Overview of De-cap for ERAI Conference 2012

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Incoming Insp, Optical Microscopy, Cross-Sectioning, Decapsulation, RIE, Wire Pull, Die Shear, Seal, PIND, Wet Chemical Deprocessing, SEM

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(Shared Resource)
Doc Control Administrator

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Decapsulation(De-cap)

Overview

1) Explain why de-cap has become an integral part of a counterfeit avoidance inspection process
2) Provide evidence of de-cap being used to identify suspect counterfeit parts
3) Discuss challenges associated with die verification
4) Offer guidance relative to what to do when die markings cannot be compared to the manufacturer's datasheet
5) Outline the significance or insignificance of having a "golden sample " for comparative purposes
6) Explain when and if de-cap can or cannot accurately conclude if a part is or is not counterfeit
7) Explain when OCM verification is required
8) Offer guidance relative to determining the minimum lot size to be tested
9) Offer guidance relative to selecting samples for test from a large lot
10) Provide guidance that will assist attendees in the avoidance of "false positive " or "false negative" interpretations

Decapsulation(De-cap)

Definition

- Decapsulation is the process utilized to expose or access the internal die within a device package for subsequent inspection and various testing.

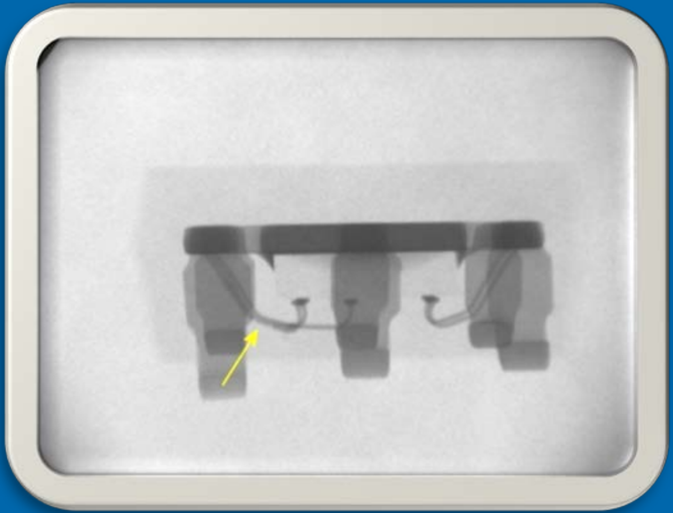
- Decapsulation is typically referred to via slang De-cap, hereafter DRTL will refer to as De-cap.

De-cap Techniques

- Mechanical
- Chemical
- Plasma
- Laser
- Combinations

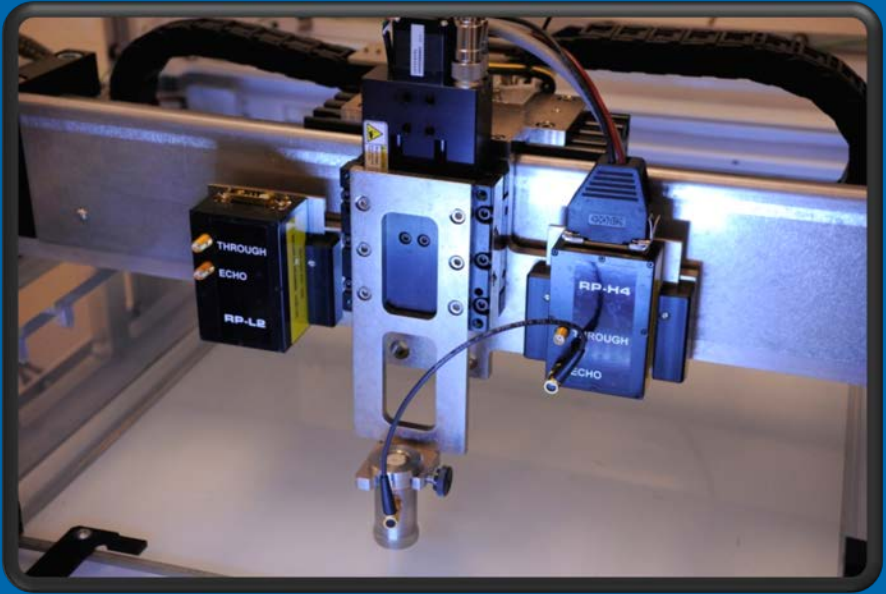
X-ray to Facilitate De-Cap

- Real time x-ray system
- Three axis x-ray images recorded
- Package Examples
    - Transistor Outline (TO)
    - Ceramic Devices (Metal Lid?)
    - Plastic Parts
    - Resistors
    - Capacitors
    - Transformers
    - Filters
    - Etc.



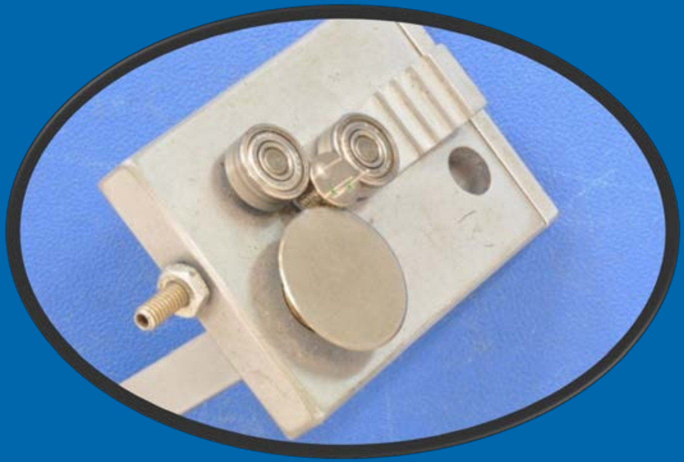
CSAM to Facilitate De-Cap

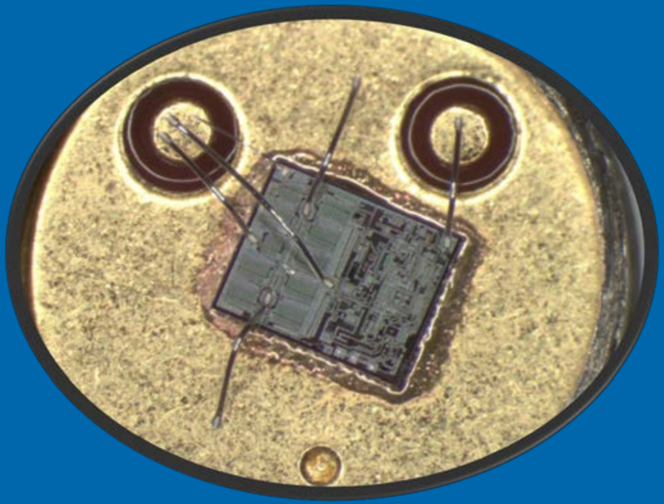
- Scanning Acoustic Microscopy (CSAM)
- Transmitted or Reflected?
- Package Examples
    - Plastic Parts
    - Resistors
    - Capacitors
    - Transformers
    - Filters
    - Etc.



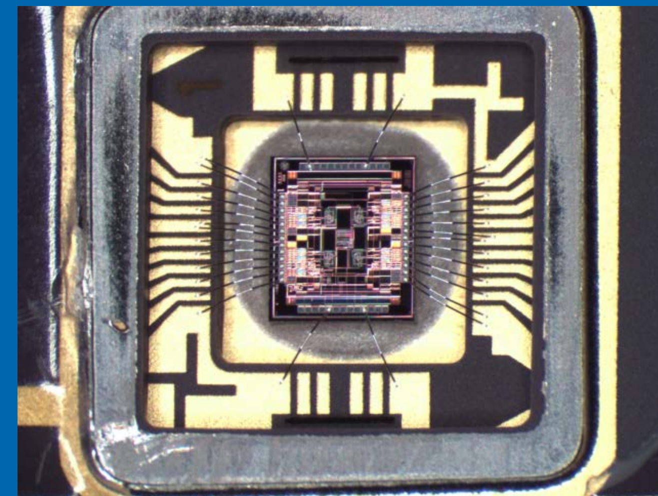
Mechanical De-Cap

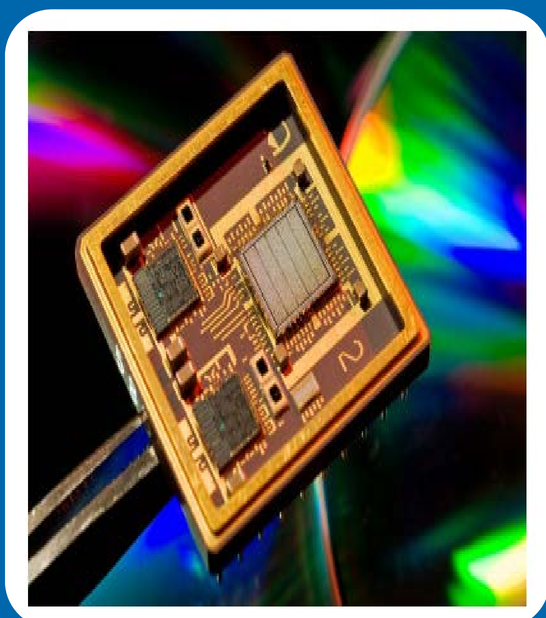
- Delidding and/or decapping are examples of mechanical de-cap
- Transistor outline (TO) package requires the lid removal via cutting of metal lid or weld

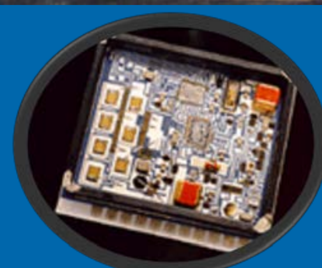




Mechanical De-Cap







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Chemical De-Cap

- The two methods of chemical decap are manual and auto-decap. Manual decap means adding acid to a beaker on hotplate and dipping devices to dissolve the plastic. Special decap equipment can virtually eliminate the need for the beaker and hotplate. Auto-decap is safer and quicker than manual decap, and minimizes the use of acids, an advantage in terms of cost and environmental factors.
- DRTL utilizes a auto-decap as the preferred method. The software-driven a Nisene JetEtch II system that can automatically control which acids to use, the proper volume, and the necessary dwell time to remove the encapsulant. After a procedure has been established for a particular package type, it can be saved for future use. This equipment ensures accuracy and repeatability of decap.

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Chemical De-Cap

- Plastic Parts
- Resistors
- Capacitors
- Transformers
- Filters
- Etc.

Chemical De-Cap

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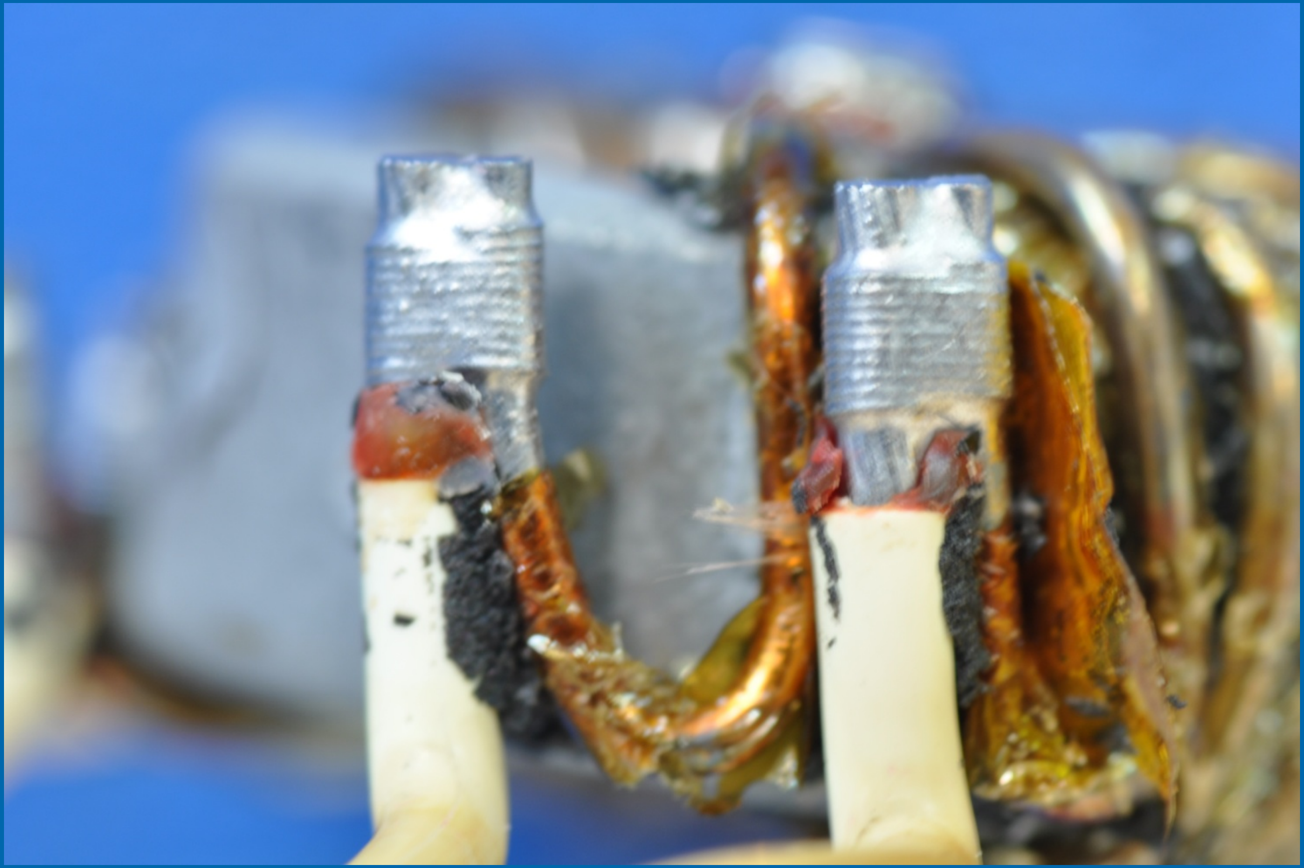
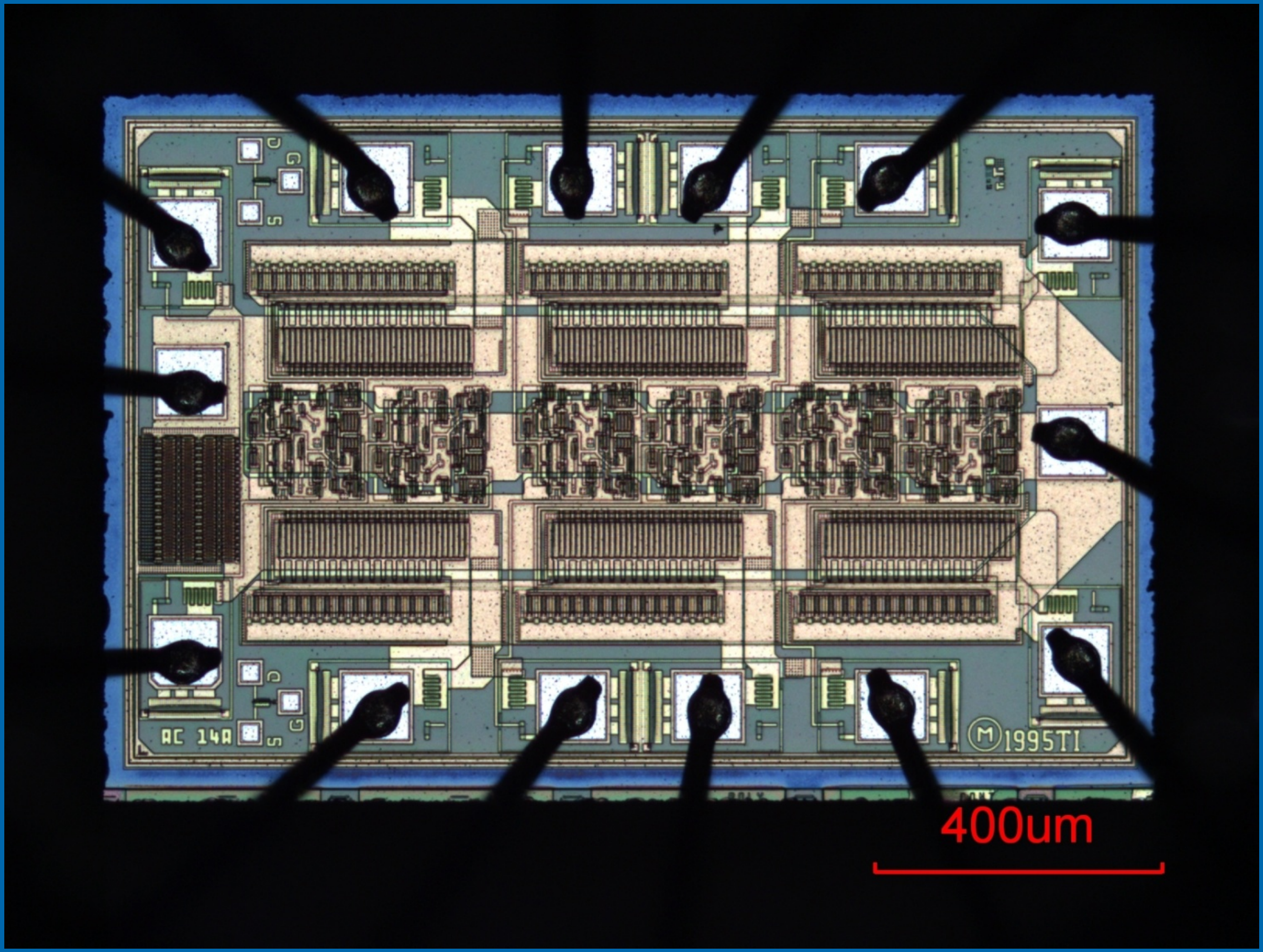
Chemical De-Cap

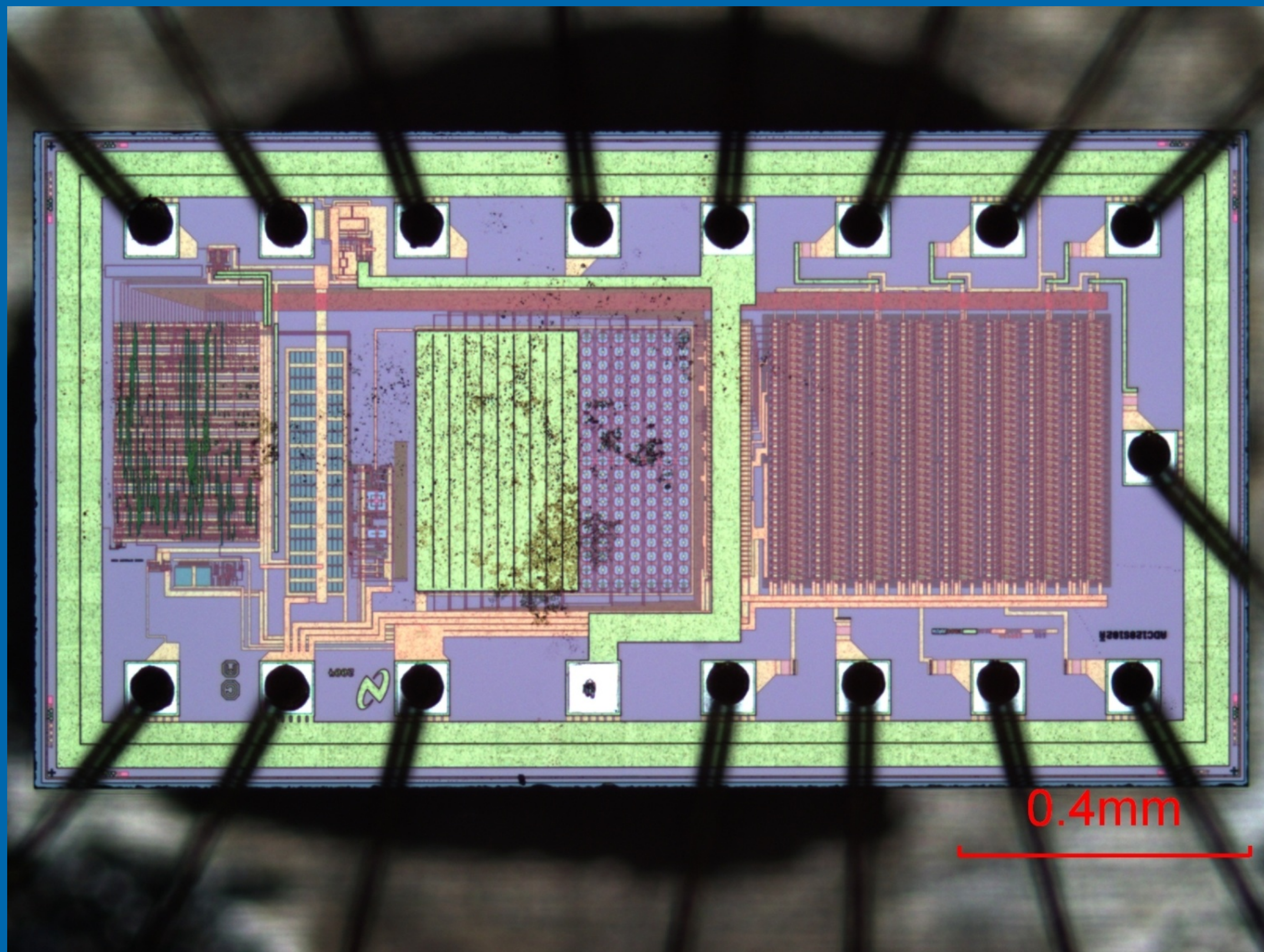
Chemical De-Cap



Chemical De-Cap



Chemical De-Cap



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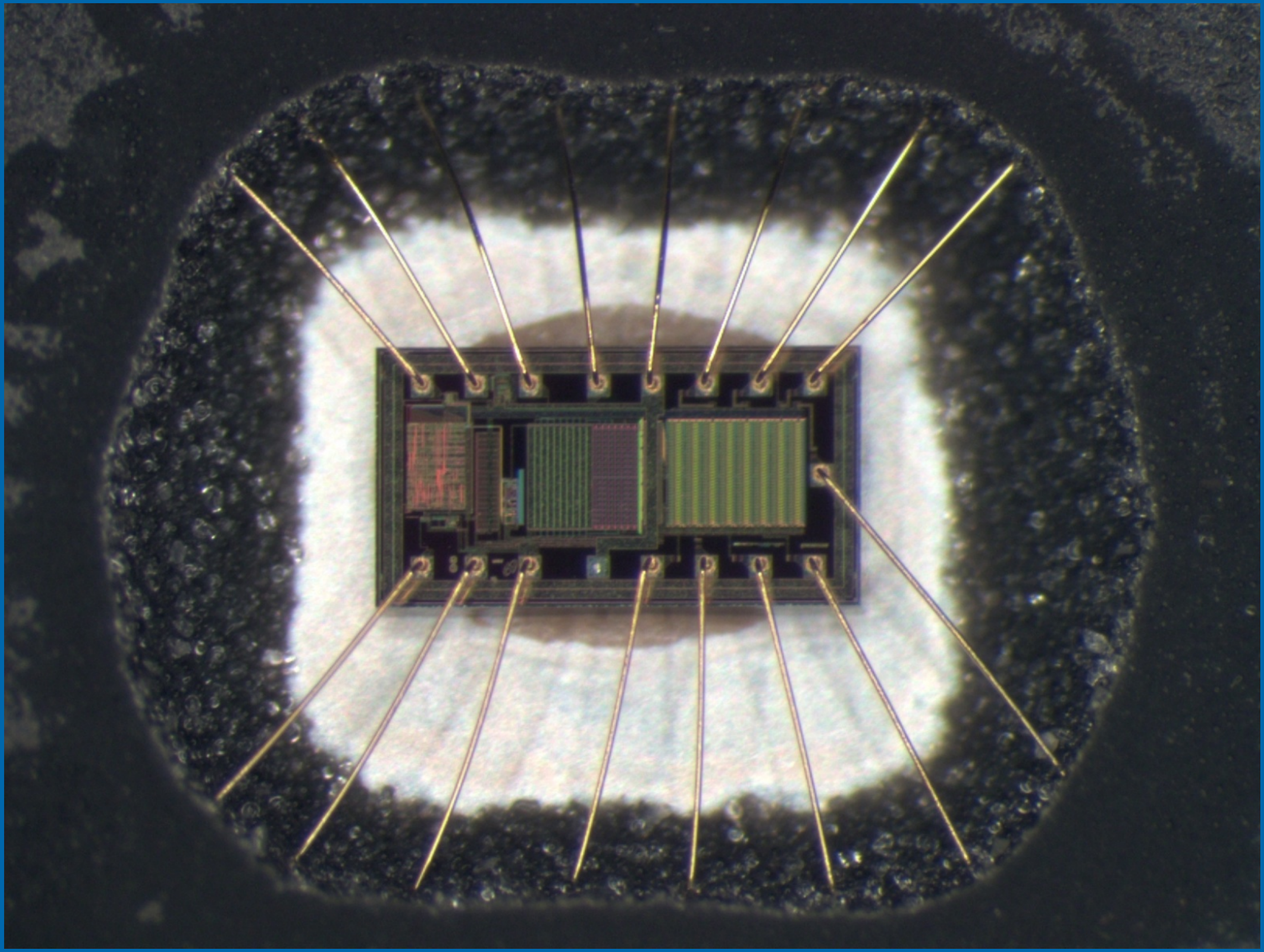
Chemical De-Cap



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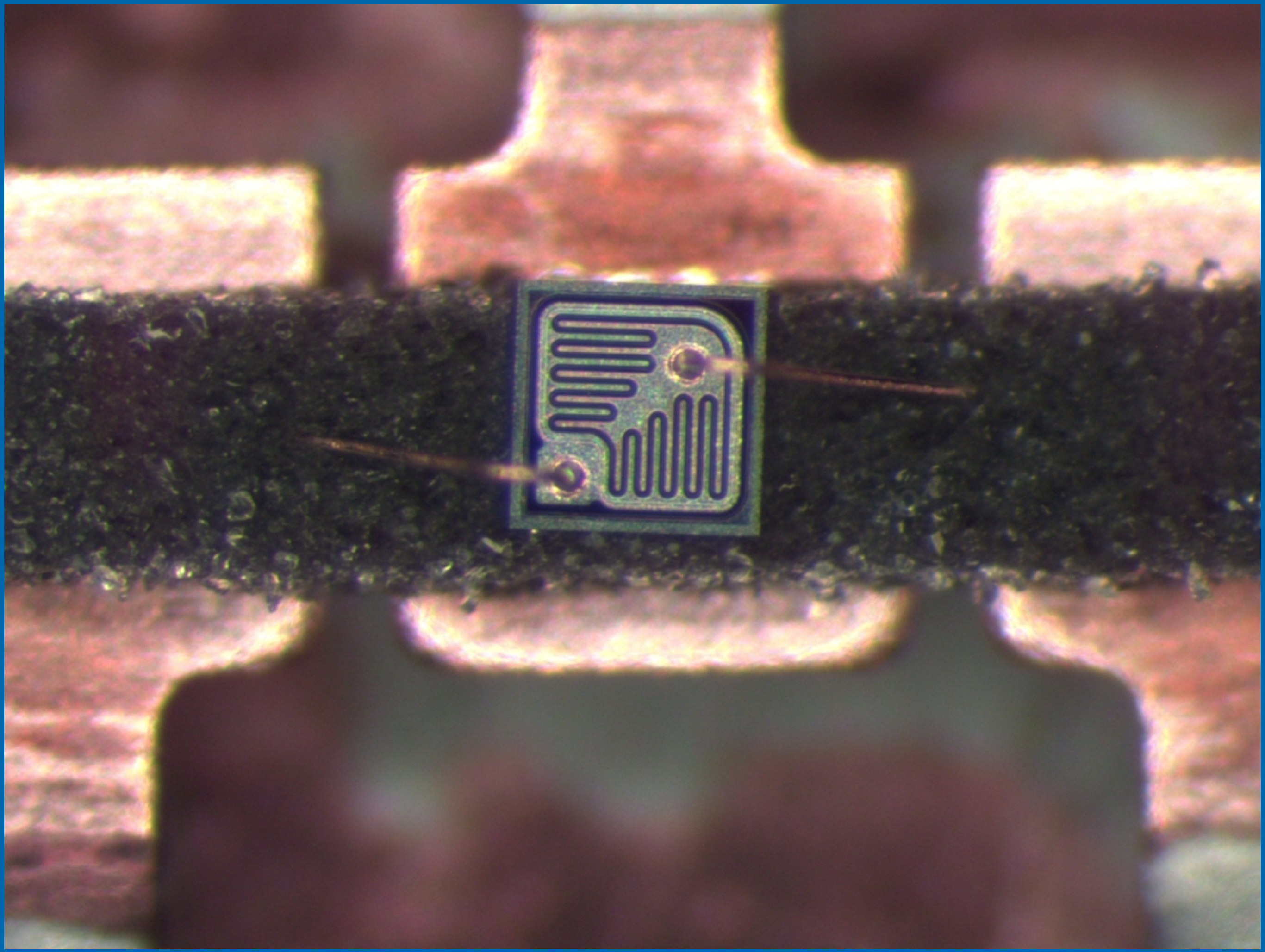
Chemical De-Cap



Chemical De-Cap

Why use ????

- Quality of Marking
- Location and MFG Logo
- Lack of Marking
- Missing Construction
- Date Codes
- Lead Frame
- MIL-STD?
- Etc.

Plasma De-Cap

- Plasma etching removes plastic by making it react with a gas which can easily be vented out. This requires expensive plasma etching machines but is very clean and selective. It also takes longer compared to other techniques.

Plasma De-Cap

- Oxygen(O_2)
- Tetrafluoromethane (CF_4)
- Argon(Ar)
- Nitrogen(N)

Plasma De-Cap

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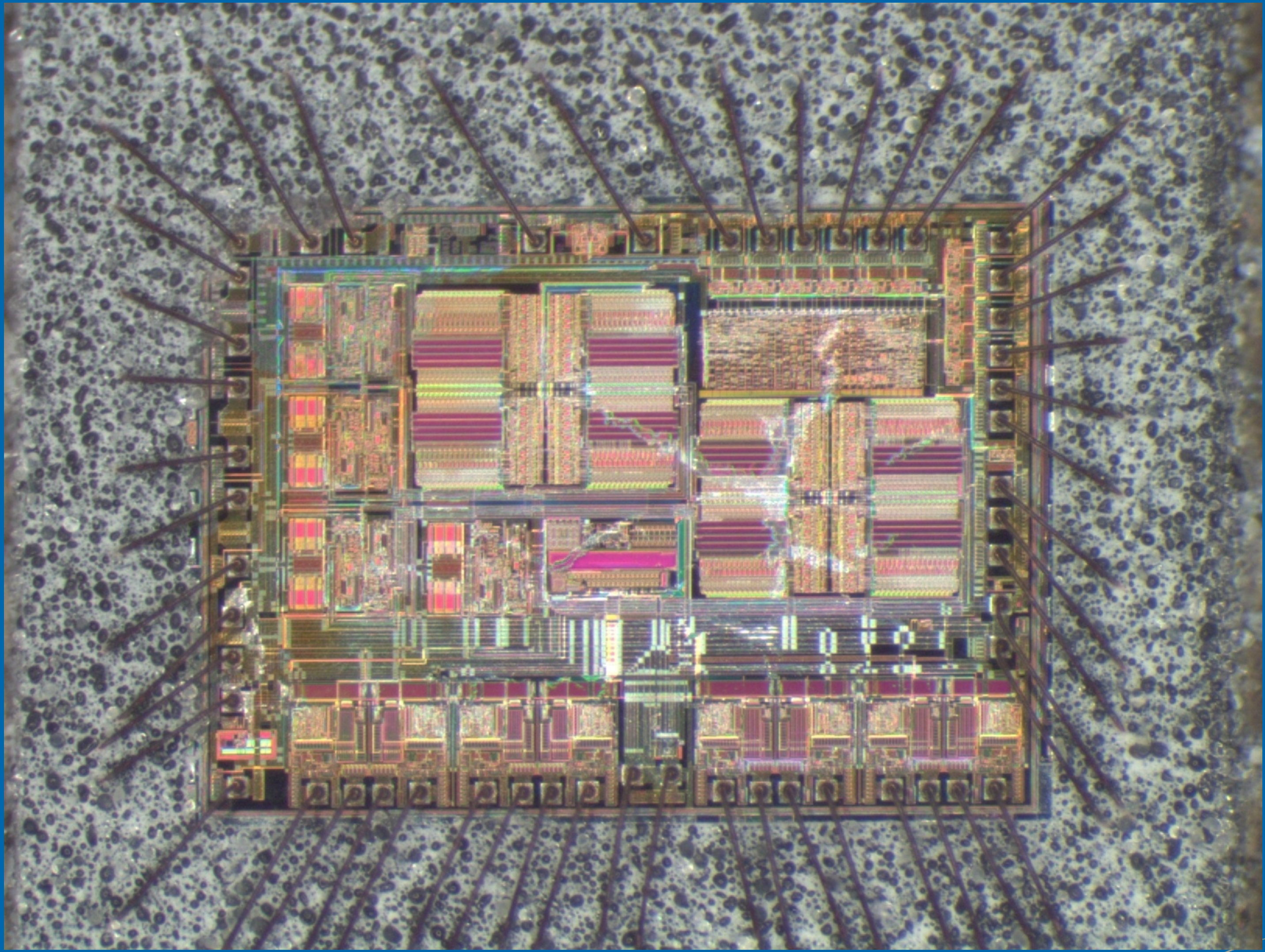
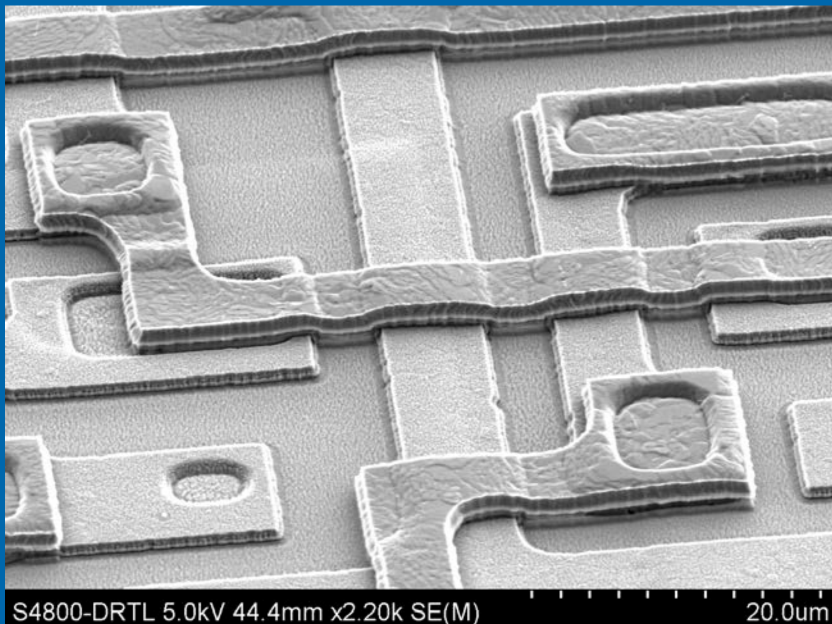
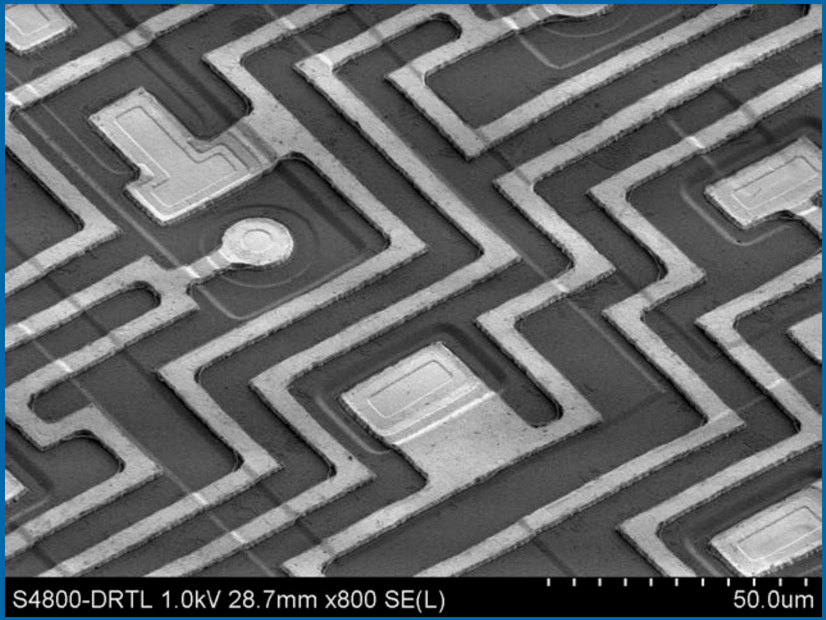
Plasma De-Cap

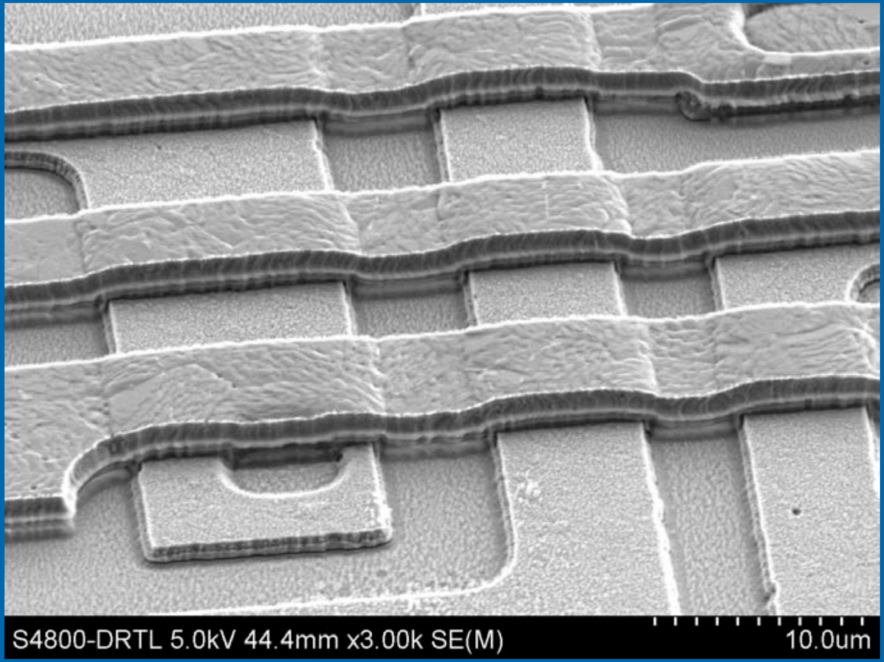


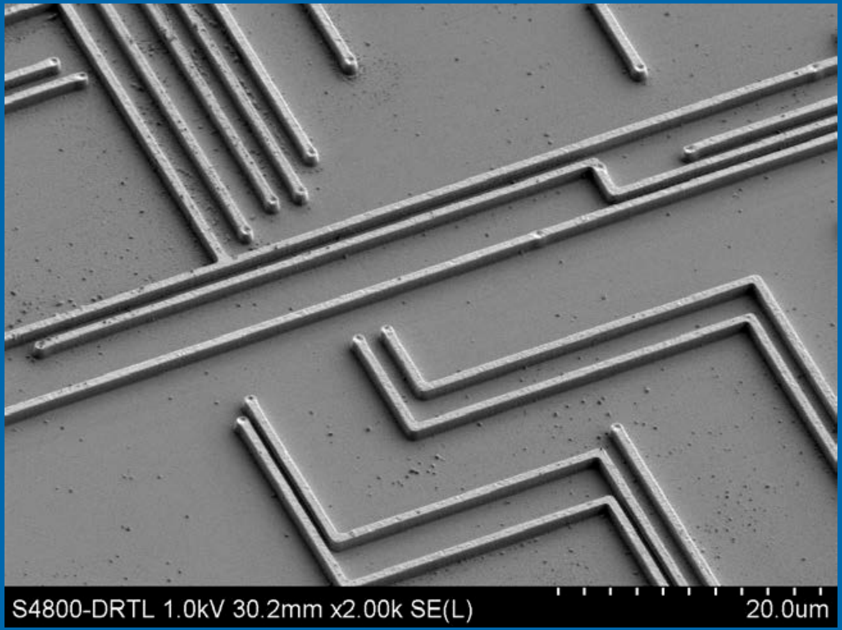
Plasma De-Cap



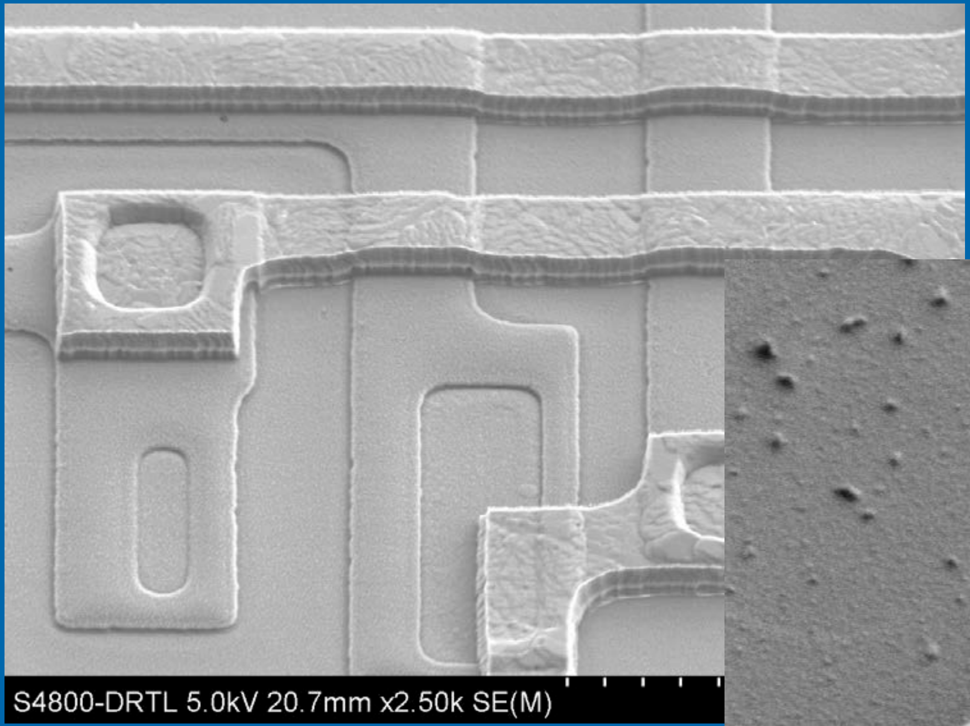


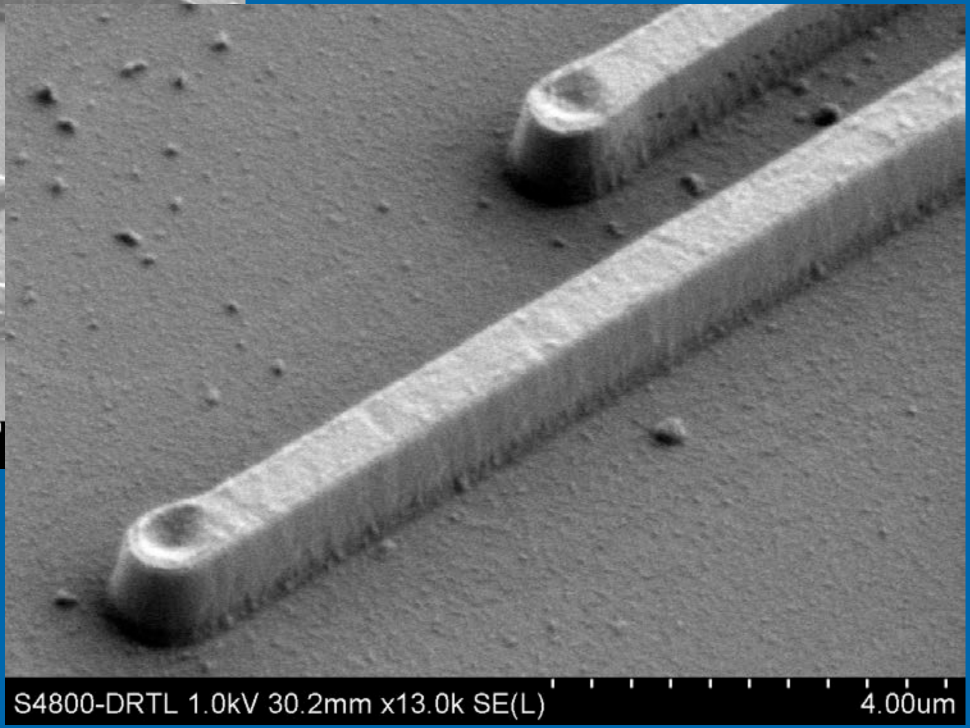
Plasma De-Cap





Plasma De-Cap

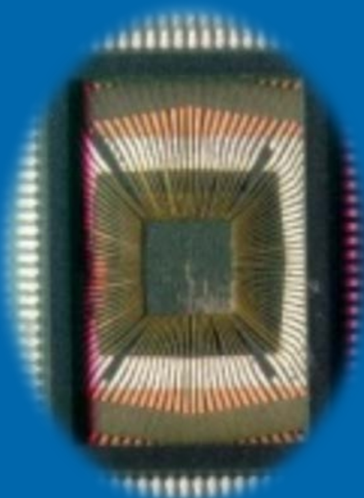


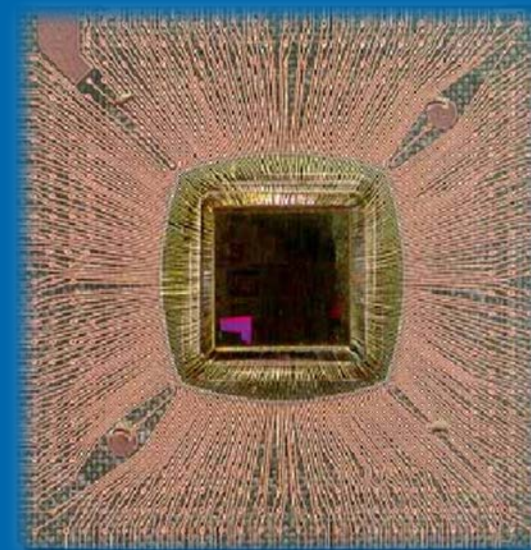


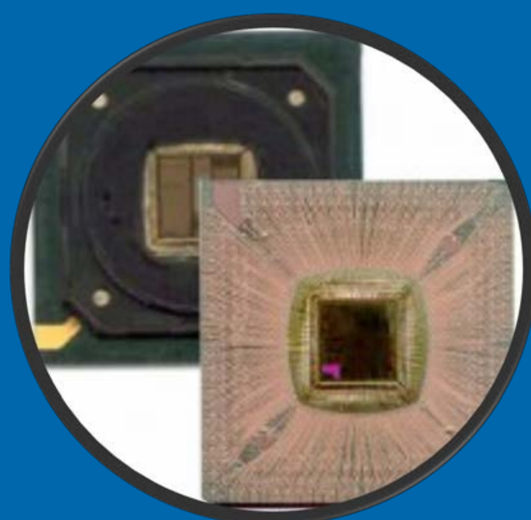
Laser De-Cap

- Laser Ablation or Decap Systems are specifically designed for effective decap of IC packages, containing either a single or multiple die .
- The actual amount of material removed can be measured by camera focal-depth techniques or by using an external mechanical indicator.
- Following laser ablation, the die surface can be exposed via a low temperature wet etch, applied either manually (with a suitable dropper) or automatically (with an automated acid decap machine), avoiding electric and mechanical alteration of the component.

Laser De-Cap







G-19 Decap and Internal Inspection Draft - Ver_3-14-12 (2)

Decapsulation, Disassembly, and Internal Inspection Process for Counterfeit Part Detection

Note: The document's format and font TBD by G-19 Subcommittee

G-19 Decap and Internal Inspection Draft - Ver_3-14-12 (2)

• Introduction

The inspection of a component's internal structure, such as the top surface of a microelectronic die or metallization traces of a thin-film resistor, **is a critical task in assessing whether a part may be considered counterfeit.** Characteristics that are not normally visible during optical examination on the external case of a production part can be examined after a decapsulation or disassembly process to determine if they are consistent with what would be expected from an original component manufacturer device.

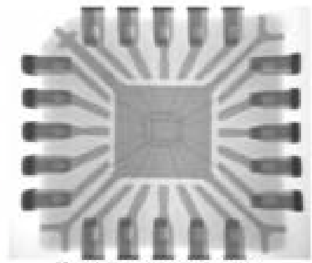
• Purpose

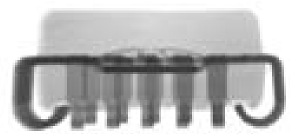
The purpose of this document is to provide guidelines and requirements associated with the use of decapsulation, disassembly, and internal inspection as part of the process to authenticate the identity of the manufacturer of a part, **and/or to discern and document characteristics that are consistent with counterfeit parts.**

Appendix A
Decapsulation and Photodocumentation Examples

Example 1 – Single die facing away from the mounted side

External Optical Image


Top View X-ray Image


Side View X-ray Image

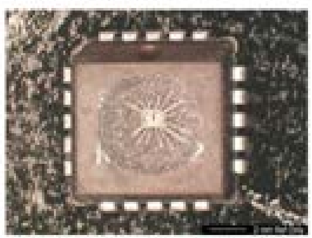


Photo of the Decapsulated Part

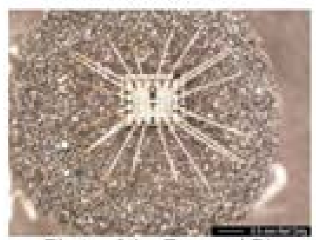


Photo of the Exposed Die

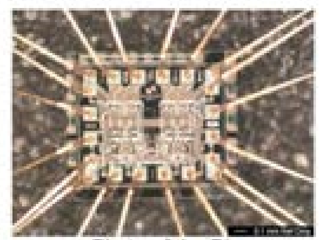


Photo of the Die


Brightfield Image of the Die

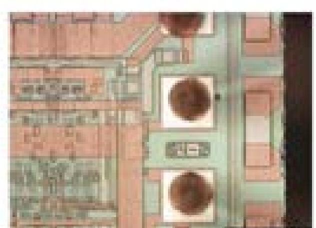


Photo Showing a Part Marking

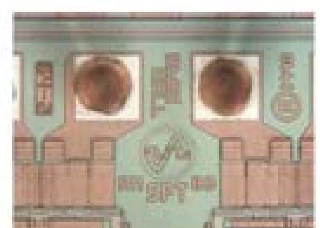


Photo of the Manufacturer Logo

DRTL Supports SAE G19 Proposed Test Flow Summary

TABLE ---- ACTIVE DEVICES RISK MITIGATION SCREENING FLOW PRELIMINARY
(microcircuits & semiconductor devices)

Steps	Mechanical/Environmental/Electrical Inspections/Tests	4 Critical Risk	3 High Risk	2 Moderate Risk	1 Low Risk	0 Very Low Risk
1	External visual Inspection,EVI$_G$ (General)	Y	Y	Y	Y	Y
2	Remarking & Resurfacing	Y	Y	Y	Y	Y
3	XRF	Y	Y	Y	Y	Y
4	External visual Inspection, EVI$_D$ (Detailed)					
5	Delid Physical Analysis					
6	SEM/OPTICAL					
7	Radiographic/X-RAY					
8	Acoustic Microscopy (AM)					
9	Miscellaneous					
10	Seal (hermetic devices)					
11	Temp cycling/ End point electrical					
12	DC Curve Trace					
13	Full DC Test, Ambient Temp					
14	DC,Key(AC,Switching, Functional),Ambier					
15	DC,Key(AC,Switching, functional), Ambie					
16	DC,Key(AC, Switching, Functional), over T					
17	Burn-In & Final Electricals with Limits & Delta Limits					

Key: Y – Yes, test performed
AN-As necessary

Component Test Plan Defined

HIGH RISK

- DPA (MIL-STD-1580)
- External Visual
- Internal Visual
- X-ray
- XRF
- CSAM
- Solderability
- Environmental Stress Test
- Thermal Shock
- SEM
- EDX/S
- FTIR/TGA
- Electrical Test
- Burn-In
- Fine & Gross leak
- RGA
- PIND

MEDIUM RISK

- AS5553
- DPA
- External Visual
- Internal Visual
- Marking Permanency
- X-Ray
- XRF
- Thermal Cycle
- Electrical Test
- Burn-In
- Fine & Gross Leak

LOW RISK

- IDEA 1010
- Photograph Parts
- Co-planarity
- Damaged Leads and Terminations
- Contamination and Oxidation
- Evidence of Poor Handling, Storage or Prior Use
- Rework or Refurbishment
- Remarked and Substandard

G-19 Decap and Internal Inspection Draft - Ver_3-14-12 (2)

13. Certification Sample Questions (question answers available in Section 14)

13.1.

13.1.1. Chemical Handling

1. (True or False) Nitric acid should not be rinsed with isopropyl alcohol while decapping.
2. (True or False) Acetone and Alcohol bottles must be stored in color coded rinse bottles while under the fume hood, "red" for Acetone "yellow" for Isopropyl.
3. (True or False) Acid spills should be treated/cleaned with dry paper towels since they can absorb fluids quickly.
4. (True or False) Acid bottle storage within the fume hood is not acceptable. Small Erlenmeyer flasks (identifying the acids accordingly) with stopper are appropriate.
5. (True or False) Technicians wearing glasses are not required to wear safety goggles while under the fume hood since their glasses are considered a form of protection.

13.1.2. Safety Equipment Required

1. In the event of a chemical spill, __________ should be on hand.
   A) Bucket of water
   B) Mop
   C) Chemical spill containment material
2. Which of the following should be present in every chemical lab?
   A) Chemical grade fume hood
   B) Chemical storage cabinet
   C) Eye wash station
   D) All of the above
3. (True or False) An emergency shower station is required in every chemical lab.
4. Which of the following should be worn at all times while decapsulating?
   A) Chemical grade lab coat
   B) Chemical grade lab gloves
   C) Face shield/eye protection
   D) All of the above
5. (True or False) Tweezers should always be used to handle a component until it has been thoroughly rinsed of all chemicals.

13.1.3. Proper Techniques for Manual and Automated Decapsulation

1. When selecting a gasket size for a component, you should pick a gasket that

ISO 17025 Field of Tests

Scope of Accreditation to ISO/IEC 17025:2005

FIELD OF TEST	SPECIFIC TESTS OR PROPERTIES MEASURED	SPECIFICATION, STANDARD METHOD OR TECHNIQUE USED	*DETECTION LIMIT/ RANGE/ EQUIPMENT
Non-Destructive Testing (NDT)	Elemental content by XRF (Lead, tin, etc.)	JESD213	Fischerscope XDAL
Non-Destructive Testing (NDT)	Radiographic Examination / Inspection	MIL-STD-883, Method 2012 MIL-STD-750, Method 2076 MIL-STD-202, Method 209	X-TEK Model: Orbita
Non-Destructive Testing (NDT)	Acoustic Microscopy (CSAM) Examination / Inspection	IPC/JEDEC, J-STD-035	Sonix Echo
Mechanical	SEM Examination / Inspection	MIL-STD-750, Method 2077 MIL-STD-883, Method 2018	Hitachi S-4800
Mechanical	Internal Examination / Inspection	MIL-STD-883, Method 2010 and 2013 MIL-STD-750 Method 2072	Olympus BX50
Mechanical	Particle Impact Noise Detection (PIND)	MIL-STD-883, Method 2020 MIL-STD-750, Method 2052	Spectral Dynamics PTI Model: 4511 I
Mechanical	Die Shear Grams of Force	MIL-STD-883, Method 2019 MIL-STD-750, Method 2017	Dage 4000

http://www.DRTLonline.com

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ISO 17025 Skill Set Model

Skill Set Model

Note: Instruction-related review / training includes the related:
TSTI = Instructions
TSTC = Checklists

Competency

Experience:	EXP
Training Class:	TRC
On the Job Training	OJT
Observation:	OBS
Test:	TST
Education:	EDU

Evaluator

Clifton Aldridge	CA
[Name]	Initials
[Name]	Initials
Mark Northrup	MRN
Chris Hoover	CH
Instructor	INS

Color Key
Pending Skill Training
Completed Skill Training
LATE Skill Training

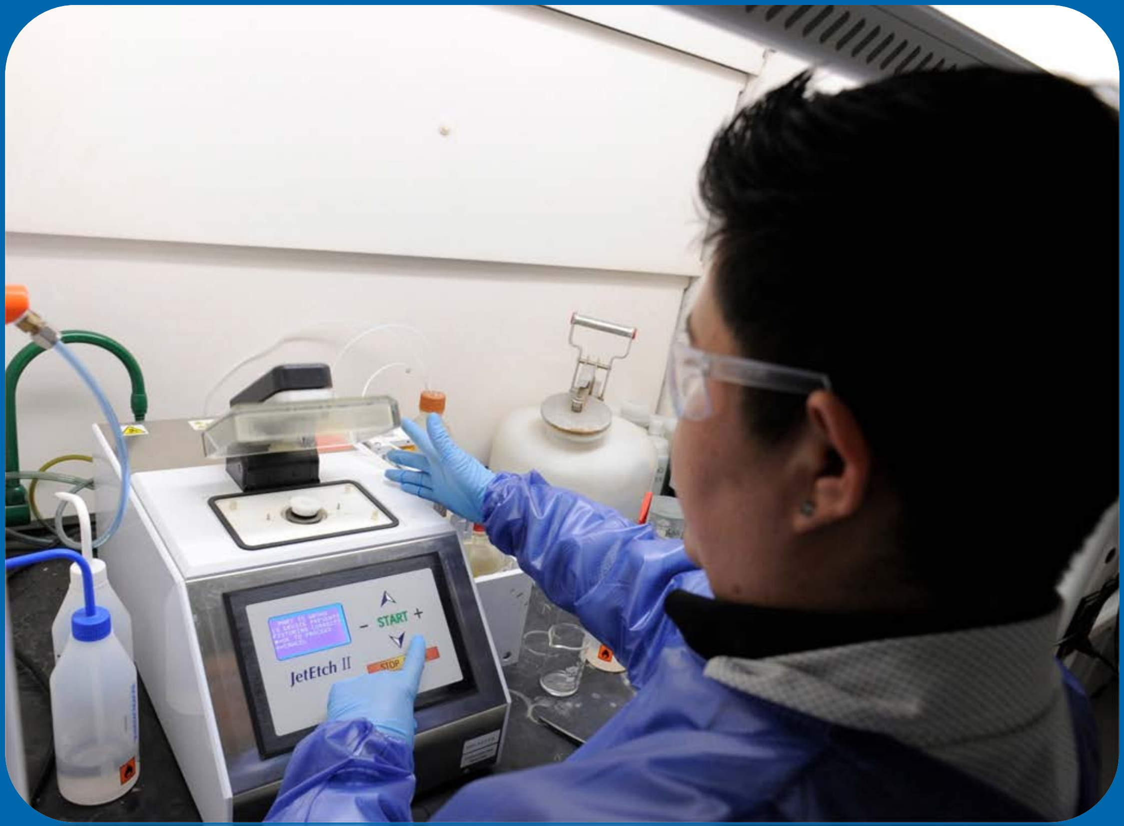
Andy Buchan
Device Engineer

Process	Planned	Eval. Method	Evaluator	Completed								
TSTP-001, Testing Process	11/30/11	OJT	CA	11/30/11								
TSTI-001, SEM Examination	11/30/11	OJT	CA	11/30/11								
TSTI-002, Internal Examination	11/30/11	OJT	CA	11/30/11								
TSTI-013, Olympus BX50 Leica MZ80 - Infinity Camera Operating Procedure	11/30/11	OJT	CA	1/24/12								
TSTI-004, Wire Bond and Die Shear Test Instructions	11/30/11	OJT	CA	11/30/11								
TSTI-012, Wet Saw Operation	11/30/11	OJT	CA	1/20/12								
TSTI-014, Chemical Decapulation Instructions	11/30/11	OJT	CA	11/30/11								
TSTI-015, Sample Mounting Instructions	1/24/12	OJT	CA	1/24/12								
TSTI-016, Solderability Testing	1/24/12	OJT	CA	1/24/12								
TSTI-005, XRF	1/24/12	EXP	CA	1/24/12								
TSTI-006, Radiographic / X-ray Examination	1/24/12	EXP	CA	1/24/12								
TSTI-007, PIND	11/30/11	OJT	CA	11/30/11								
TSTI-008, Acoustic Microscopy	11/30/11	OJT	CA	11/30/11								
TSTI-009, Seal Test Operation	1/24/12	OJT	CA	1/24/12	8/2/11	TRC	CA	8/2/11	6/15/12	TRC	CA	Pending
TSTI-017, External Inspection of Devices	1/24/12	OJT	CA	1/24/12	8/2/11	TRC	CA	8/2/11	6/15/12	TRC	CA	Pending

Dynamic Research and Testing Laboratories – Business Instruction

DYNAMIC RESEARCH AND TESTING LABORATORIES, LLC DRTL	*Document Title:* **Radiographic / X-Ray Examination**
	Document Number: **TSTI-006, Rev. B**
Document Owner: **Rachel Garcia** *Backup Owner:* **Clifton Aldridge**	*Approver(s):* **Clifton Aldridge**
Parent Document: **TSTP-001, Testing Process**	*Notify of Changes:* **All Dynamic Research and Testing Laboratories Employees**
Referenced Document(s): **TSTC-006 Radiographic Inspection - Discretes; TSTC-007 Radiographic Inspection – ICs; TSTC-008 Radiographic Inspection – Passives; HRMF-004 Skill Set Model; DRTL Database; Orbita Manual 2004; MIL-STD-750 Method 2076, MIL-STD-883 Method 2012 , MIL-STD-202 Method 209; REG-003, Record Register**	

Can You Afford Not To have A Risk Mitigation Strategy ?



Thank you !

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