



MICROTECH LABORATORIES LLC

www.Micro-Labs.com

John Olson - President

Identifying the root cause of a problem
is the first step to finding a solution.



Microtech Company Overview



- ▶ Privately owned company located in Plano, Texas founded in 2000
- ▶ Customers from broad array of industries
 - ▶ Semiconductor IC, Defense/Aerospace and Commercial Products
 - ▶ Support for large IDM's and fabless semiconductor companies
 - ▶ Extensive Reverse Engineering capability and litigation support
- ▶ Experience with CMOS (28/22/14nm), Bipolar, RF SiGe, GaAs, GaN, SiC, for power, digital and mixed signal process technologies
- ▶ ISO 9001:2008 Certified
- ▶ MIL-STD 883, Method 2018: MIL-STD 750, Method 2077, MIL-PRF 19500, App D.



Quality
Honesty
Integrity
Timely



Microtech Company Overview



- ▶ Broad range of failure analysis capabilities with special expertise in complex analog/mixed-signal analysis
- ▶ For analog and mixed-signal designs schematic and layout databases can be viewed and electrical analysis performed to correlate with the global isolation findings.
- ▶ General focus on fast cycle time and quality of results with detailed reports. Our team takes pride in finding the correct answer.



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Criteria Labs



- ▶ Partnership with Criteria Labs colocated in Texas



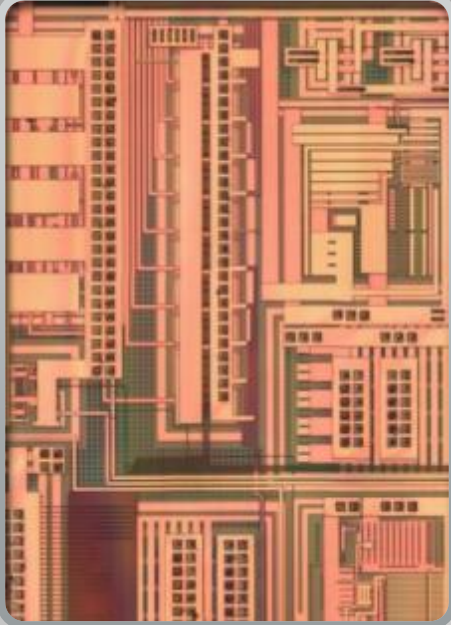
- ▶ Assembly and Packaging
- ▶ ATE Testing
- ▶ Reliability Testing
- ▶ Full Qualification, DPA and Failure Analysis Flow



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Timely



Microtech Company Overview



- ▶ Failure Analysis of IC continuity, parametric, and functional failures
- ▶ PCB, Electronic Assemblies, Components and IC analysis
- ▶ Competitor Evaluation and Construction Analysis
- ▶ Reverse Engineering and Circuit Extraction
- ▶ Services work such as Decapsulation, Cross-section, etc...
- ▶ Backside polishing and preparation of IC's for analysis
- ▶ Qualification and DPA work on consumer IC's for military applications



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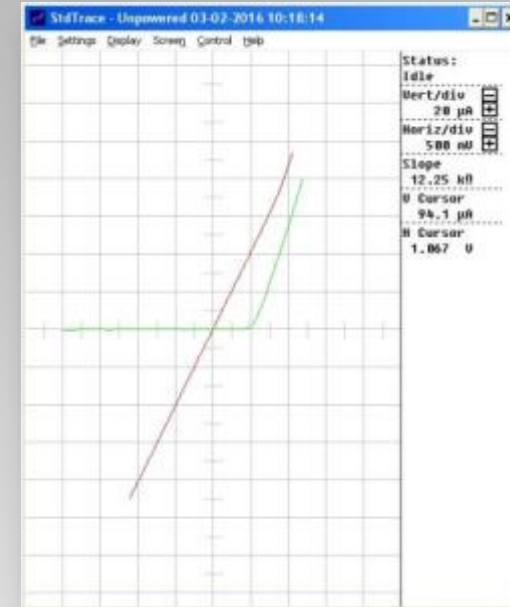


Microtech Company Overview

2 UTI Multi trace curve tracers



- Six Bus system
- 441 pin capable
- 625 pin capable
- Switchable supplies

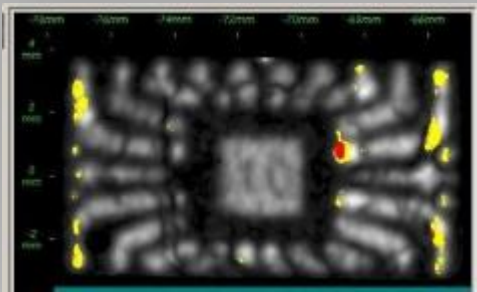


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Microtech Company Overview

Sonix UHR-2001 SAM



- 15, 75, 150 MHz transducer
- Detect delamination and voiding in IC's, PCB's, MCM's, etc...



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Scanning Acoustic Microscope



Characteristics of Ultrasonic Waves

- Freely propagate through liquids and solids
- Reflect at boundaries of internal flaws and change of material
- Capable of being focused, straight transmission
- Suitable for Real-Time processing
- Harmless to the human body
- Non-destructive to material

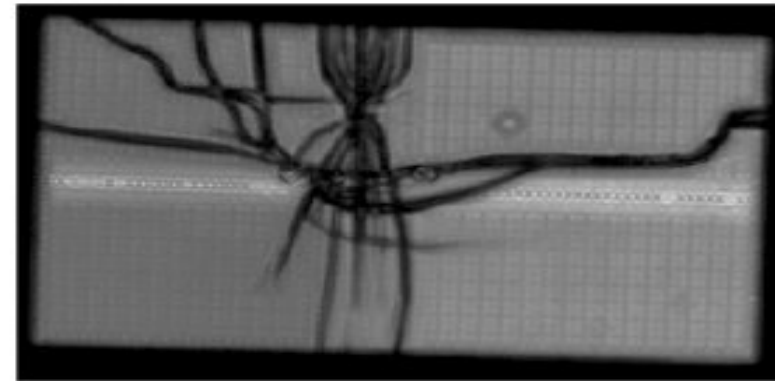
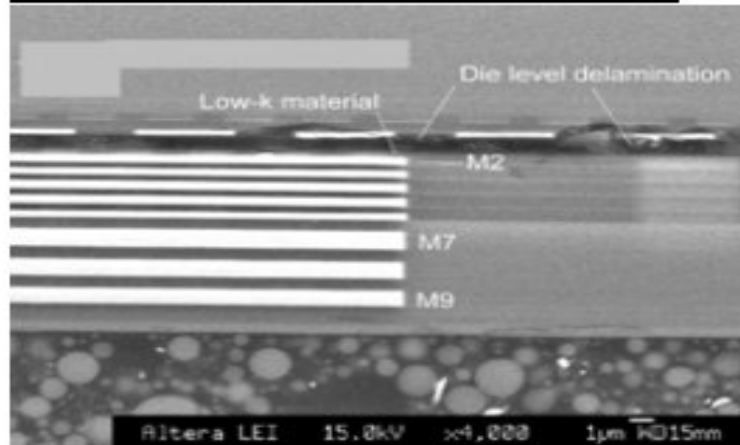
Scanning Acoustic Microscope

Case Studies:



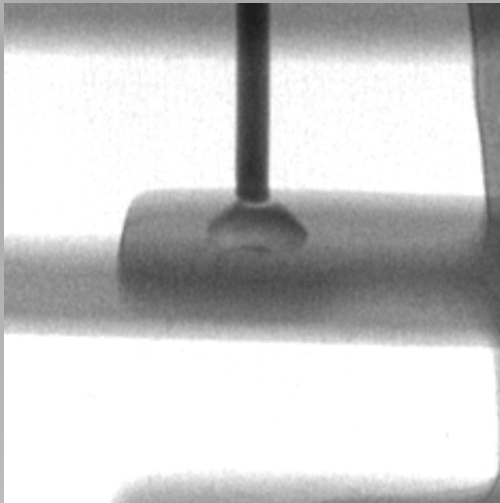
Uses:

- Die Delamination
- Die cracks



Microtech Company Overview

G.E. Nanomex Real-time X-ray



- Real time x-ray
- IC and PCB inspection
- Data video recordable

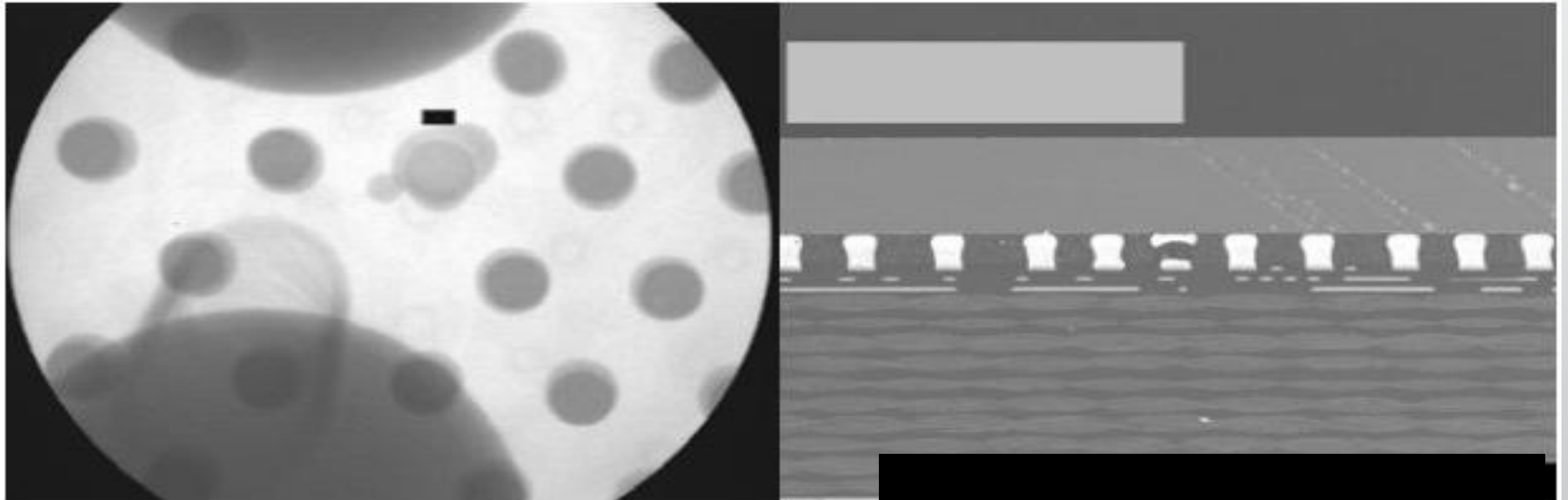


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Package X-ray

Case Study: Cold Solder Joint



Microtech Company Overview

Xradia XCT-200 3D X-Ray

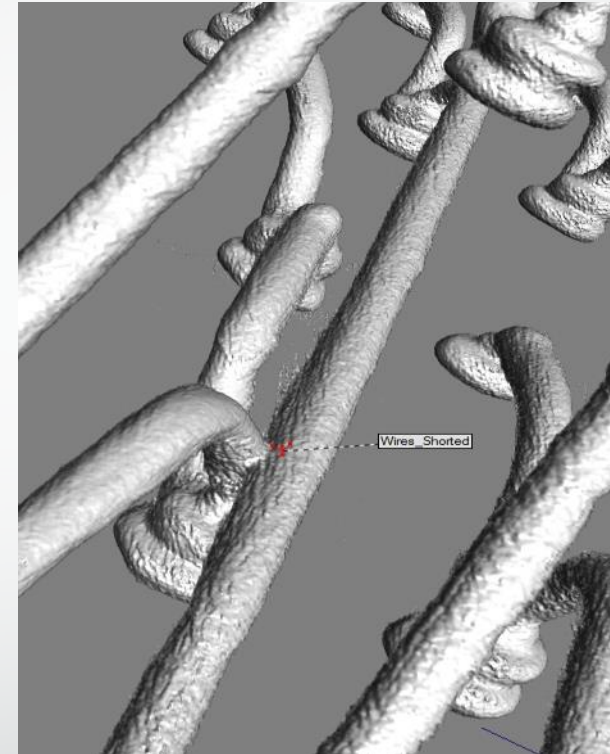
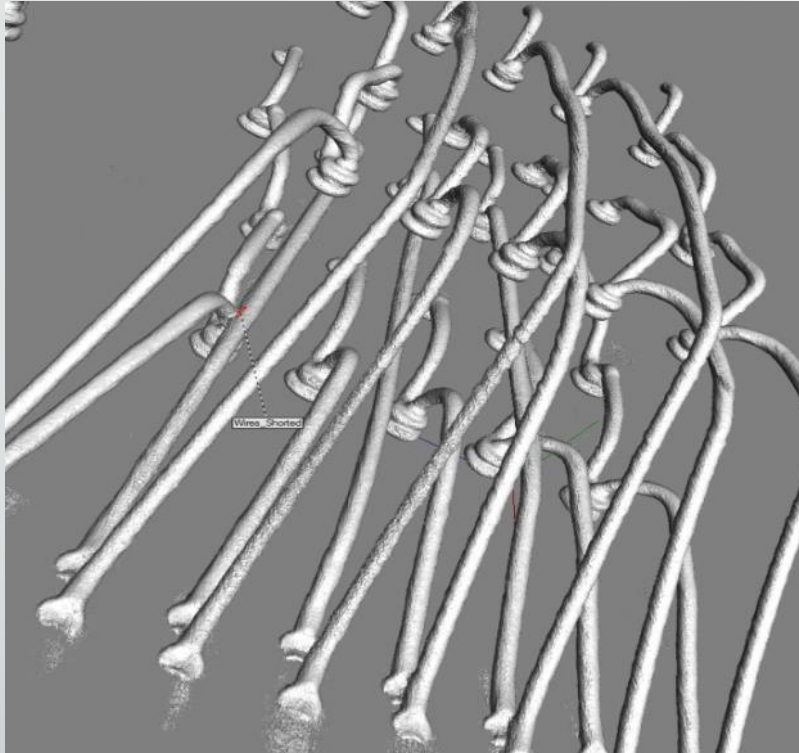
- Dedicated 3D X-Ray
- IC and PCB inspection
- $<0.7\mu\text{m}$ 3D Voxel
- Virtual cross-sectioning/delaying
- Full dataset provided to customer with viewing software



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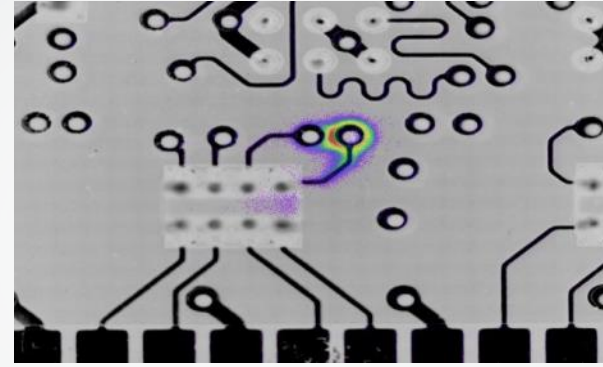
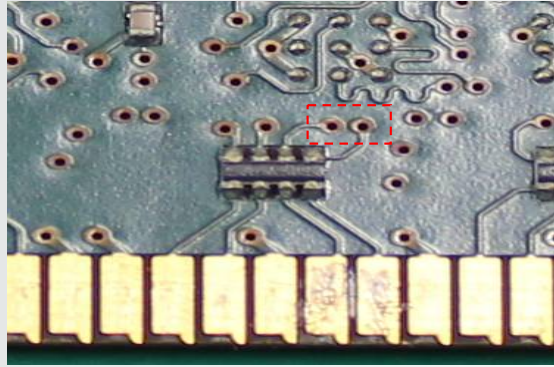
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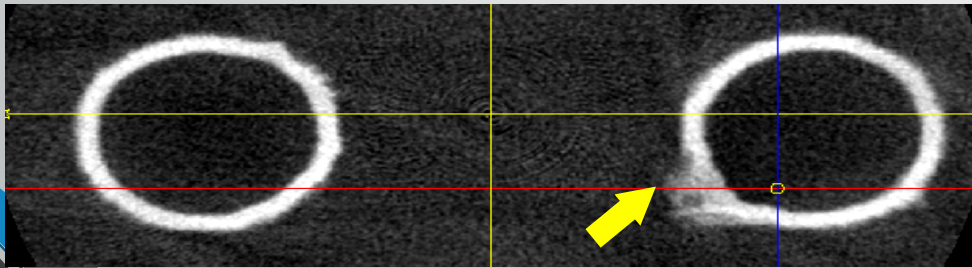
Package with 3 stacked dies had wire from bottom die shorting to wire from third die. The initial area was found using thermal imaging.

3D X-ray Case Study: Thermal/3D X-Ray

PCB Module Leakage at Substrate



Leakage localized to defective via on the substrate.
Confirmed with 3D x-ray CT.
Totally non-destructive method to identify the root cause.



X-ray CT (50x)



3D X-ray CT

Microtech Company Overview



Decapsulation Services

Laser ablation and low temperature acid decapsulation for gold, copper and silver bond wires



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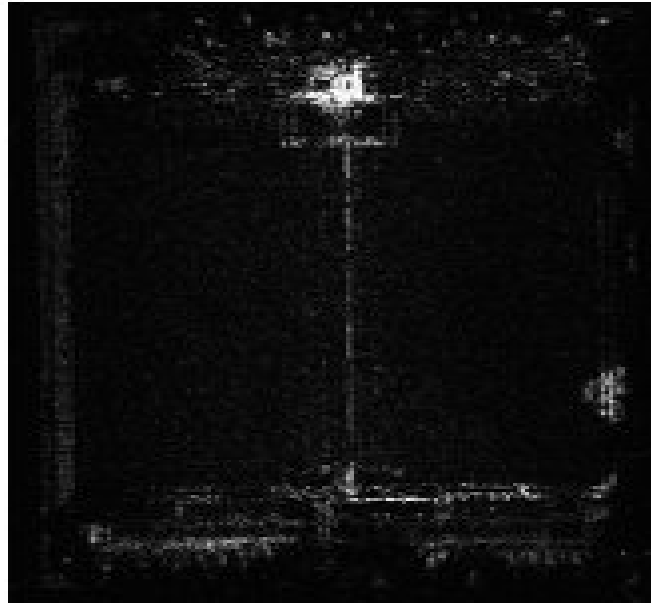


Global Isolation Techniques

- **Liquid Crystal** – Thermal Technique based on property to liquid crystal response to polarized light in presence of heat. Need 1mA or more leakage.
- **Lock-In Thermography** – Thermal Technique using thermal imaging camera with lock-in amplifier while pulsing current through failure.
- **Emission Microscopy** – Optical Technique using InGaAs camera to capture light given off from electron-hole recombination. Based on principle that silicon defects result in recombination center. (nA leakage detection)
- **TIVA/OBIRCH** (Thermally Induced Voltage Alteration/Optical Beam Induced Resistance Change) – Laser Scanning technique whereby constant current of voltage source is monitored while rastering laser across IC surface. Based on principle that when a material is heated its resistance changes which results in the constant current/voltage source responding.
- If Global Isolation fails, then you are left with on die probing and circuit analysis

Global Isolation Liquid Crystal Analysis

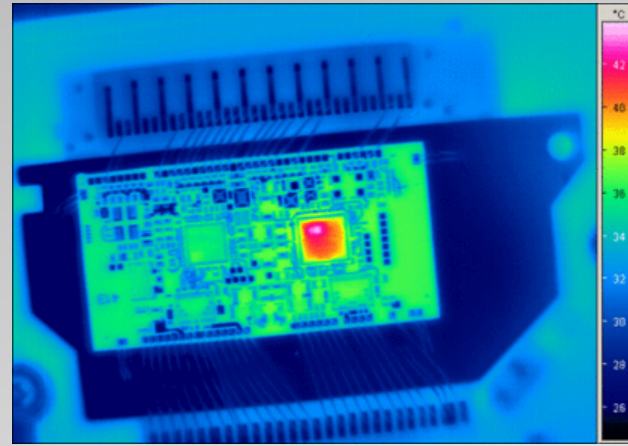
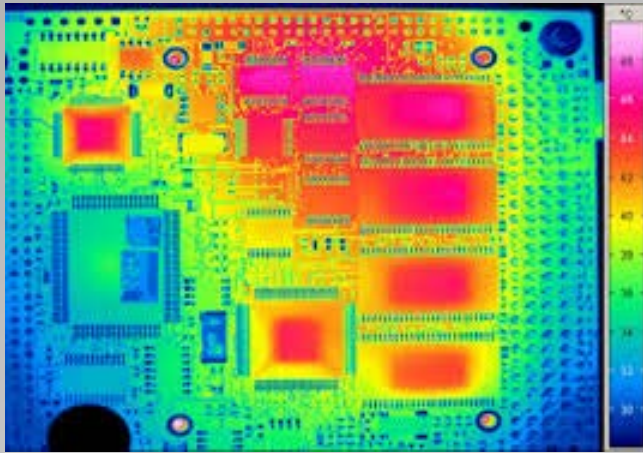
- Thermal Sensitivity 25mW
- Uses Polarized Light
- Visualize light diffraction
- Detects Shorts, High IDD
- Can give False information
- Limited spatial resolution
- Good for gross failure



Global Isolation

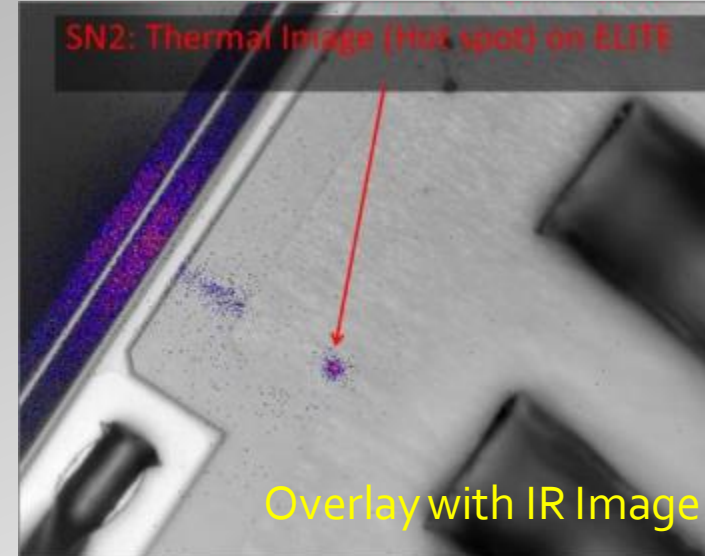
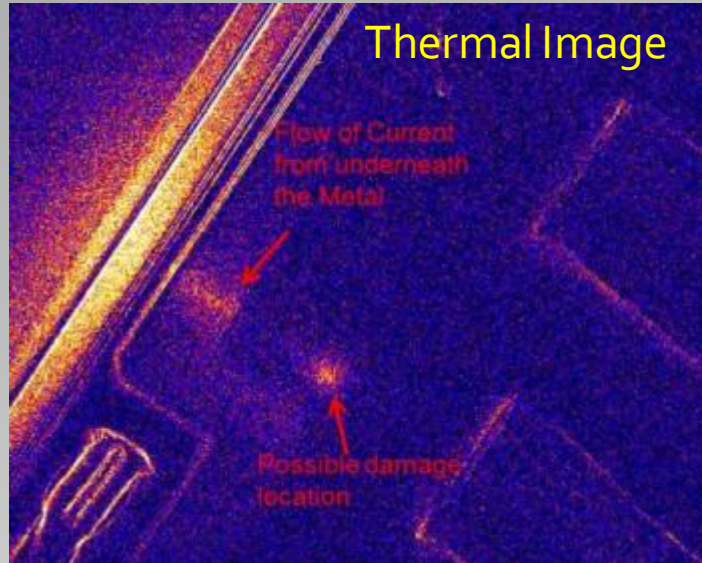
Lock-in Thermography

Application: Locate Line shorts, ESD damage, EOS Damage, Device latch-ups, PCB shorts and Identify faulty components on PCB's



Global Isolation

Silicon Carbide Thermography Image

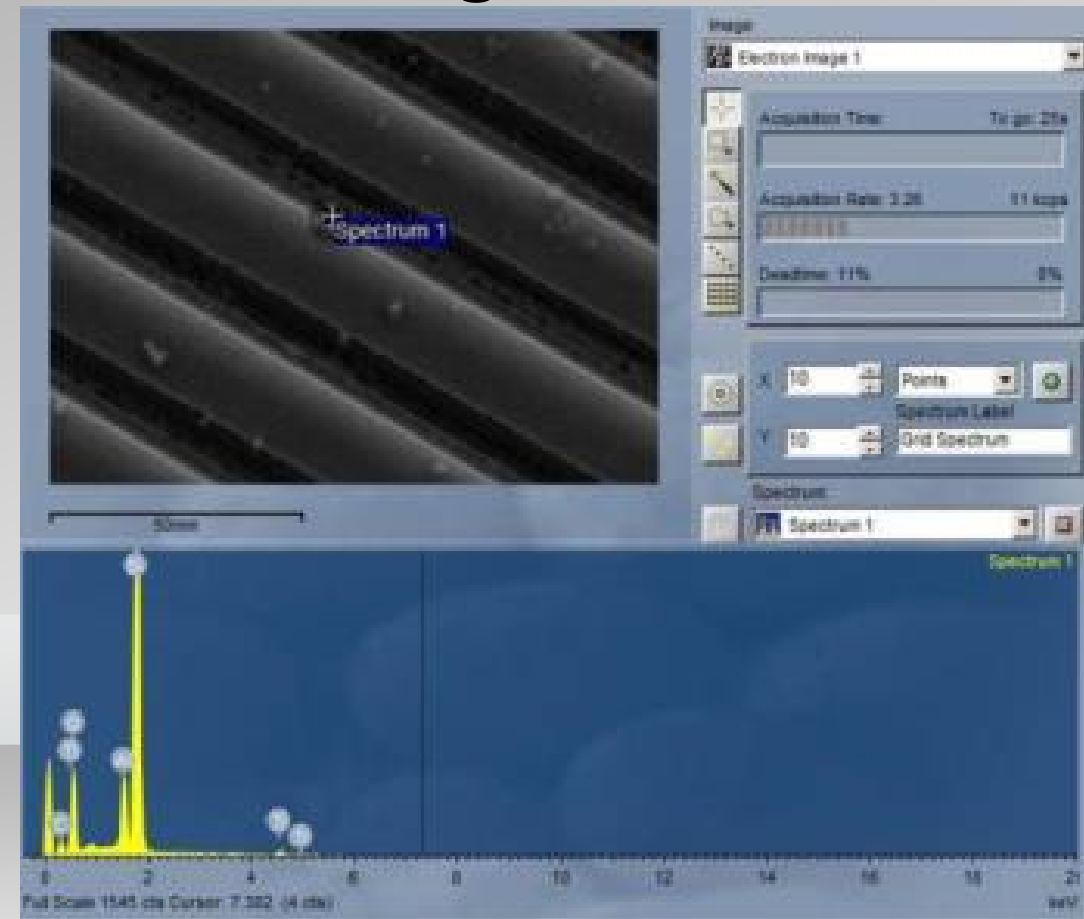


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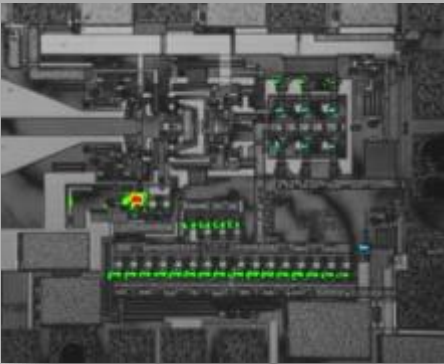
Global Isolation

Silicon Carbide Damage



Global Isolation: EMMI/TIVA

Semicaps SPEMS 1350



- InGaAs EMMI Detector
- LSM for TIVA/OBIRCH
- 300mm probe station

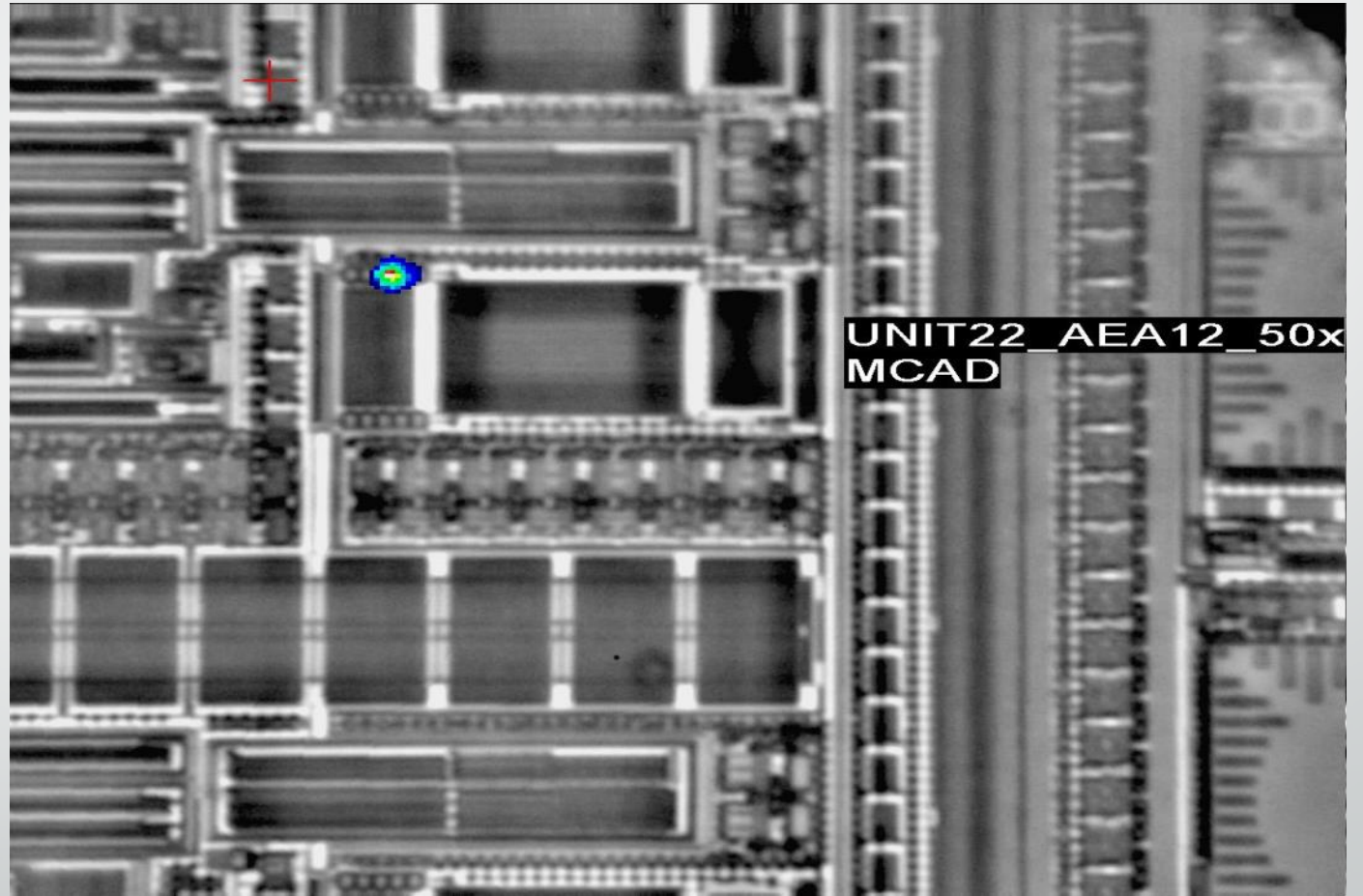


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Frontside EMMI

- Easy access to die
- No CAD required
- Metal Busses block light from electron/hole recombination



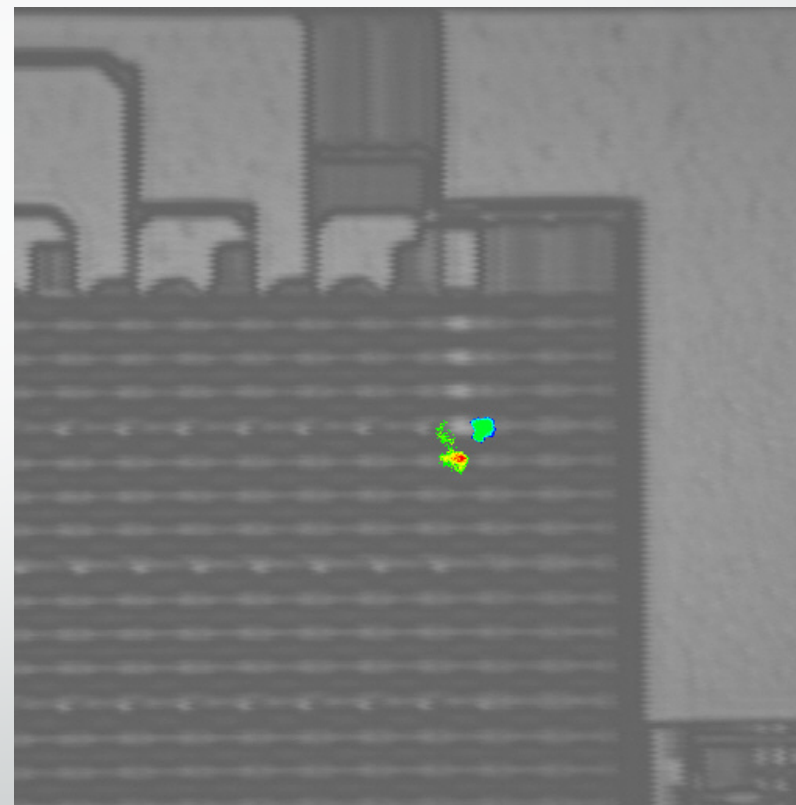
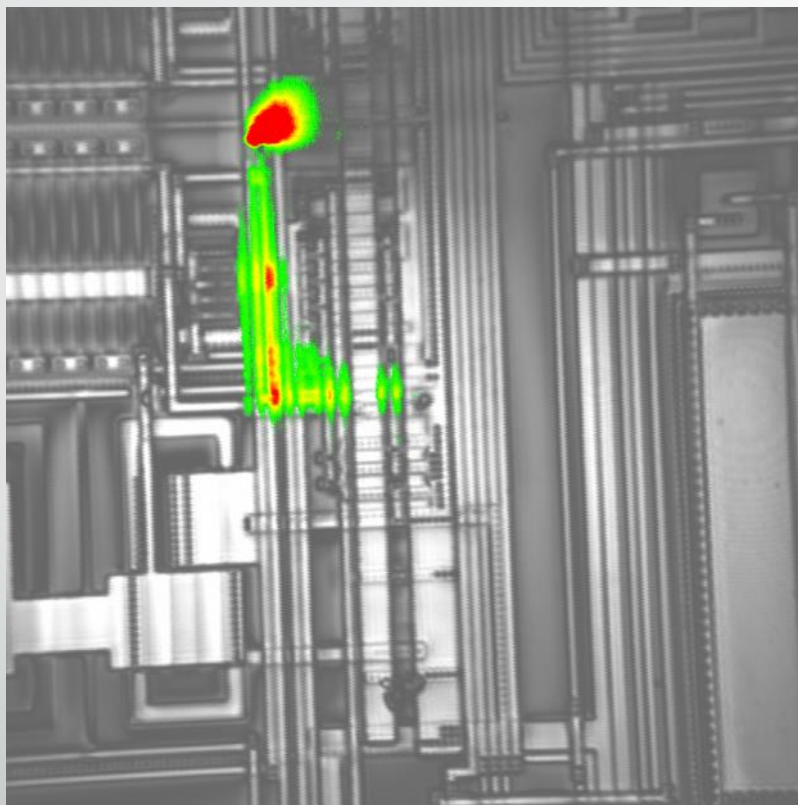
Backside EMMI

- Limited imaging for Navigation
- CAD overlay can be used
- IR image from LSM is usually overlaid.
- Best Sensitivity for low level leakage (nA)
- Sample Preparation can be significant depending on package type

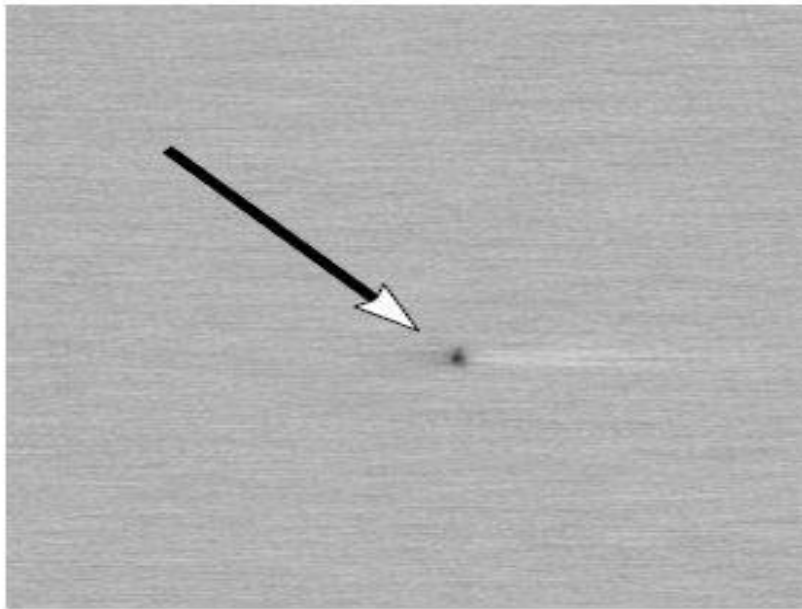


Emissions

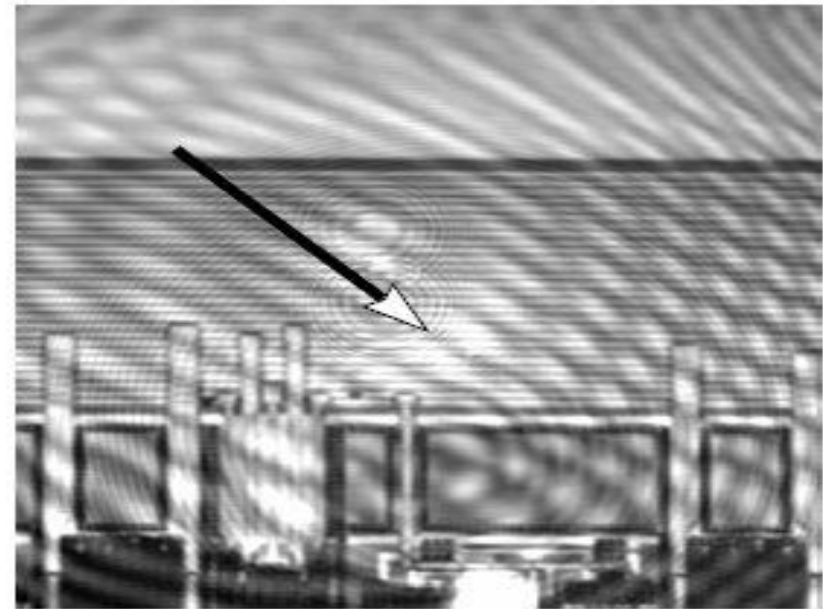
Frontside TIVA Images



Backside TIVA Example



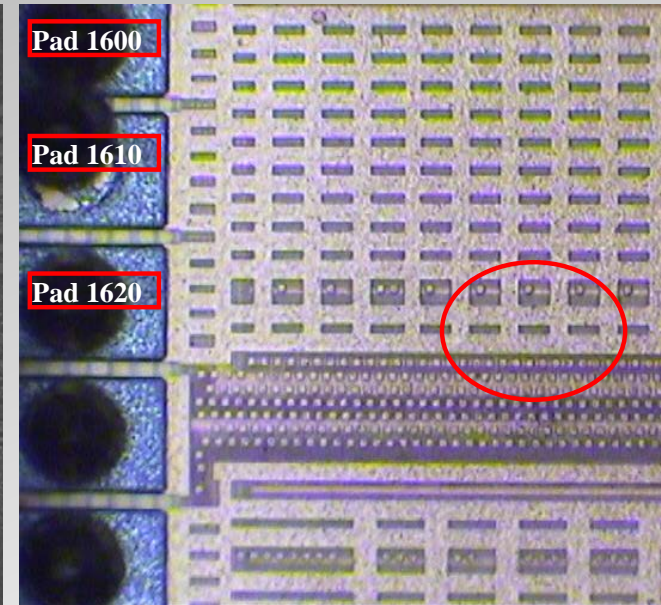
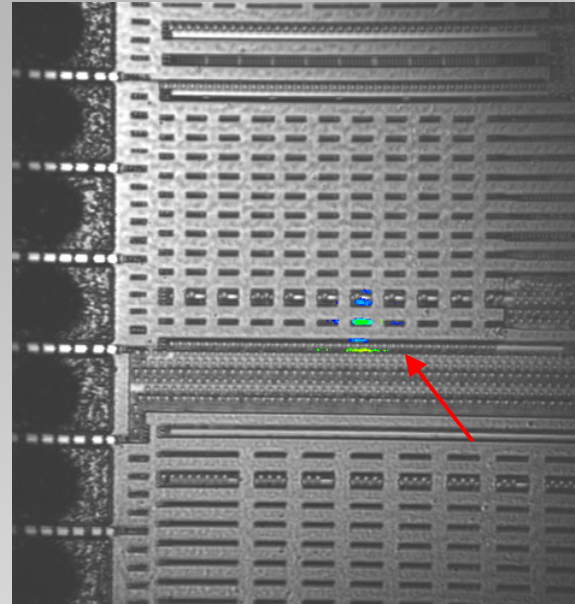
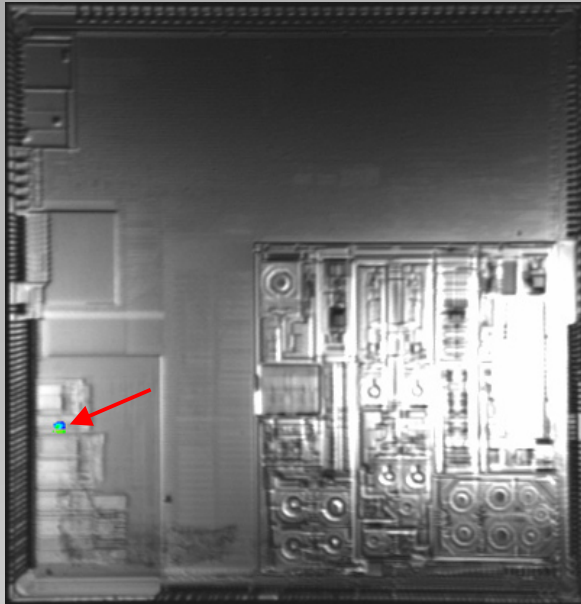
TIVA image



Reflected light image

Global Isolation

RF SiGe TIVA Isolation

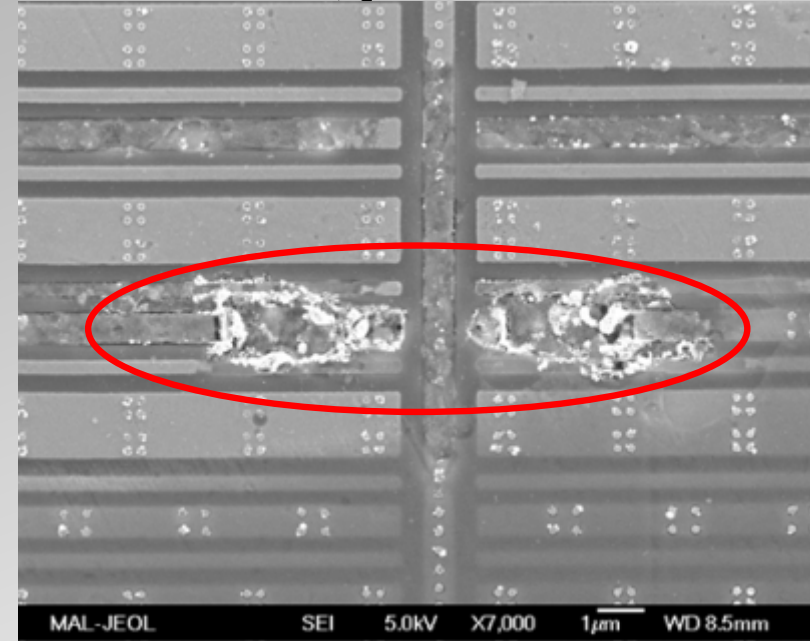
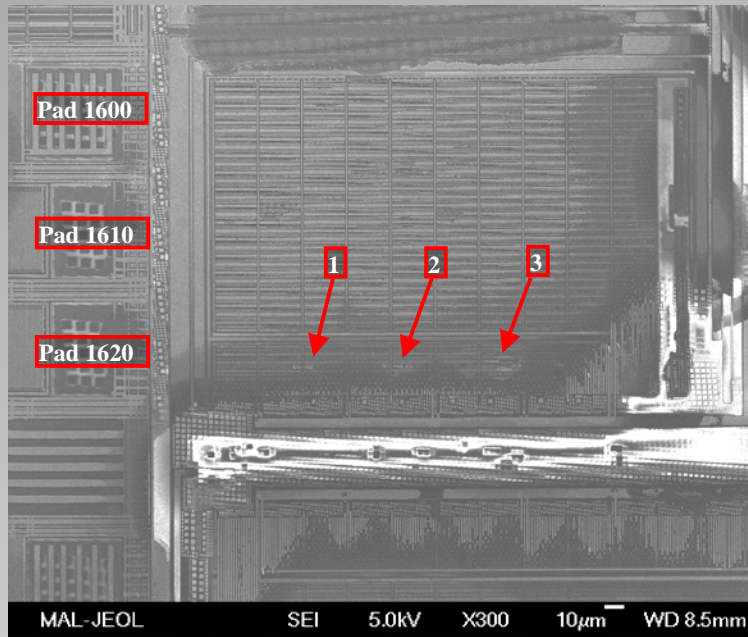


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Global Isolation

RF SiGe Deprocessing

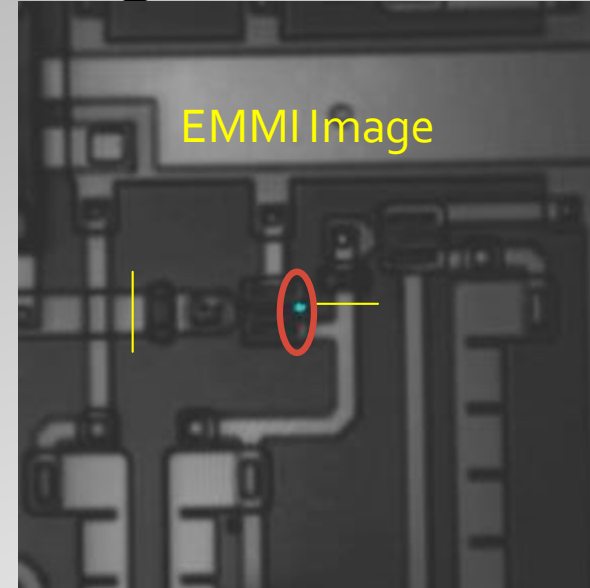
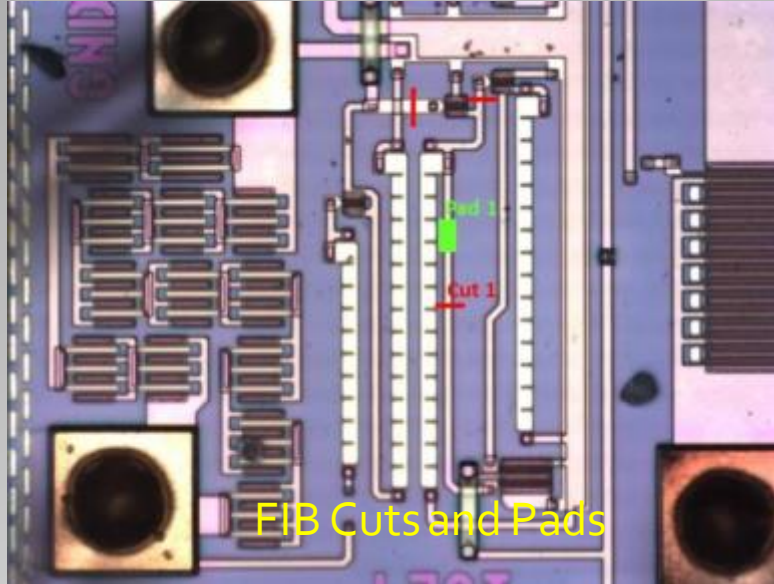


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Global Isolation

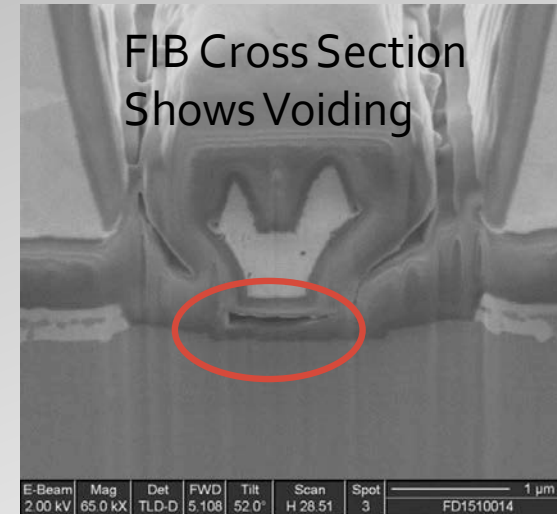
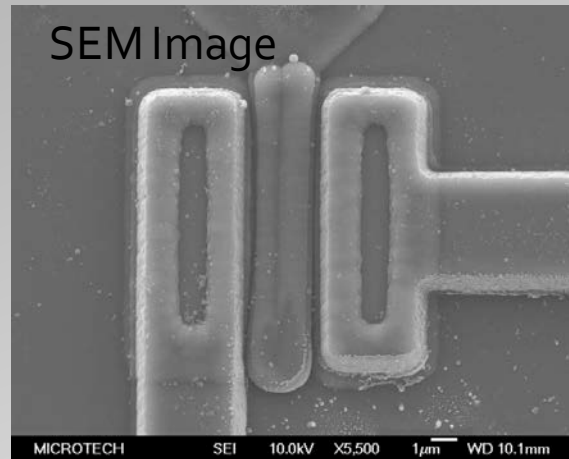
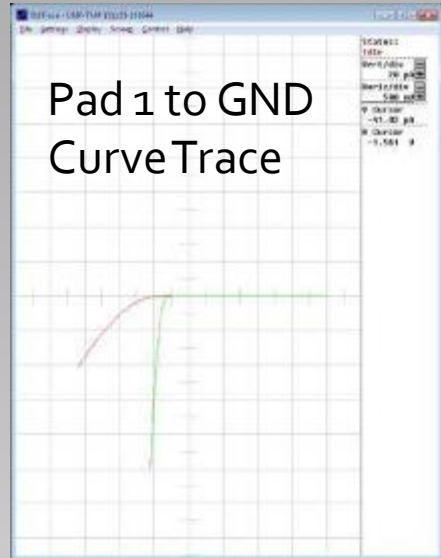
Gallium Arsenide Leakage Isolation



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Gallium Arsenide Leakage Isolation

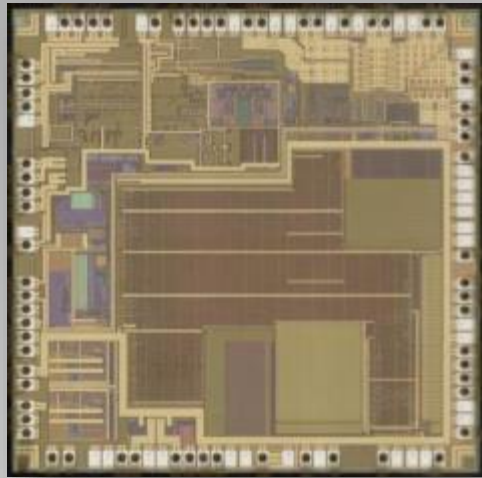


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Digitally Enhanced Optical Imaging

Olympus BX51 Automated Stage Microscope



- Full die montages
- Multi focus stacked imaging



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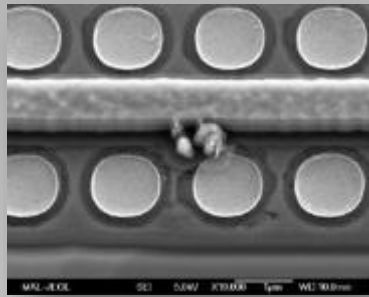


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Electron Microscope Imaging

JEOL 6500 FESEM

w/ Energy Dispersive Spectroscopy



- Images of 45nm features
- Oxford Inca 450 EDX

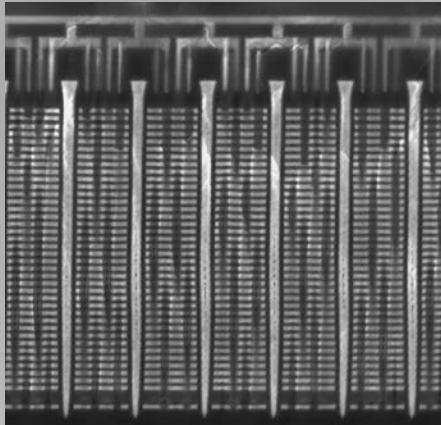


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Electron Microscope Imaging

FEI Nova Nanosem 450



- Variable Pressure SEM
- 0.5 KeV to 30KeV
- Images of 14 nm features
- Holds 4" dia. samples

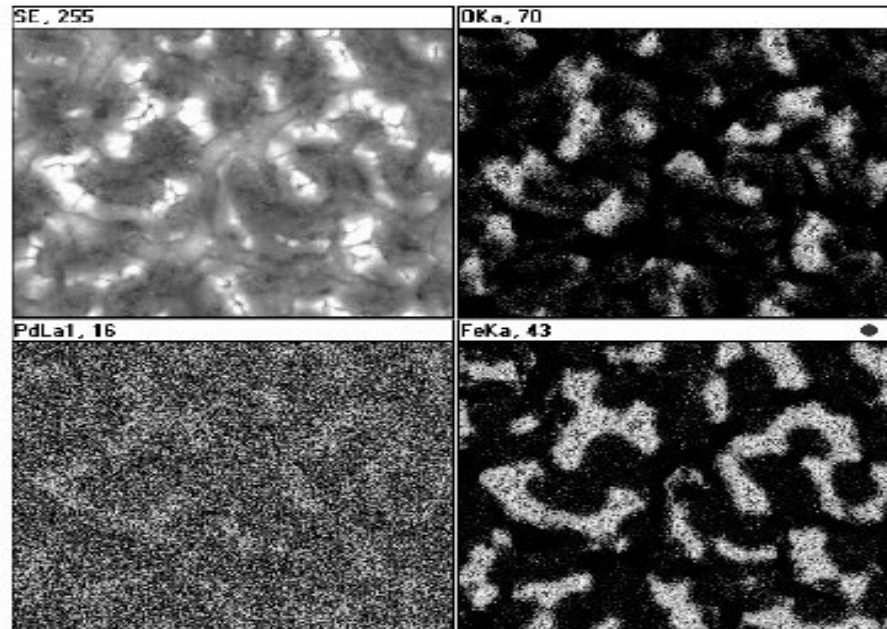


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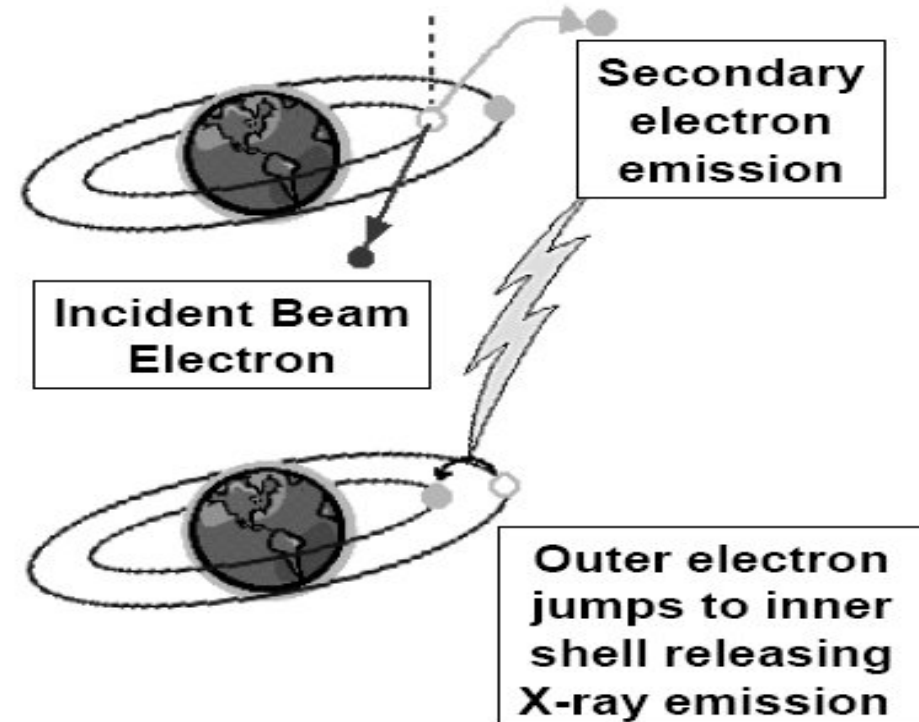


EDX for SEM Materials Analysis

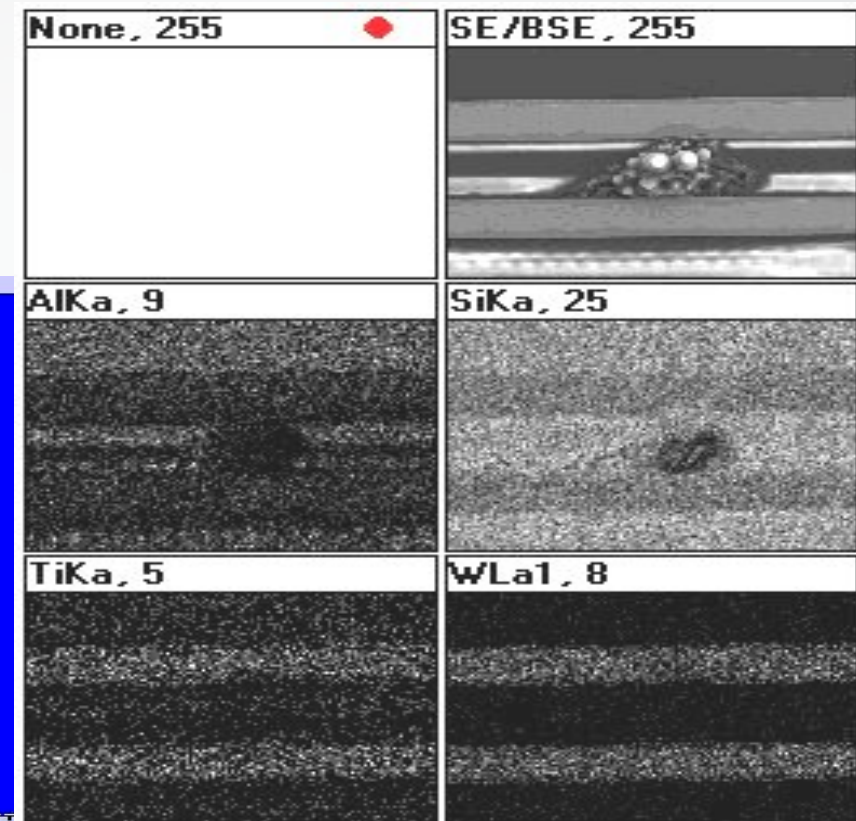
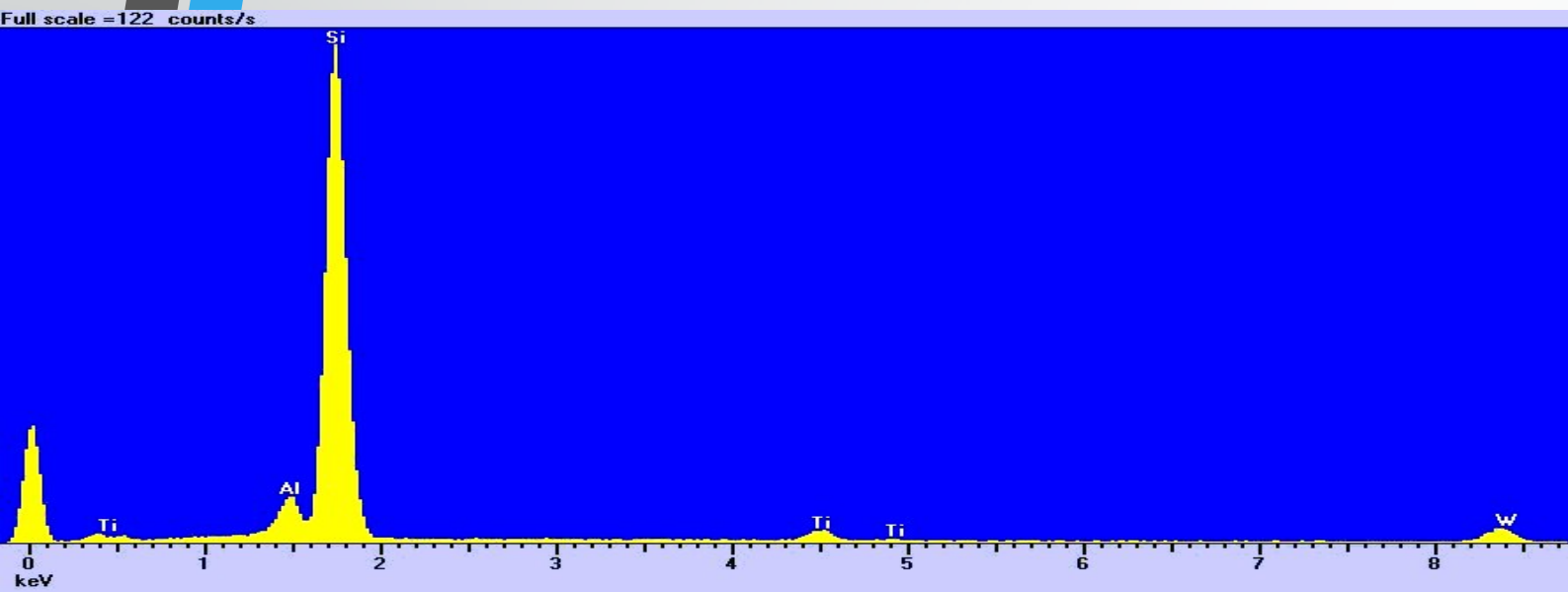
Energy Dispersive X-ray



X-ray Emission



EDX Materials ID



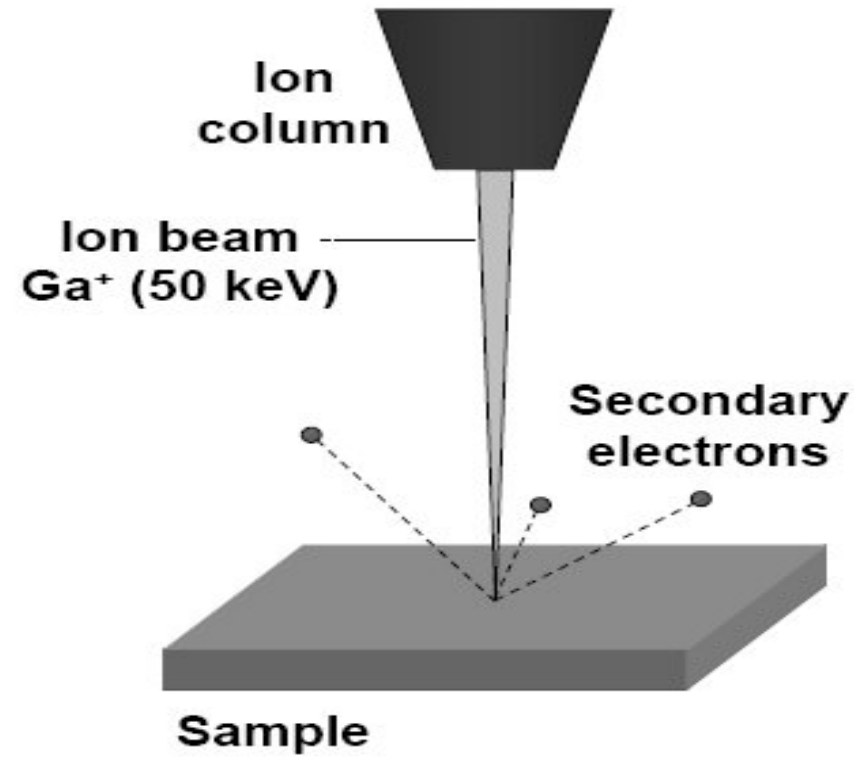
Focused Ion Beam

FEI P₃X Circuit Edit FIB

FEI Dual Beam FIB



FIB Tool Basics

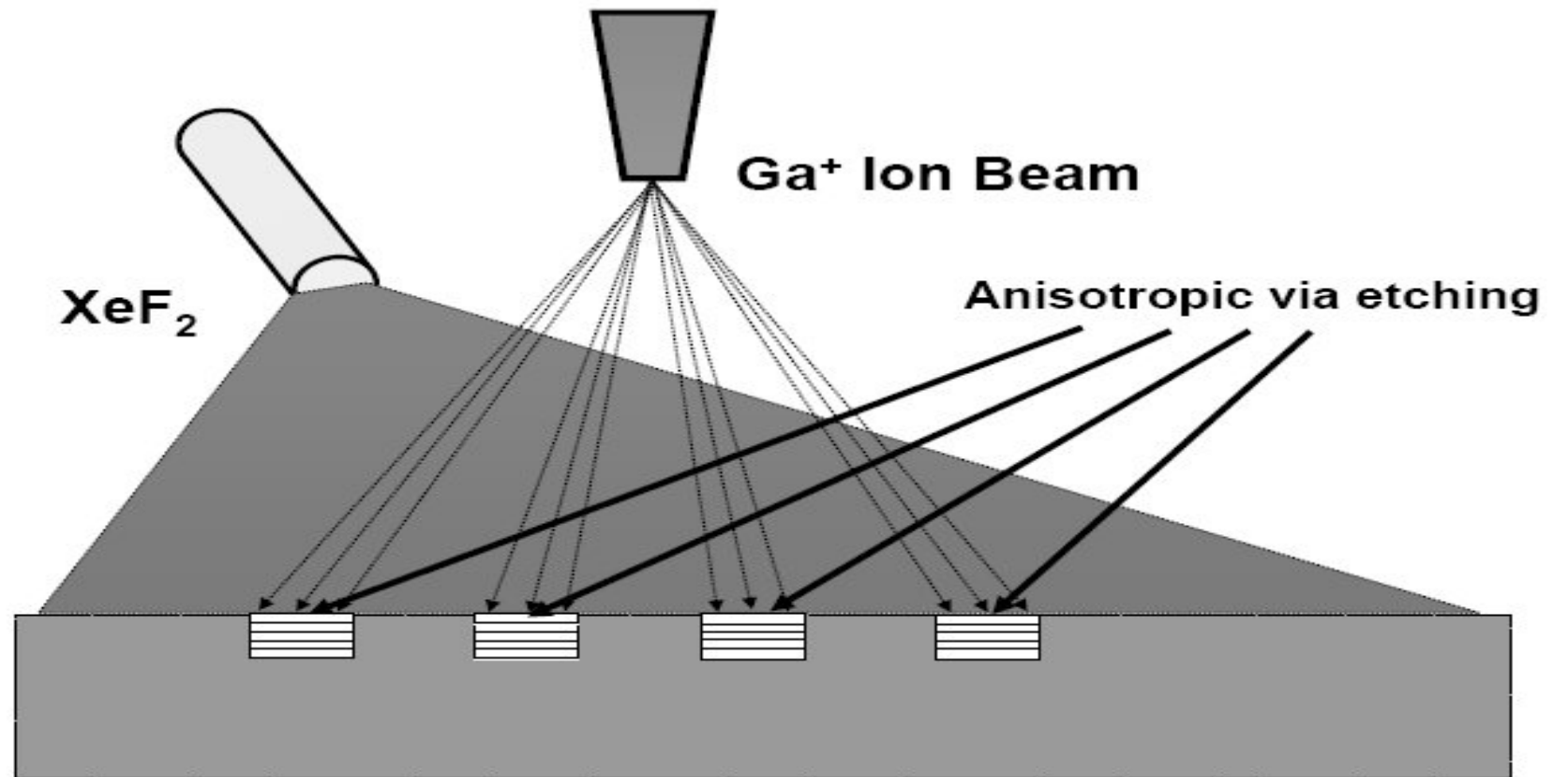


Like an SEM, but primary beam is Ga^+ (30 - 50 keV)

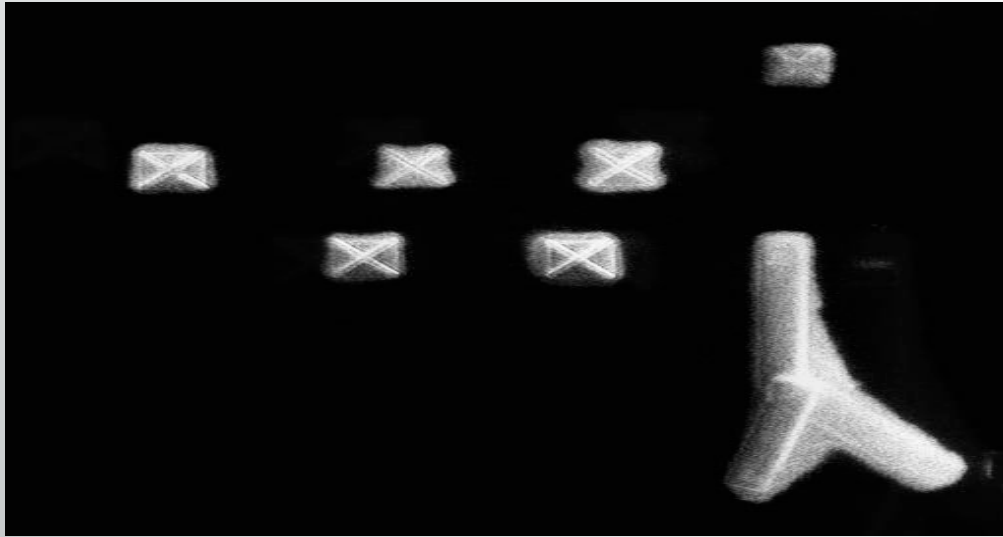
Use beam to sputter

Image by collecting secondary electrons

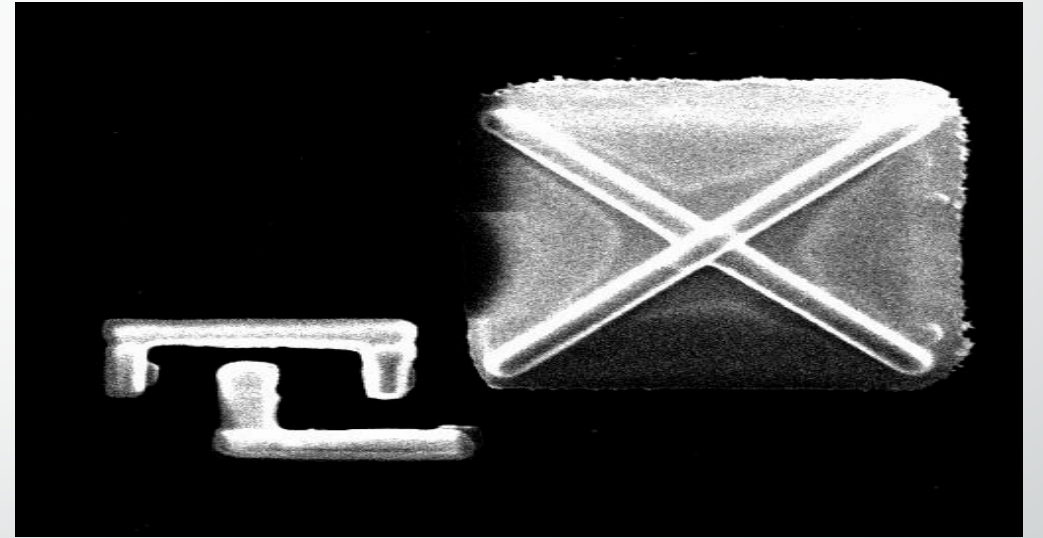
GAE Etching into Oxide



Probe Pads for Characterization

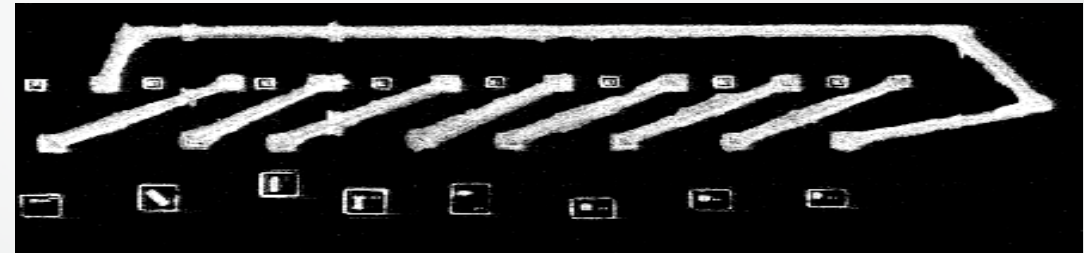
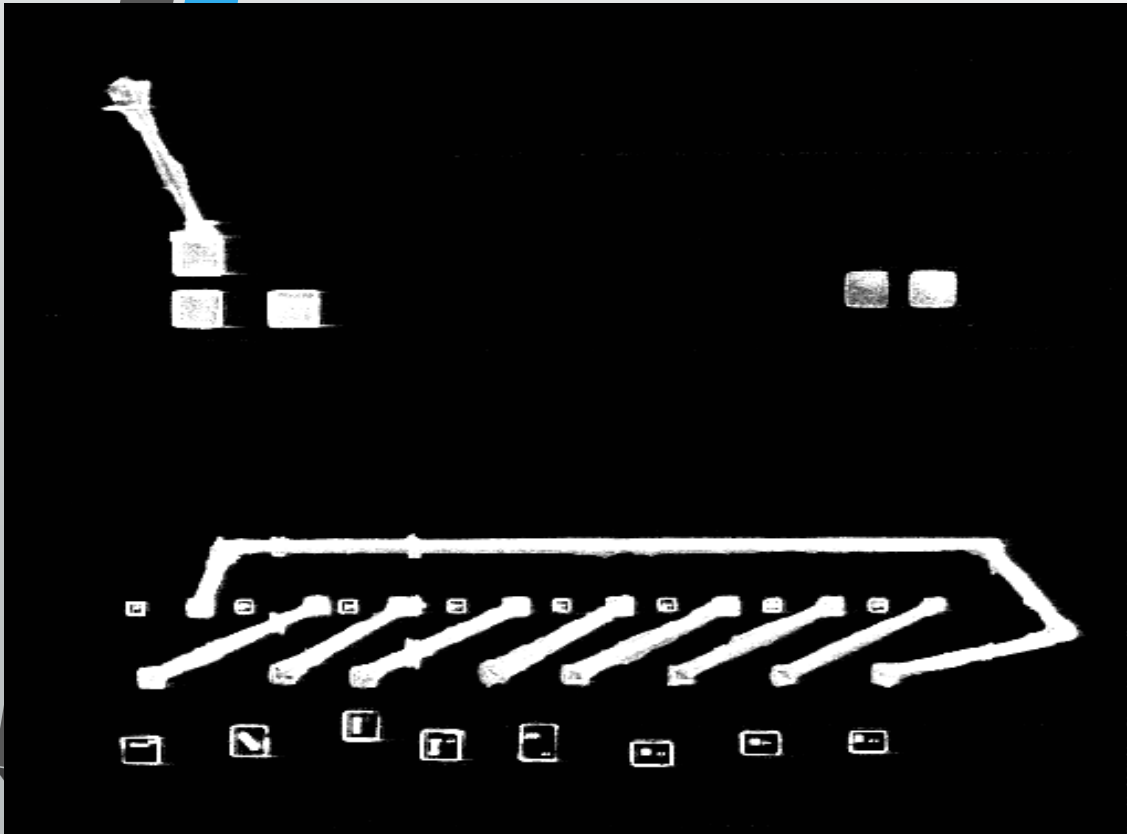


IC modification and 6 5x5um FIB probe pads



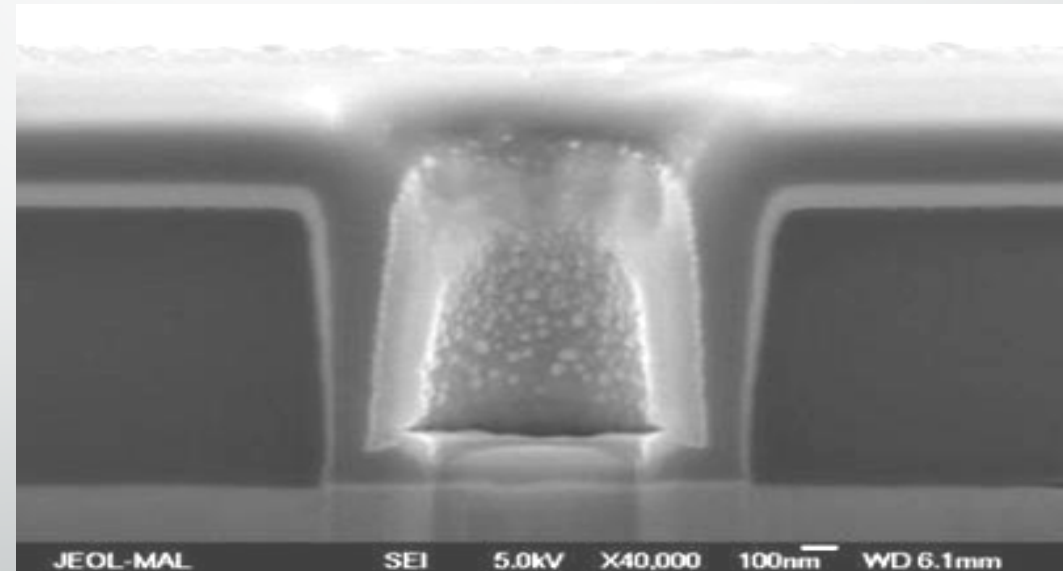
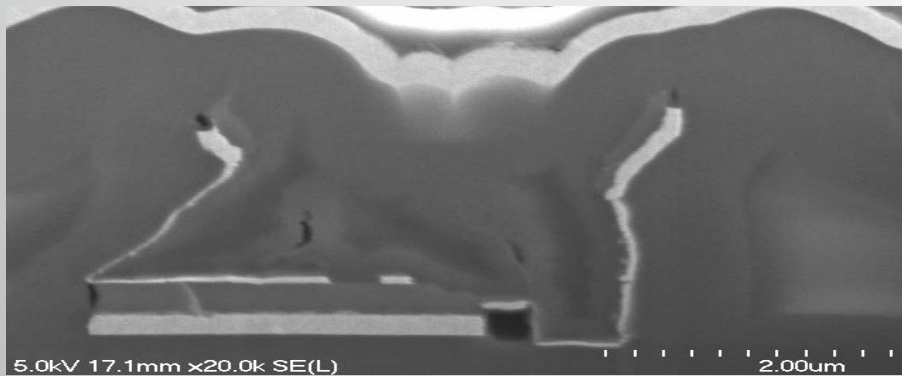
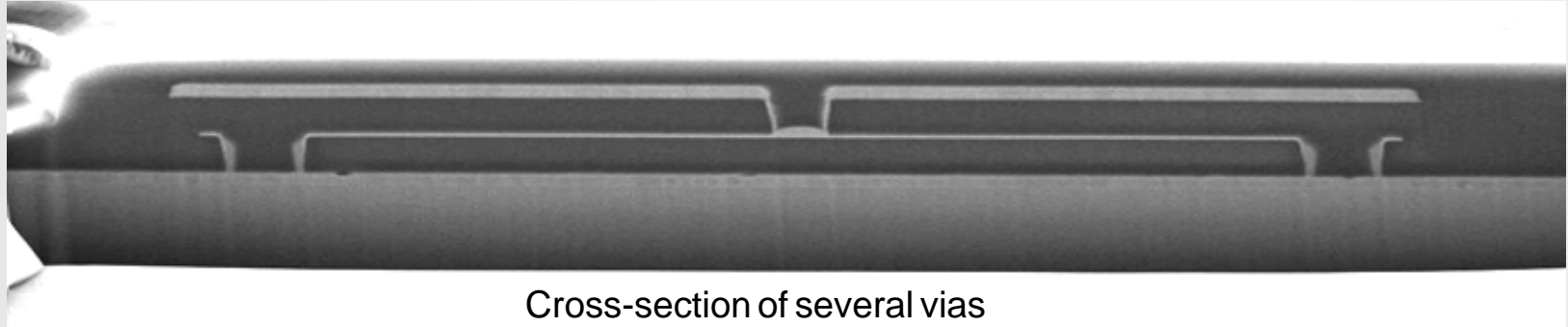
IC modification with FIB probe pad

IC Modifications



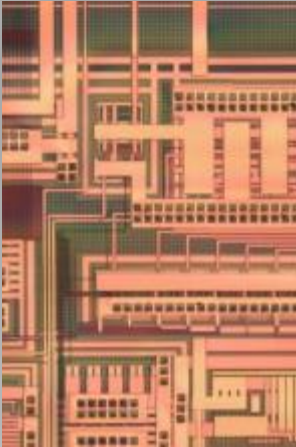
Circuit modification to shift 8 phases of PLL on 6 level 130nm device:
The edit consisted of 16 cuts on met3 and 17 jumpers from met3 to met3.
The 7 diagonal jumpers are $7\mu\text{m} \times 0.7\mu\text{m}$. The edit was completed successfully on 3 devices.

Dual Beam FIB Cross-Sections



Deprocessing

Chemical Deprocessing



- Wet and dry (RIE/Plasma) chemical delayering
- Chemical decorations/Stains

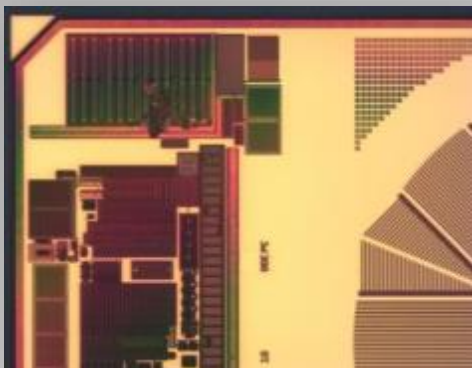


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Deprocessing

3 Allied HighTech Multiprep Polishers



- Mechanical Polishing
- Backside Thinning
- Precision Delayering
- Whole die Delayering



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Teardowns

Reverse Engineering

- Complete Device Teardown
- TV's, Phones, Smart Watch
- System and IC level detail
- Electrical Testing

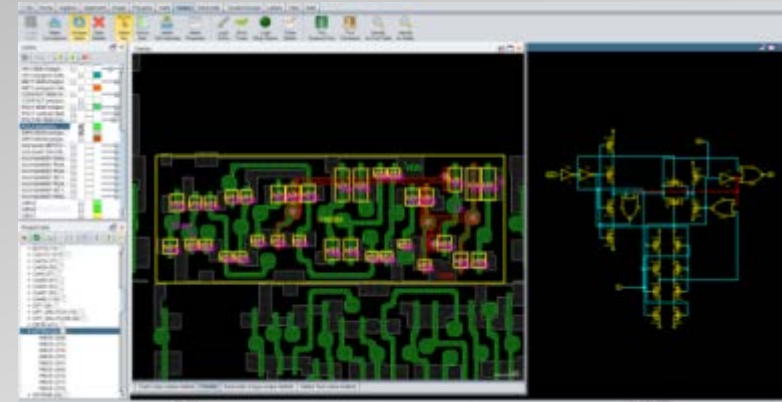
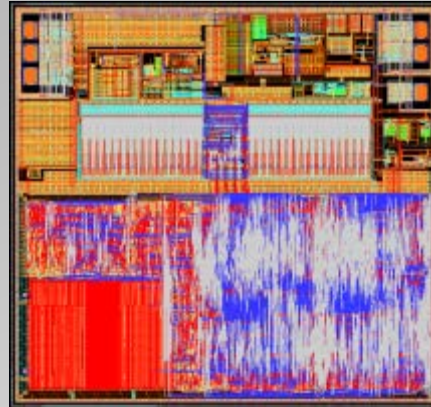
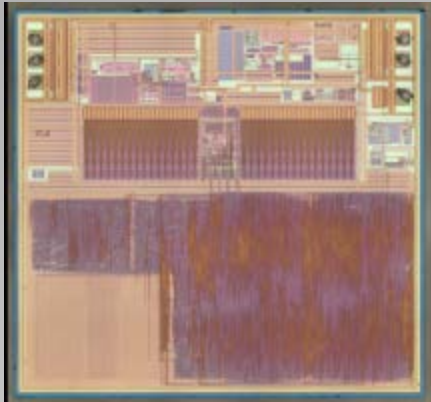


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Reverse Engineering

Circuit Extraction



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