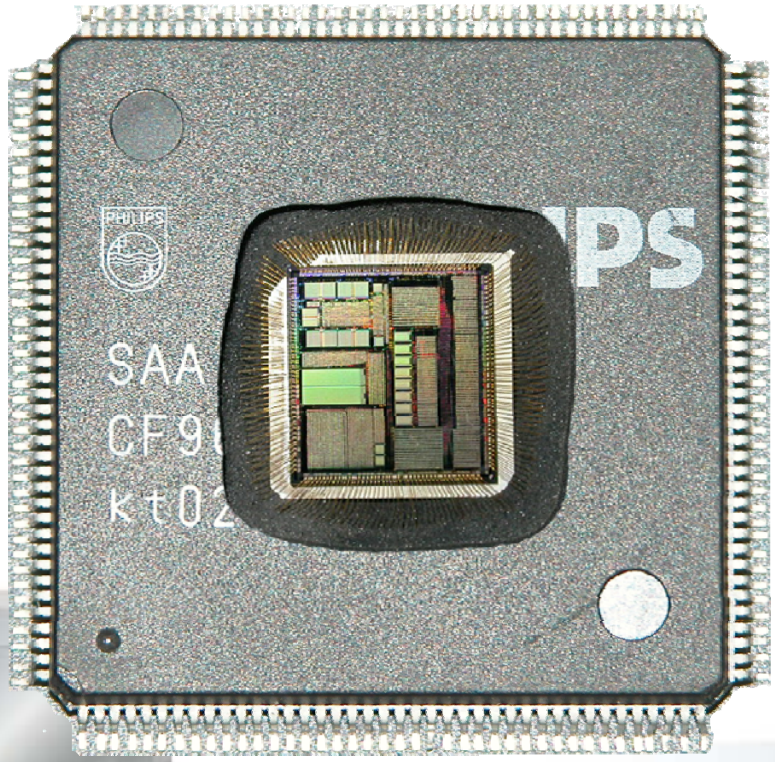
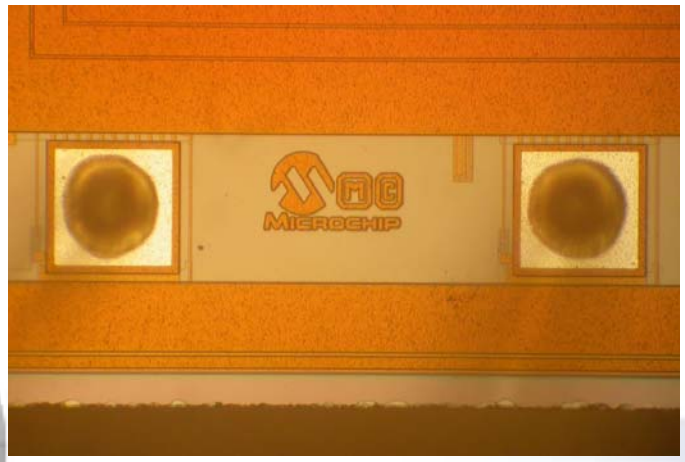
Comparison of visual info available



- OCM markings
- OCM logo
- Die presence
- Die size
- Bond wire integrity
- Bond pad integrity
- Double ball bond inspection
- Manufacturing defects
- Field failures
- Handling mistakes

OCM Markings

- Most prized info at die level is OCM markings
  - Sometimes TOO prized
- Not always present
- Sometimes only OCM logo and no component number
- Match with external markings doesn't guarantee it an authentic or conforming component
- OCM markings can create "tunnel vision"



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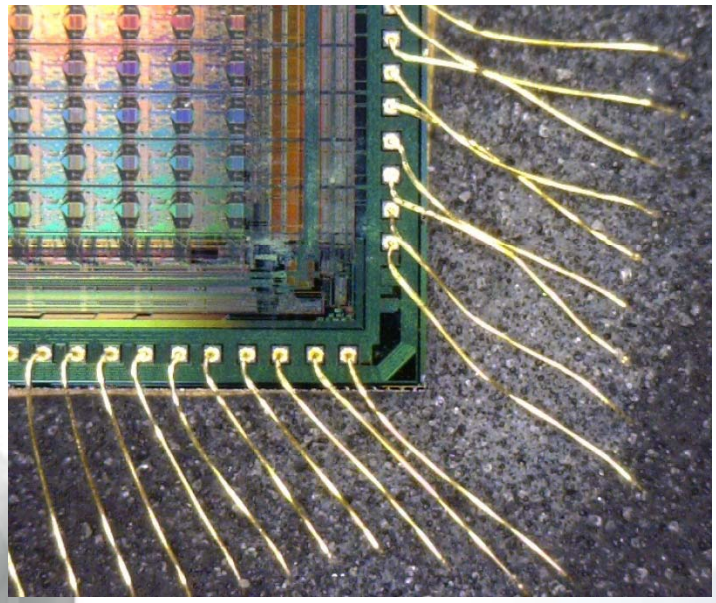
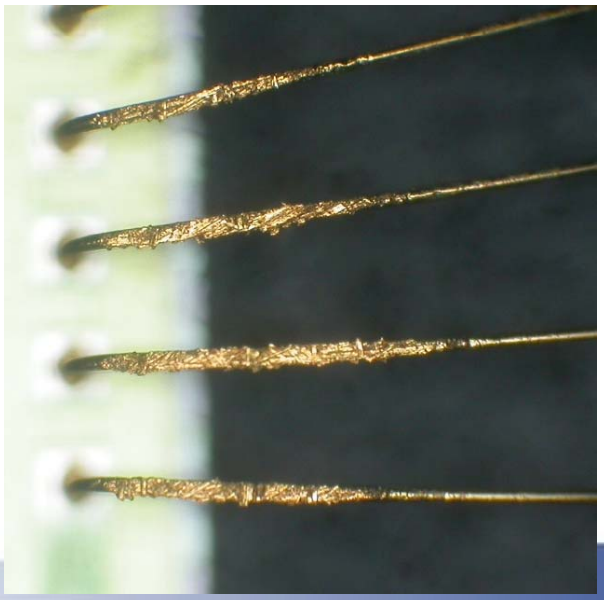
Poor handling

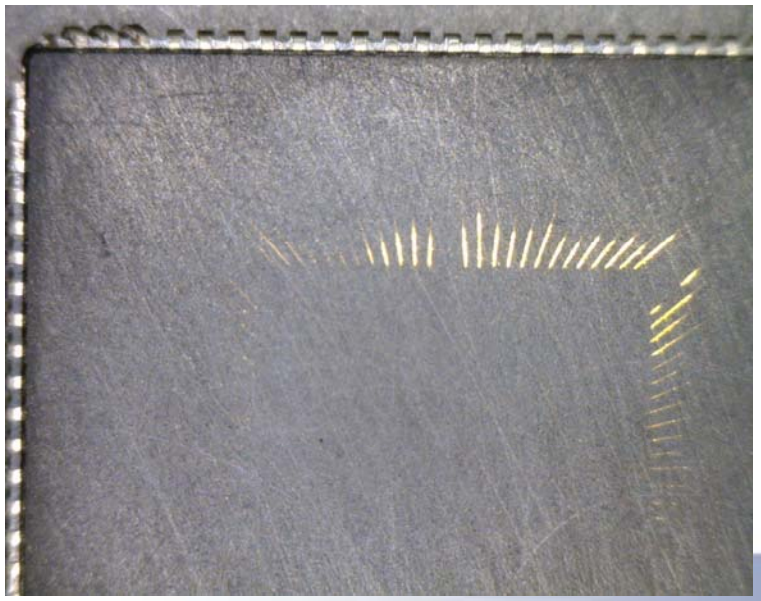
- Internal components are very delicate and easily damaged
- Counterfeiters cover over mistakes and bank on poor quality control





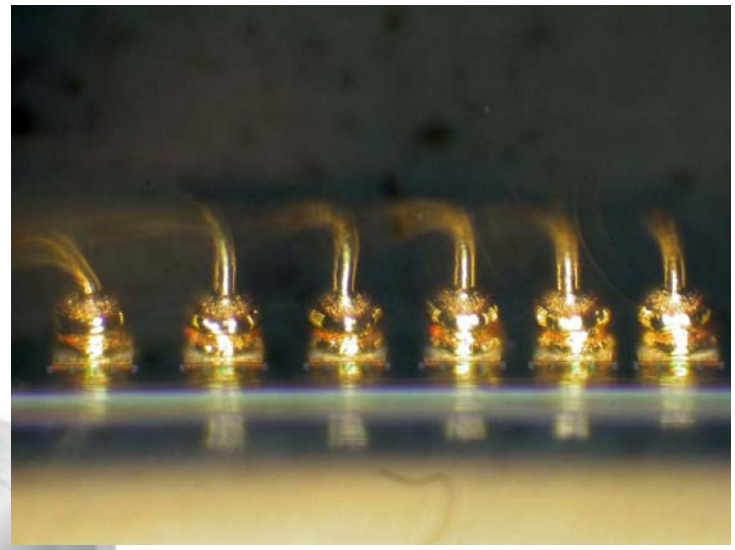
Poor handling

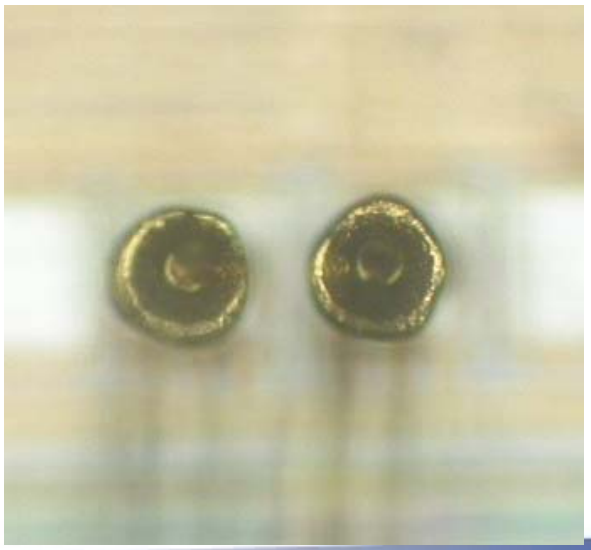
- Result of oversanding (and damage to bond wires)
- This mistake would be covered over during black topping



Double bonds?

- Double bonds are perfect example of proper inspection
- Bad inspection passes counterfeit component
- Good inspection spots this counterfeits Achilles heal





What does the equipment look like?

- Functions off nitric and sulfuric acid.
- Heats chemicals to desired temp which then etch plastic mold away.
- Requires chemical grade fume hood for safety.
- Doesn't attack die surface, unless exotic package is used.
- Purges waste into separate bottle for storage until disposal.
- Alternate methods include laser and plasma etching with require more cost and either cannot completely decap or require great lengths of time for decap.

Sample Comparison

- In a perfect world a golden sample or data sheet is available
- “Goldens” or “data sheets” aren’t required
- Many up-coming standards hinge on comparison of sample inconsistencies
- Precision manufacturing means highly consistence test results
- Document ALL minor details for comparison
- Die markings are important but much more info is available
- Die size can be common but die design are very different

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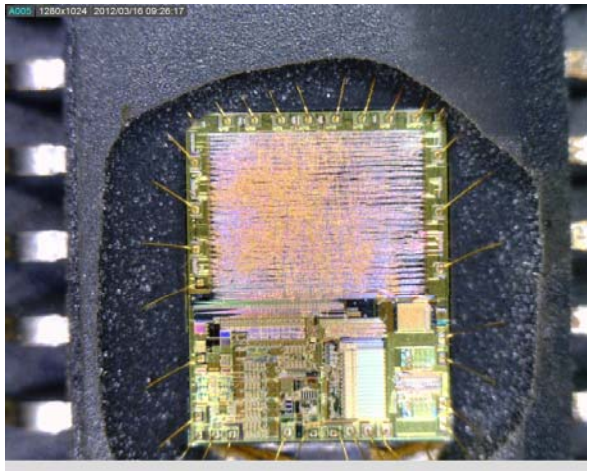

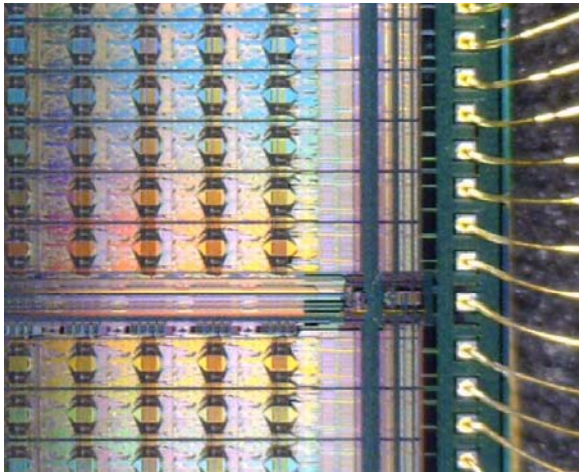

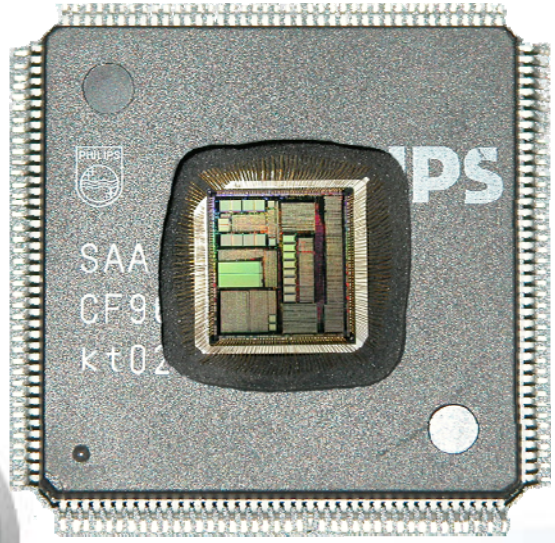

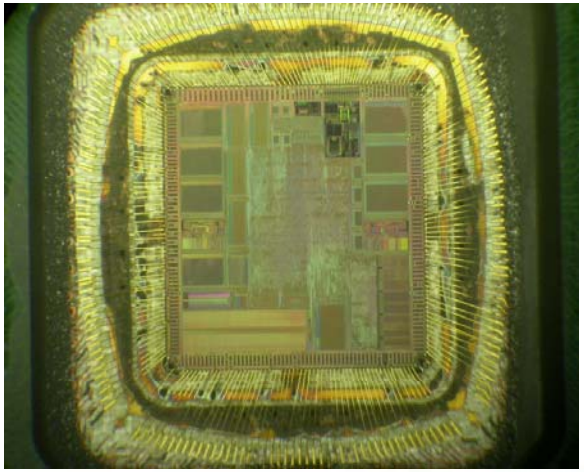

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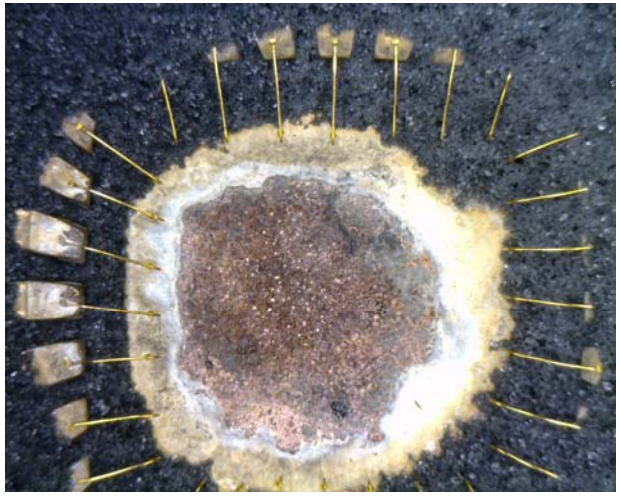
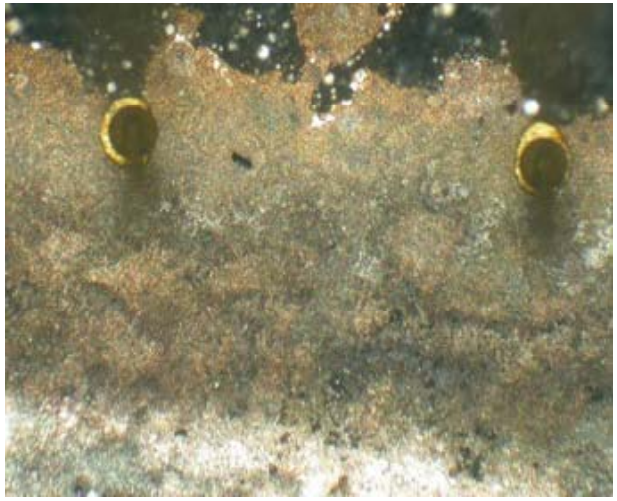
Test Samples



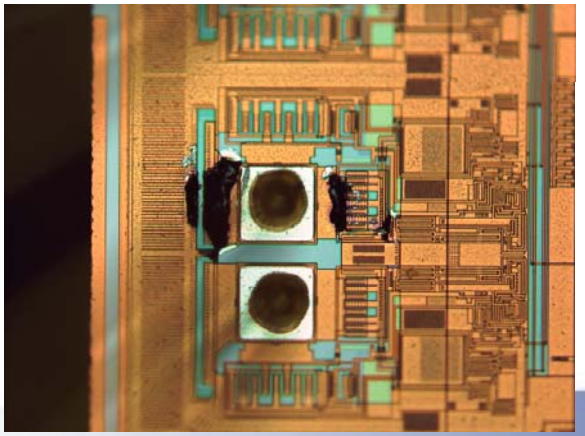
- **"Dummy" sample**
- **Could pass x-ray**
- **Had OEM markings on exterior**



- **Wires were bonded to die pad**
- **Complete process minus wafer**
- **Will pass all external visual inspection**

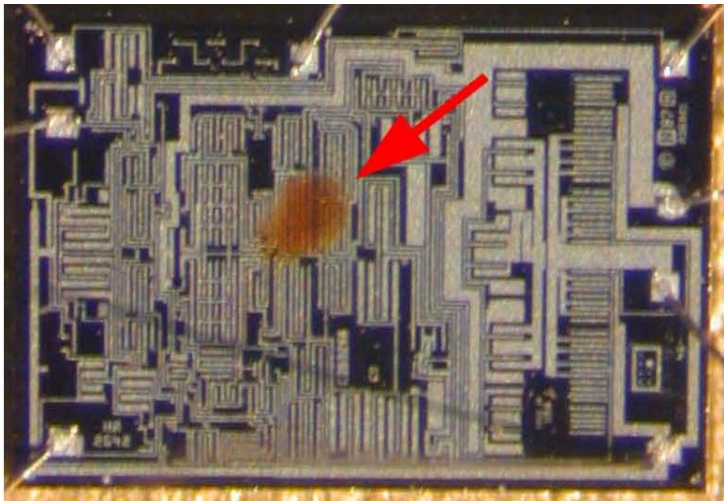
Field Failures

- Many field failures can be inspected for and documented using metallurgical microscopy
- Field failures mean a component has been used in the field and is no longer useable
- Component may still function
- Component is counterfeit if sold as new, many times no modification to the component is made
- Field failures can be used to fill
- remaining quantity or order or
- supply entire order
- Example of ESD failure



OCM rejects

- OCM's frequently reject non-conforming components for many reasons
  - Manufacturing error, design error, incomplete build etc.
- These components are supposed to be destroyed but many make it into supply chain
- OCM rejects are particularly dangerous because they *will* pass inspection since many have an error that is **very** difficult to inspect for
- OCM rejects receive a mark of some kind to denote failure
- This rejects are used to inspect for a fix to the design flaw



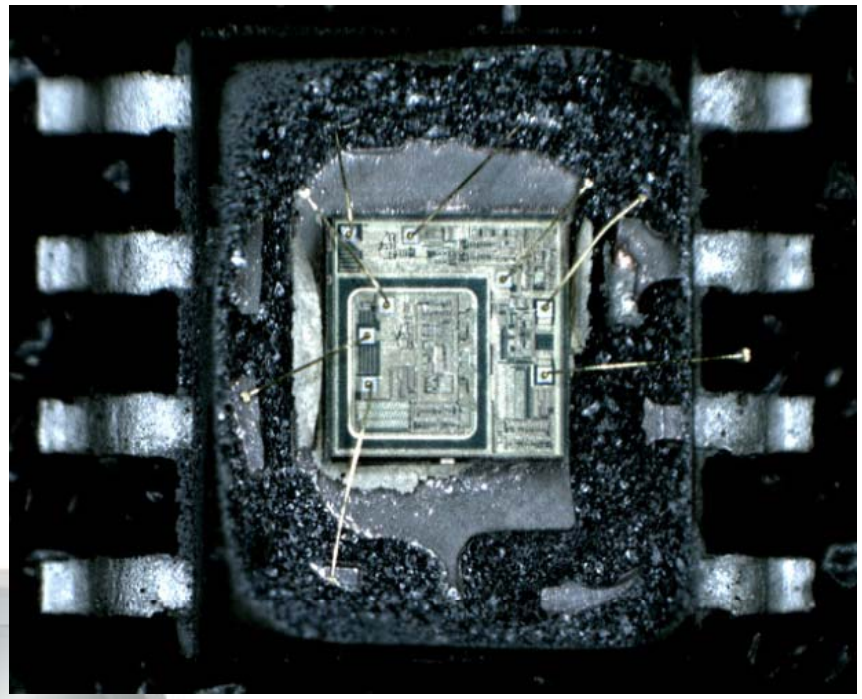
What should your inspection process look like?

- Easy to follow checklist
- Set aspects to document
  - Markings
  - Bond wires
  - Die/dice size
  - Etc.
- Reason of any red flag(s)
  - Didn’t match other decapped components
  - Non conforming
  - Etc.
- Track record of employee that documented findings

What should your inspection process look like?

- Single employee inspecting sample batch, not multiple employee's inspecting multiple components
- Explanation of results
  - "Bond wires conform to all components within sample batch."
  - "Uniform die size amongst all samples."
- If internally testing – Definitive answer of pass or fail
  - Remember, IC's are precision manufactured. Results should display this precision
- If testing for another company – decision if you will validate components
  - Keep legal matters in mind with this

How bad decap can effect results



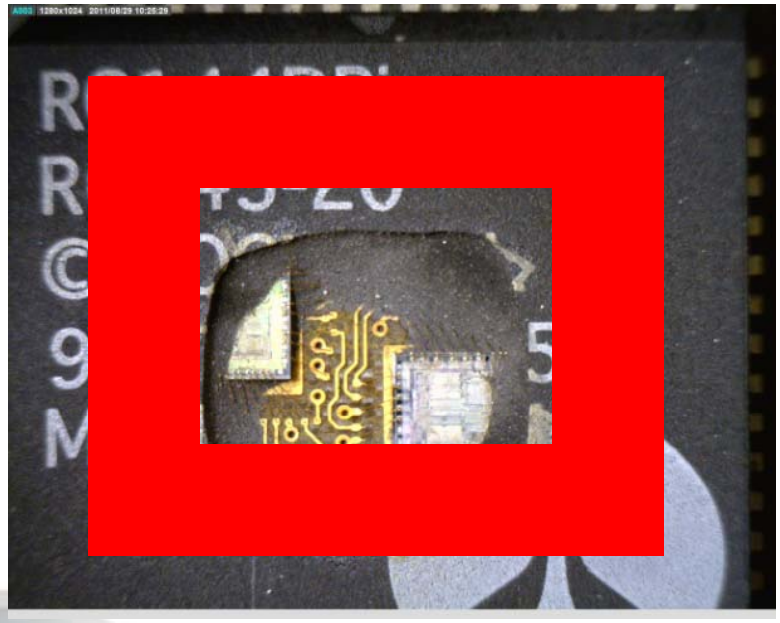
Problems

- Wire bond detachment
- Over exposure to chemicals
- Die detachment

Info Lost

- Damage caused by decap or counterfeiter?
- Comparative details
- Electrical functionality

How bad decap can effect results



Problems

- Red box indicates incomplete decap opening
- Only partial corners of dice exposed

Info Lost

- OCM markings
- Internal structural integrity
- Comparative details
- Who knows what else

How bad decap can effect results

- Incorrect decap can electrically fail a device after decap
  - No further electrical tests can be run after decap which blocks potentially critical information
- Damage during decap can lead to incorrectly failing a good device
- Damaged component during decap leaves door open for your findings to be questioned
- 4 keys to correctly decap
  1. Open all corners of die/dice present
  2. Don't over etch
  3. Leave bond wires intact
  4. Expose enough bond wire to thoroughly inspect
- Follow these 4 guidelines and you will have a component perfect for inspection

Some quick numbers

- 1 Bottle of nitric acid costs about $200 (*when supply is normal*)
- Standard bottle contains 500ml
- Typical decap uses 3-4ml of acid

Onsite Testing

- 500 divided by 5 = 100 decap's
- $200 divided by 100 = $2/decap

Lab Testing

- 100 decaps X $100 = $10,000!!

What about copper?

- Currently 90% of ICs are made using gold
- Gold prices have jumped 200% over the last couple years
- Copper is the most favorable replacement
- Copper is cheaper in cost, more efficient, and more plentiful
- By 2013 up to 70% of the market could be made up of copper bonded components
- With this change more and more independent distributors will see copper bonded components in their stock

How this change affects you

- More of your stock will start becoming copper
- Copper components are much more tedious to test
- Decapsulation must be reworked to be done properly
- Without prior knowledge of the internal components you must open a part to first see what it is
- Testing can take a lot longer per part when compared to a gold bonded component.
- Test houses do charge more for copper component testing

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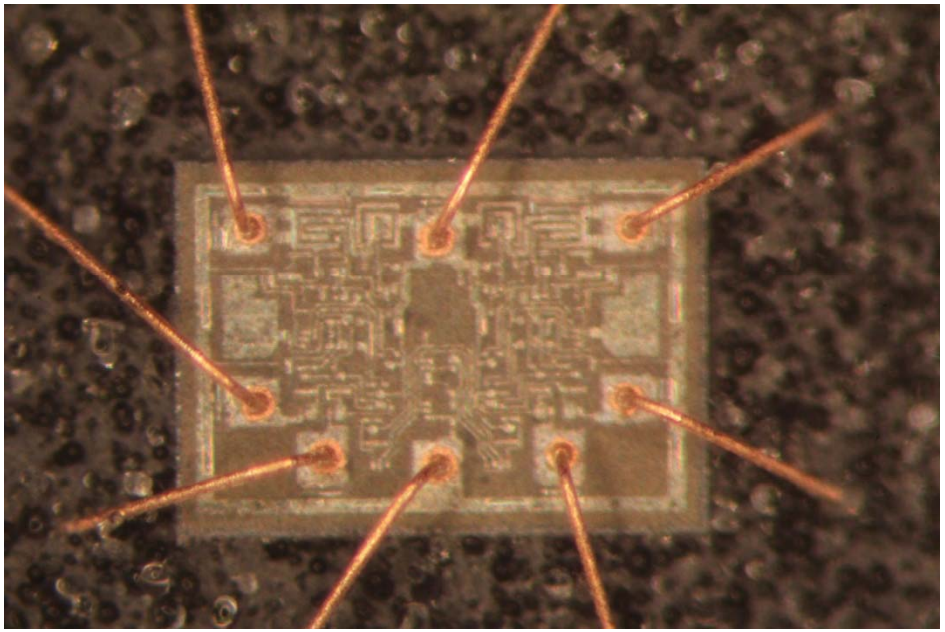
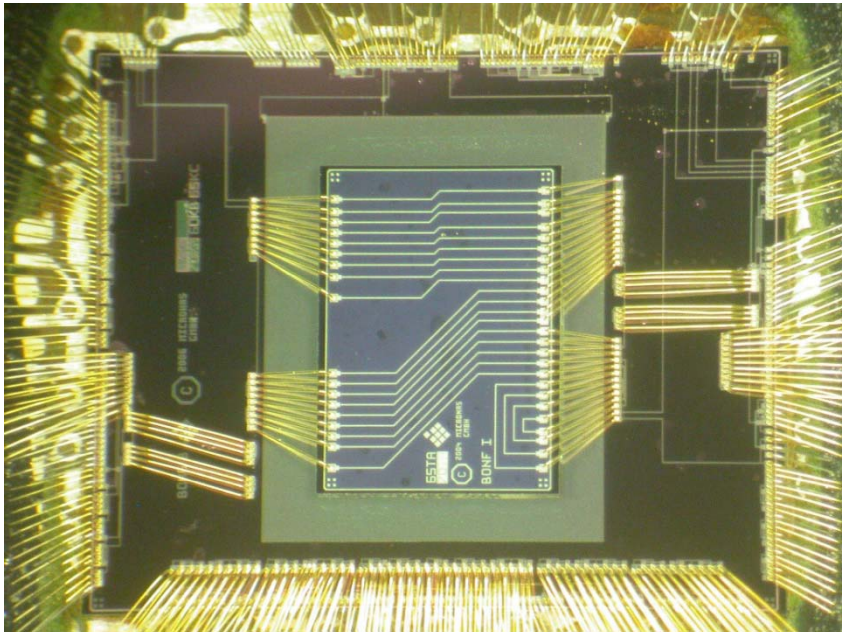
Can you see the difference?





How do you know if it's copper?

- As with other components, unless prior knowledge of the component is in hand you will have to open a part and inspect
- Other metals used in components don't react with nitric and sulfuric as harshly as copper
  - Copper wiring will not look as "clean" after decap
- If no wires are present that could be a clue
- General rule – start with nitric acid on all decap since it is a less aggressive chemical

How the industry is changing

- Counterfeiters attend same counterfeit conferences everyone else does.
  - They are learning how to beat our testing methods…and getting better and better all the time.
- Outside of die harvesting, counterfeiters are not counterfeiting at the die level.
  - This makes decapsulation a cornerstone test for authentication.
- More and more companies are educating themselves on testing and decap inspection.
- A large percentage of companies performing in-house testing are using it as a marketing ploy.
  - Majority of industry will only actively test if they stand to profit.

How the industry is changing

- New, more advanced technology in integrated circuits makes decap very difficult
  - Copper bonded, GaAs, Indian Phosphide, thermal heated plastic are just a few
- Industry is accepting trend of change towards being more responsible
  - SAE standards, more companies purchasing testing equipment.
- Overall industry must be one of evolving growth.
  - No one standard will provide a solution.

Questions?
Comments?