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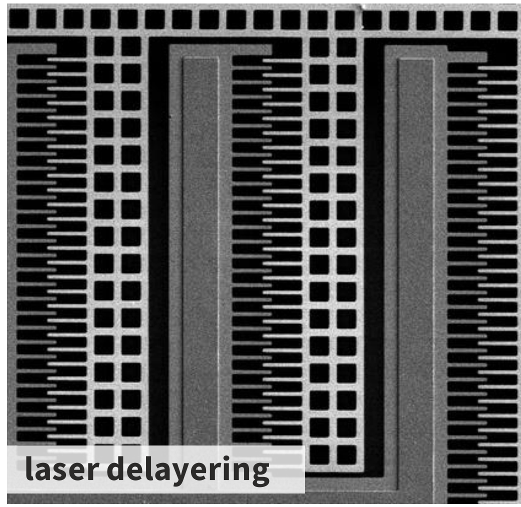
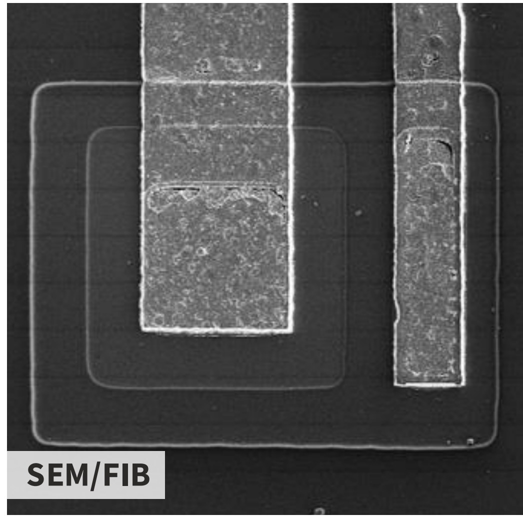
Semiconductors testing

Semiconductor industry continues to develop and the state-of-the-art semiconductor devices are not only getting smaller than their precursors, but also more complex. As a result, they require more sophisticated tools needed for development, prototyping, identification and control of defects, as well as making precise and high-resolution microscopic observations.

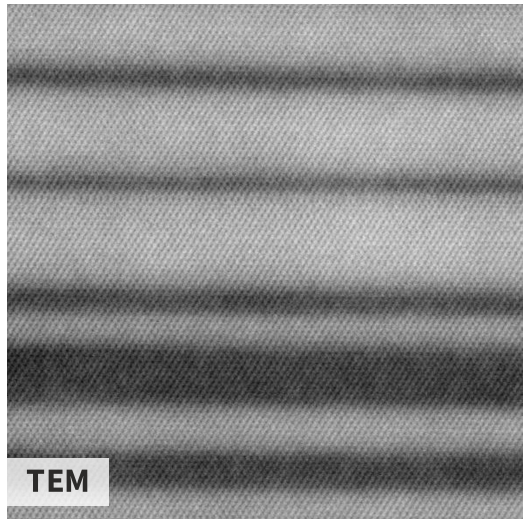
Scanning electron microscopy (SEM) in combination with focused ion beam (FIB) is a perfect technique that offers high-precision analytical capabilities.





about us

the state-of-the-art independent laboratory of nanotechnology in Poland



Accessibility
No formalities to start a collaboration

Participation in research
Opportunity to participate on-site and online

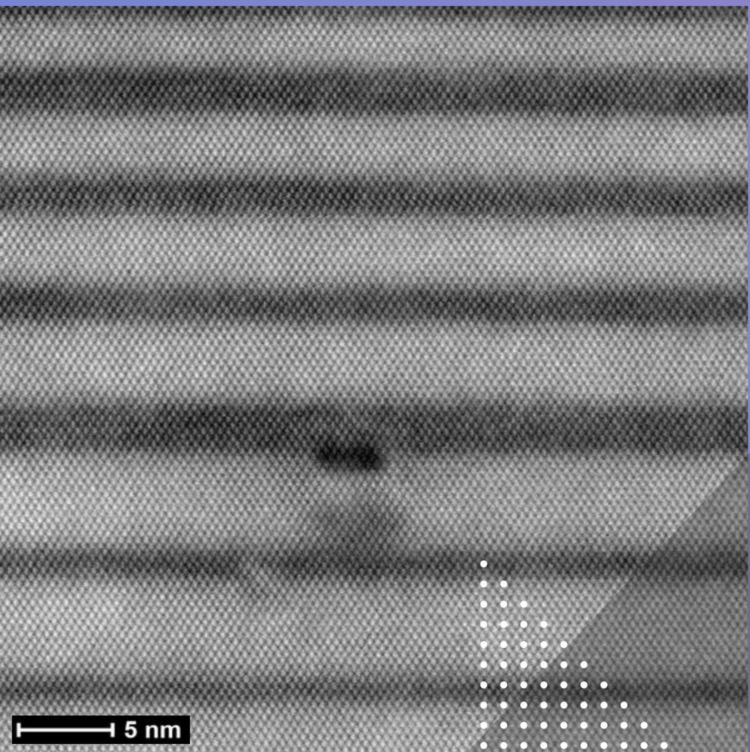
Flexibility
Research vouchers for time flexible projects, help with EU funding

IP Protection
Including NDAs, restricted access, safe for valuable samples etc.

Rapid order processing
2-weeks standard, 24/72h priority orders

Characterization of semiconductor structures

Measurements of the topography and morphology of semiconductor structures like nanowires, heterostructures, distributed bragg reflectors, quantum wells, etc. based on Ultra High Resolution Scanning Electron Microscopy (SEM) combined with Energy Dispersive Spectroscopy (EDS) for elemental analysis and Focused Ion Beam (FIB) for analysis of cross section and Transmission Electron Microscopy (TEM) lamella preparation.



Testing semiconductor structures during the design, development, and production process is crucial for several reasons:

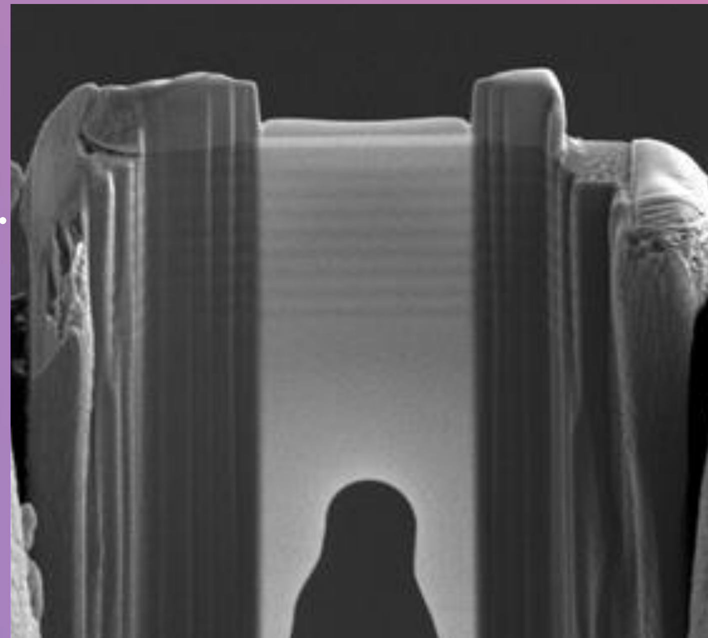
Quality Assurance: These techniques allow for the inspection of semiconductor structures at a microscopic level, ensuring that the structures meet quality standards. Detecting defects or irregularities early in the process can prevent costly errors later on.

Characterization: SEM, FIB, TEM and EDS provide detailed information about the physical and chemical properties of semiconductor structures. This characterization helps engineers understand the behavior of the materials and optimize their performance.

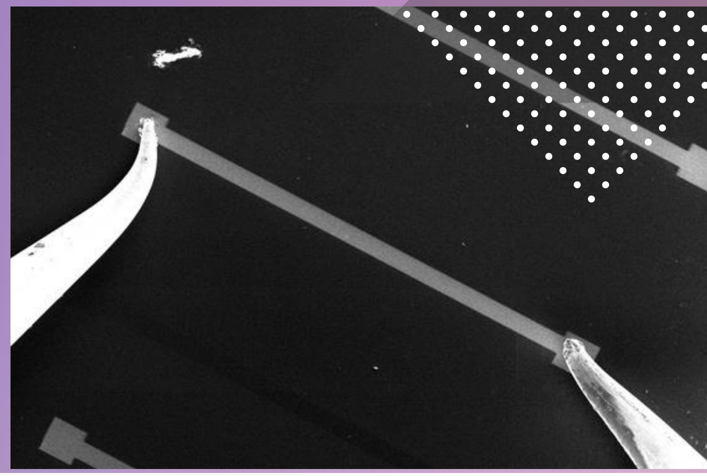
Failure Analysis: In the event of a malfunction or failure, SEM, FIB, and EDS can be used to analyze the root cause. By examining the structure at a high resolution and identifying elemental composition, engineers can determine what went wrong and take corrective action.

Process Optimization: By studying semiconductor structures during various stages of the production process, engineers can identify areas for improvement and optimize manufacturing processes. This can lead to increased efficiency, higher yields, and lower costs.

Research and Development: SEM, FIB, TEM and EDS are valuable tools for research and development in the semiconductor industry. They enable scientists and engineers to explore new materials, fabrication techniques, and device architectures, leading to innovation and advancement in the field.

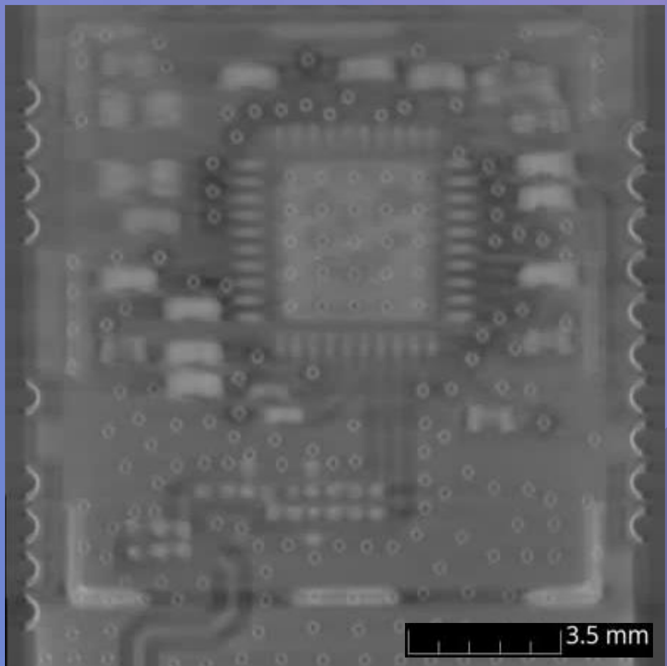


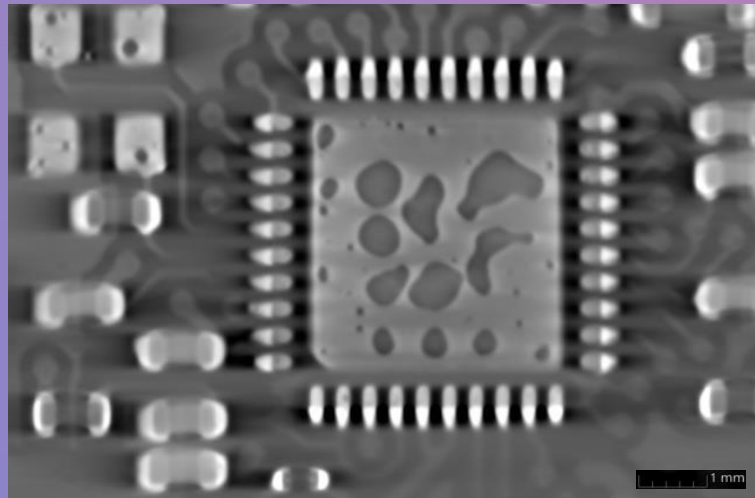
Overall, the use of SEM, FIB, TEM and EDS in the design, development, and production of semiconductor structures helps ensure quality, reliability, and performance while driving innovation and continuous improvement in the industry.



ICs testing - CT scan

Using Computerized Tomography (CT) scans to examine integrated circuits (ICs) is important for several reasons, particularly in the context of quality control, failure analysis, and research and development of advanced electronics. CT scans are a powerful tool for examining integrated circuits, offering a non-destructive means to gain detailed internal insights. This technology enhances accuracy, efficiency, and reliability in the analysis and production of ICs, ultimately contributing to higher quality and performance in electronic devices.





Benefits of Using CT Scans for IC Examination:

Enhanced Accuracy: High-resolution, 3D images provide a more accurate and complete view of the IC's internal structure compared to traditional 2D X-rays or optical inspection.

Time Efficiency: Rapid acquisition of detailed images can speed up the diagnostic process, reducing downtime, accelerating the development, and manufacturing cycles.

Failure Analysis: Allows for precise identification of failure points and mechanisms, facilitating root cause analysis and enabling targeted improvements in design and manufacturing processes.

Process Optimization: Insights gained from CT scans can help refine manufacturing processes to reduce defect rates and improve yield.

Verification and Validation: Essential for verifying the integrity of ICs in critical applications, such as in aerospace, automotive, and medical devices, where reliability is paramount.

Importance of CT Scans for IC Examination:

Non-Destructive Testing: CT scans allow for internal inspection of ICs without physically altering or damaging them. This is crucial for preserving the integrity of the components during analysis.

Detailed Internal Imaging: CT scans provide highly detailed 3D images of the internal structures of ICs. This includes viewing layers, connections, and potential defects that are not visible through traditional 2D imaging techniques.

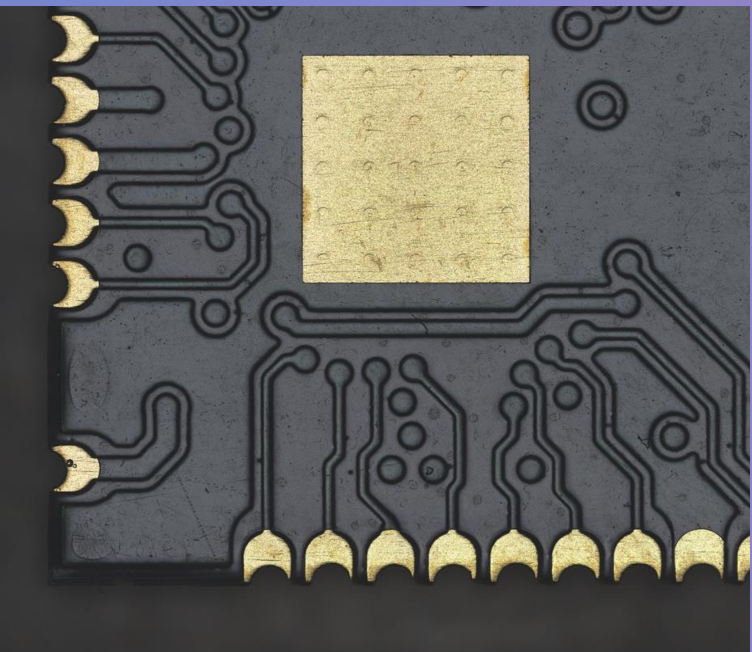
Defect Identification: They can identify and characterize various types of defects such as voids, cracks, delaminations, and inclusions. This is essential for understanding failure mechanisms and improving manufacturing processes.

Quality Control: CT scans help ensure that ICs meet quality standards by detecting defects early in the production process. This helps in maintaining high reliability and performance of electronic devices.

Reverse Engineering: For competitive analysis or legacy system maintenance, CT scans can be used to reverse-engineer ICs by providing detailed insights into their internal structure and layout.

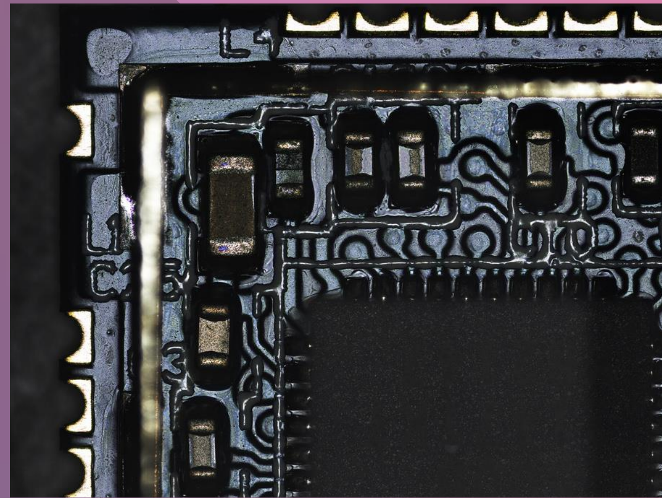
ICs testing – confocal

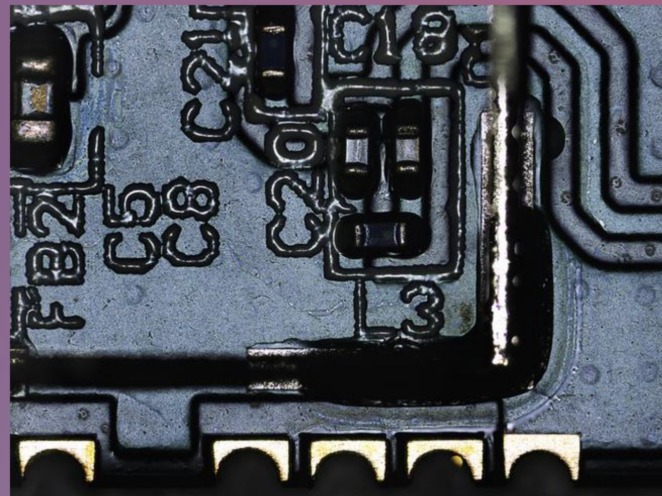
Using confocal microscopy in the testing of integrated circuits (ICs) provides high-resolution imaging capabilities, precise depth profiling, and enhanced contrast, which are crucial for detailed inspection and analysis of ICs. Confocal microscopy is an invaluable tool in the testing and analysis of integrated circuits due to its ability to provide high-resolution images. Its non-destructive nature and precise depth profiling capabilities make it particularly suited for inspecting the complex, multi-layered structures of modern ICs. By employing confocal microscopy, manufacturers and researchers can ensure higher quality, reliability, and performance of integrated circuits, driving advancements in electronics and semiconductor technology.

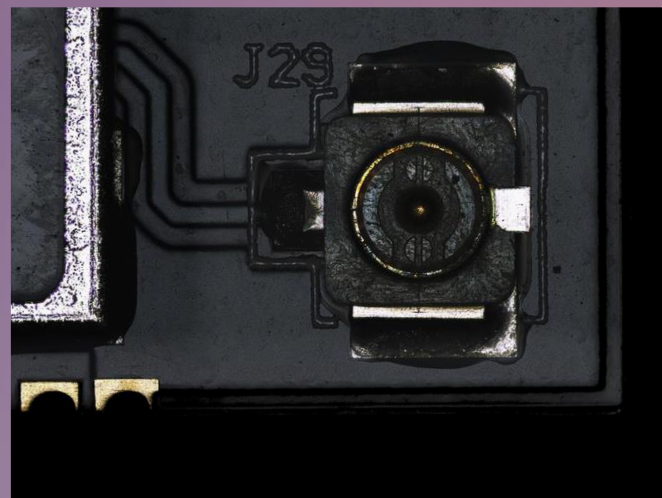


Key Reasons for Using Confocal Microscopy in IC Testing:

- Confocal microscopy offers superior lateral and axial resolution compared to traditional optical microscopy. This high resolution is essential for examining the intricate and densely packed features of modern ICs.
- The ability to resolve fine details allows for the detection of defects, such as micro-cracks, voids, or irregularities in the semiconductor material, which can affect the performance and reliability of ICs.
- Confocal microscopy is a non-invasive technique that allows for thorough examination without damaging the IC. This is important for preserving the integrity of high-value or unique samples.
- During the manufacturing process, confocal microscopy can be used to monitor the quality and uniformity of ICs, ensuring that they meet specifications and standards.
- In cases of IC failure analysis, confocal microscopy helps identify the root causes by revealing defects and anomalies that might have led to the failure, facilitating improvements in design and manufacturing processes.







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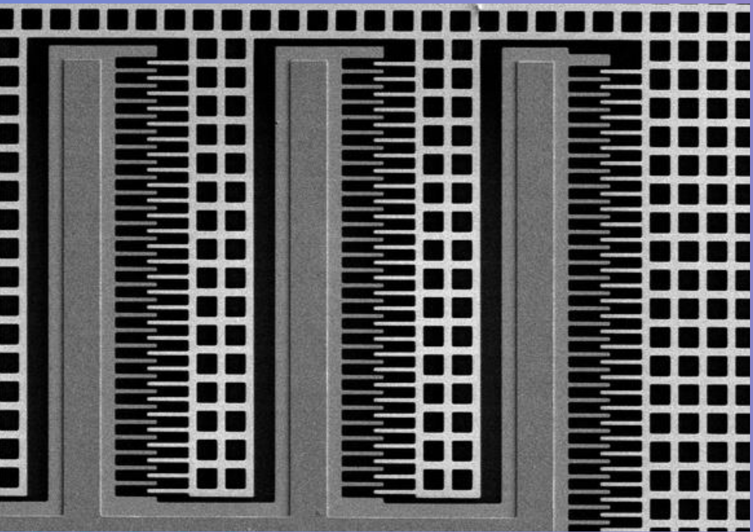
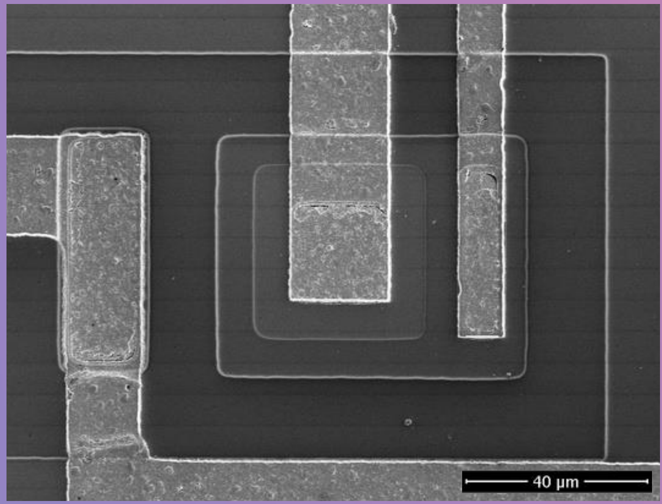
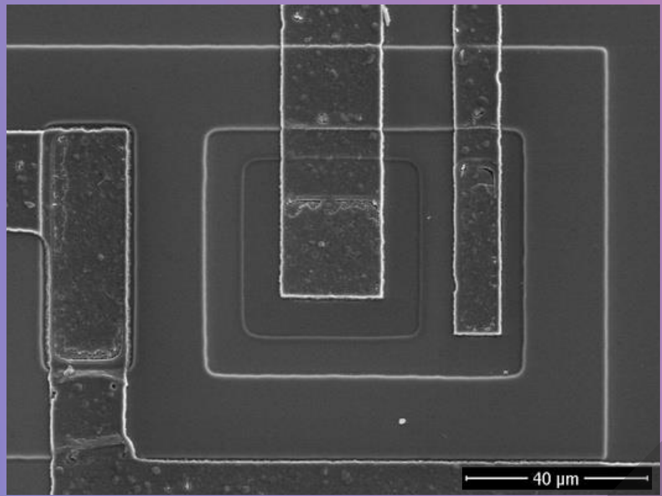
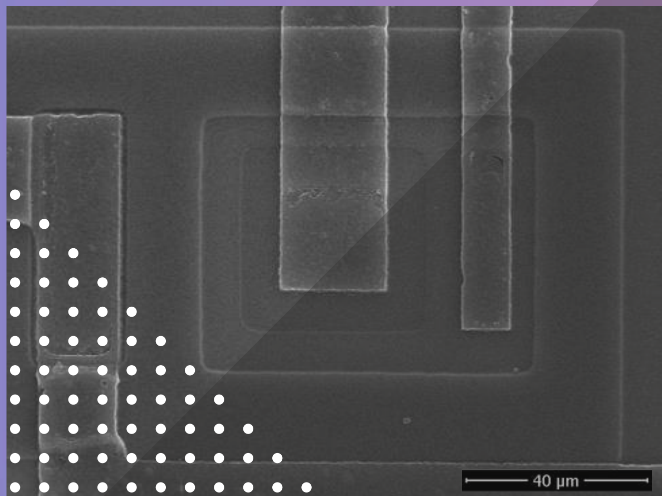
ICs testing - SEM imaging

SEM microscopy offers unparalleled advantages for the testing and analysis of integrated circuits, providing high-resolution imaging, versatile signal detection, and detailed failure analysis capabilities. Its ability to deliver detailed surface and subsurface information, combined with non-destructive testing, makes SEM an essential tool in ensuring the quality, reliability, and performance of modern ICs.







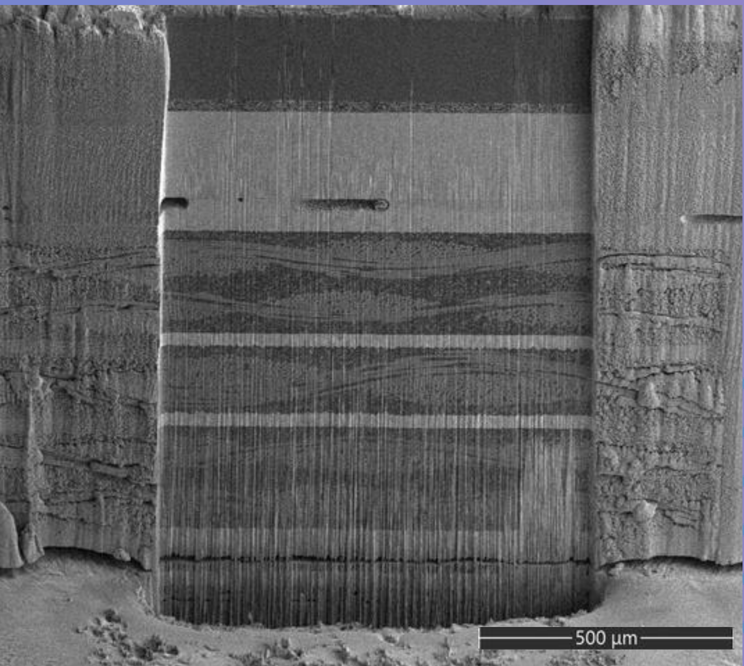


Using Scanning Electron Microscopy (SEM) for integrated circuits (ICs) testing offers several significant advantages, making it an invaluable tool in the semiconductor industry:

- SEM provides extremely **high-resolution images**, typically down to the nanometer scale. This allows for the detailed examination of surface features and fine structures within ICs, which is crucial for identifying defects and ensuring quality.
- With modern ICs having features as small as a few nanometers, SEM's **ability to visualize** these tiny features is essential for accurate inspection and analysis.
- **Secondary Electrons (SE):** These provide detailed topographical information, which is essential for examining the surface structure and identifying physical defects such as cracks, voids, and contamination.
- **Backscattered Electrons (BSE):** These provide compositional contrast, which is useful for identifying different materials and layers within the IC. This can help in detecting issues like incorrect material deposition or diffusion.
- When combined with EDS, SEM can provide **elemental composition analysis.** This is valuable for verifying the material composition of various parts of the IC and identifying contamination or impurities.
- SEM is critical for failure analysis, enabling the detailed examination of defects that may cause IC failure. This includes **identifying issues** such as electromigration, stress voiding, and contamination.
- By providing detailed images and compositional data, SEM helps engineers **trace the root causes of failures**, allowing for targeted improvements in design and manufacturing processes.

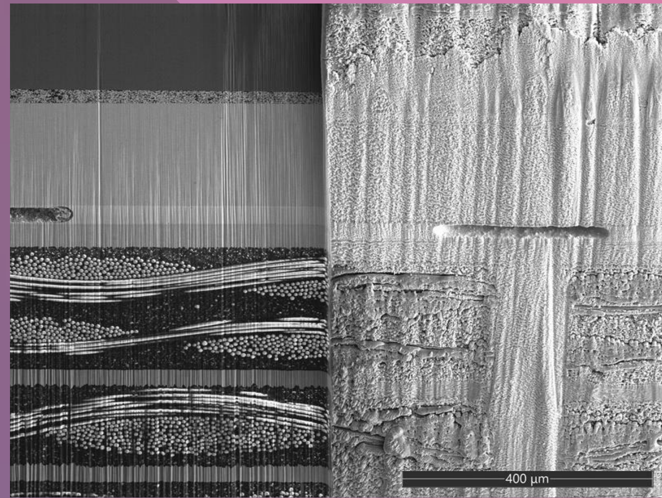
ICs testing with a femtosecond laser followed by polishing it with a Focused Ion Beam (FIB)

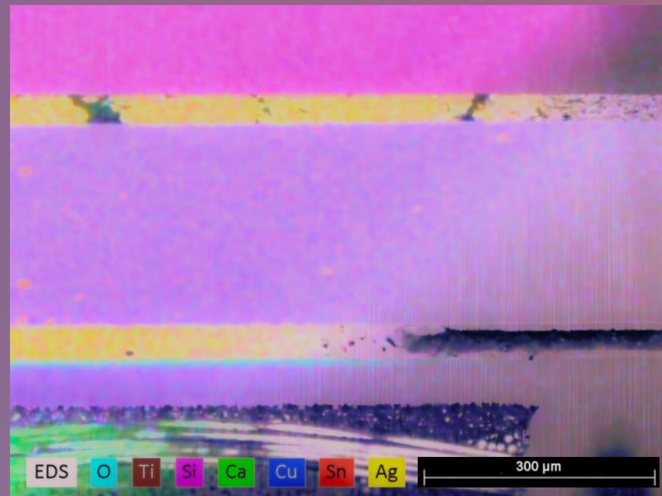
The combined use of femtosecond laser ablation and FIB polishing for cross-sectioning ICs offers significant advantages in terms of speed, precision, and quality. This approach enables detailed and accurate analysis of ICs, facilitating failure analysis, quality control, and research and development in the semiconductor industry.

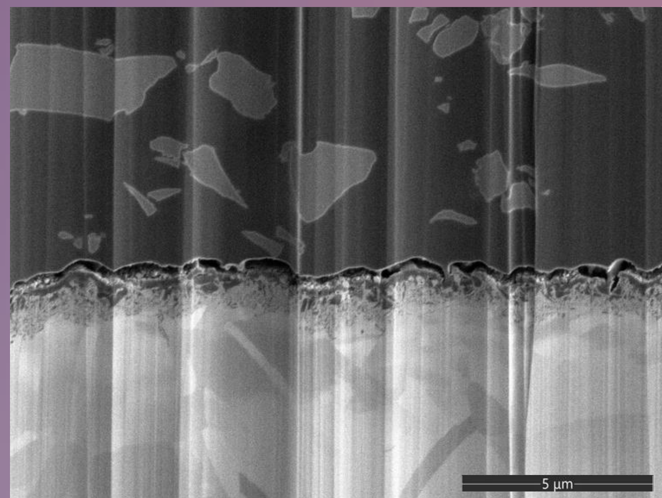


Benefits of the both methods combined:

- Rapid Bulk Removal: The femtosecond laser quickly removes large volumes of material, significantly speeding up the cross-sectioning process compared to using FIB alone.
- Precision Polishing: FIB provides the fine control needed for the final polishing steps, ensuring a high-quality cross-section suitable for detailed analysis.
- Non-Thermal Laser Ablation: The femtosecond laser minimizes thermal damage to the surrounding material, preserving the integrity of the IC features near the cross-section.
- Accurate Material Removal: FIB's precise milling ensures that only the desired material is removed, maintaining the accuracy of the cross-section.
- Surface Smoothness: The combination of femtosecond laser ablation and FIB polishing produces cross-sections with smooth surfaces, free from artifacts that could obscure important features.
- Detailed Analysis: High-quality cross-sections are essential for techniques like SEM, and Energy Dispersive X-ray Spectroscopy (EDS), which require pristine surfaces for accurate imaging and analysis.

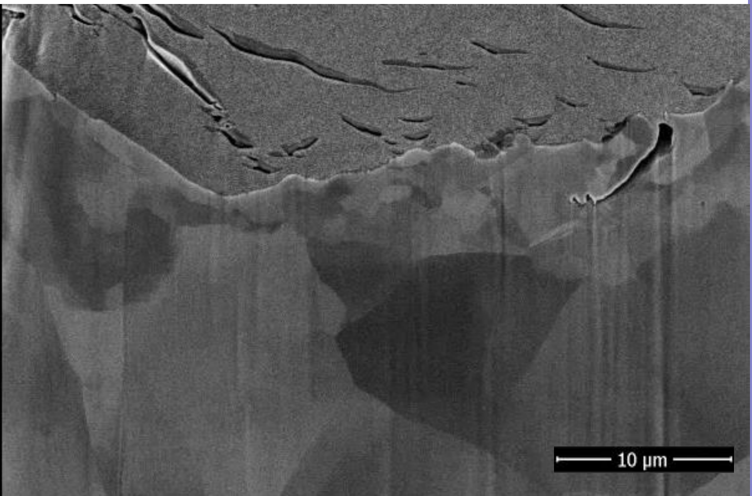






Delayering an integrated circuit (IC) with a Xenon Plasma Focused Ion Beam (Xe-PFIB)

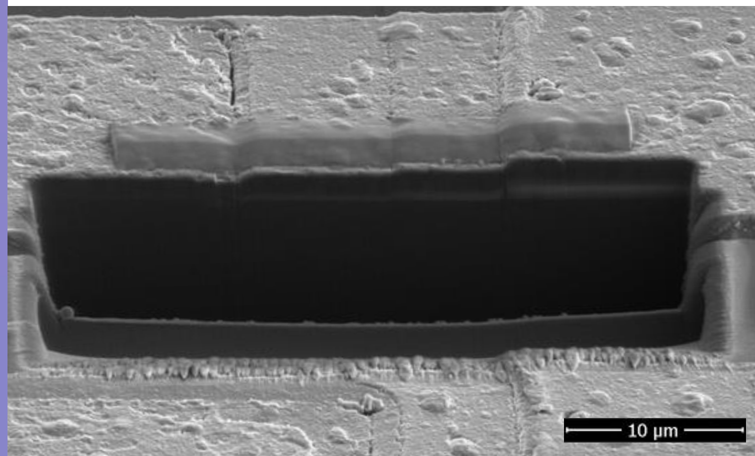
Using the method of delayering an integrated circuit (IC) with a Xenon Plasma Focused Ion Beam (Xe-PFIB) is important due to several key advantages and features that it offers. This technique is crucial for detailed analysis, quality control, and failure diagnosis of ICs. This method is critically important for its efficiency, precision, and minimal contamination. The high milling rates, combined with fine control and minimal damage, make Xe-PFIB an essential tool for detailed IC analysis. Its integrated imaging and analytical capabilities further enhance its utility, making it indispensable for failure analysis, quality control, and research in the semiconductor industry.



Importance of Using Xe-PFIB for IC Delayering:

Efficient Material Removal:

- High Throughput: Xe-PFIB can remove material much faster than traditional Gallium FIB (Ga-FIB) due to the heavier xenon ions, which results in higher sputter rates. This efficiency is critical for delayering the numerous and often thick layers in modern ICs.
- Reduced Milling Time: Faster material removal translates into shorter analysis times, allowing for quicker turnaround in failure analysis and quality control processes.



Minimized Contamination:

- Chemical Inertness: Xenon is a noble gas and does not react with the sample material. This inertness reduces the risk of introducing chemical contamination, preserving the integrity of the IC during analysis.
- No Implantation: Unlike Ga-FIB, where gallium can be implanted into the sample, xenon's larger atomic size and chemical properties minimize implantation effects, maintaining the sample's original characteristics.

High Precision and Control:

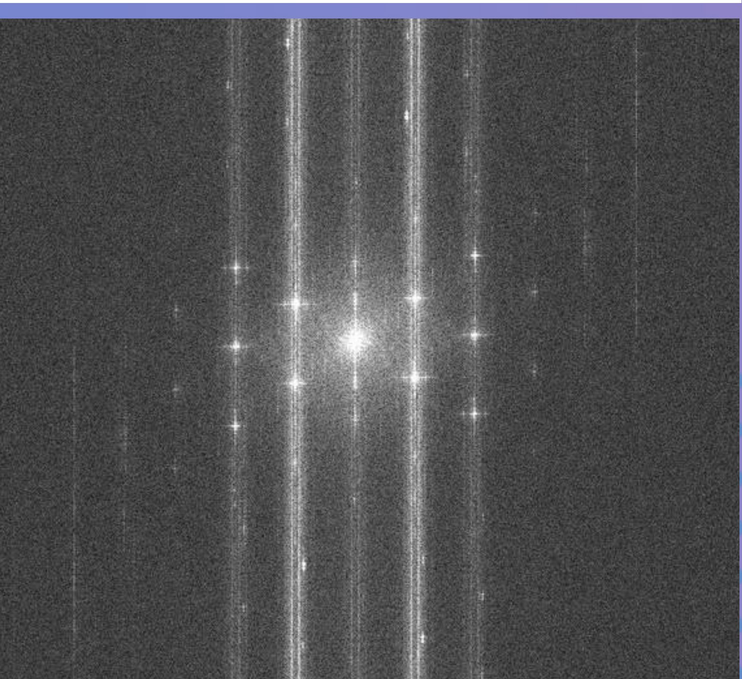
- Fine Milling: Xe-PFIB allows for precise control over material removal, enabling the creation of smooth and even cross-sections. This precision is essential for accurately exposing and analyzing each layer of the IC.
- Depth Resolution: Accurate depth control ensures that each layer can be removed incrementally, providing detailed information about the IC's structure and construction.

Enhanced Imaging and Analysis:

- Integrated SEM: Many Xe-PFIB systems are equipped with scanning electron microscopy (SEM) capabilities, allowing for high-resolution imaging of each exposed layer immediately after milling. This integration facilitates detailed, real-time analysis.
- Elemental Analysis: Coupled with techniques like Energy Dispersive X-ray Spectroscopy (EDS), Xe-PFIB allows for compositional analysis of each layer, aiding in the identification of materials and potential contaminants.

Advanced TEM Characterization of Semiconductor Lamellae

Transmission Electron Microscopy (TEM), along with Energy Dispersive Spectroscopy (EDS) and Selected Area Electron Diffraction (SAED), provides unparalleled insight into the properties of semiconductor lamellae. Our facility offers comprehensive sample preparation using both Gallium Focused Ion Beam (Ga-FIB) and Xenon Plasma Focused Ion Beam (Xe-PFIB) techniques, followed by Ultra-High Resolution Transmission Electron Microscopy (UHRTEM) analysis.



TEM analysis in its full form includes:

UHRTEM allows for direct imaging of the internal structure of semiconductor materials at atomic resolution.

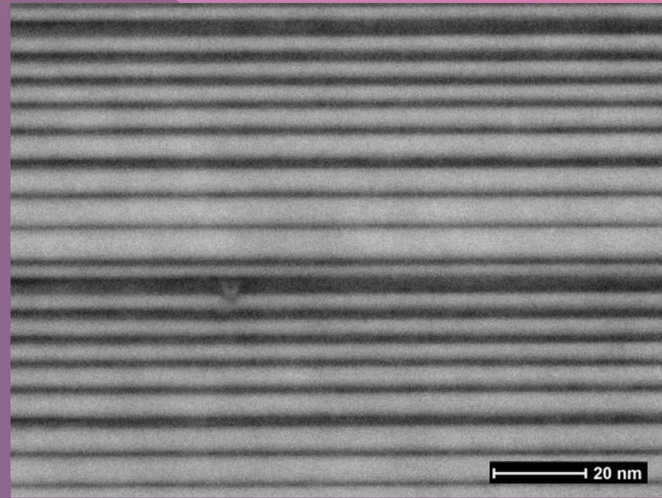
- High-resolution imaging to analyze defects, interfaces, and crystallographic orientation.
- Elemental mapping and composition analysis via EDS.
- Crystallographic phase identification using SAED.

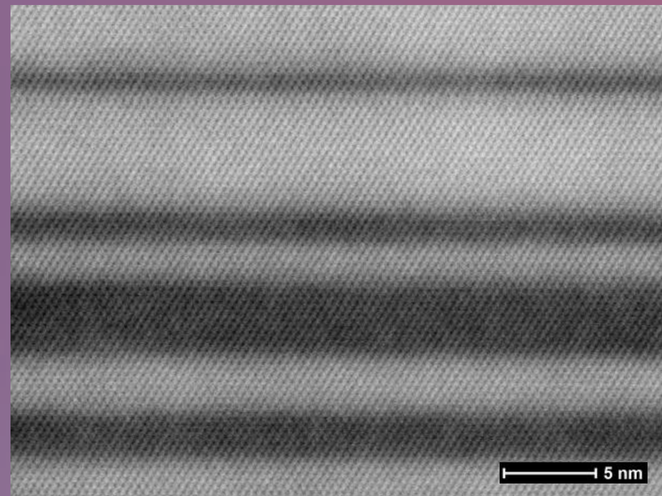
Elemental Composition Energy Dispersive Spectroscopy (EDS) integrated with TEM enables precise elemental analysis by detecting X-ray emissions from the sample.

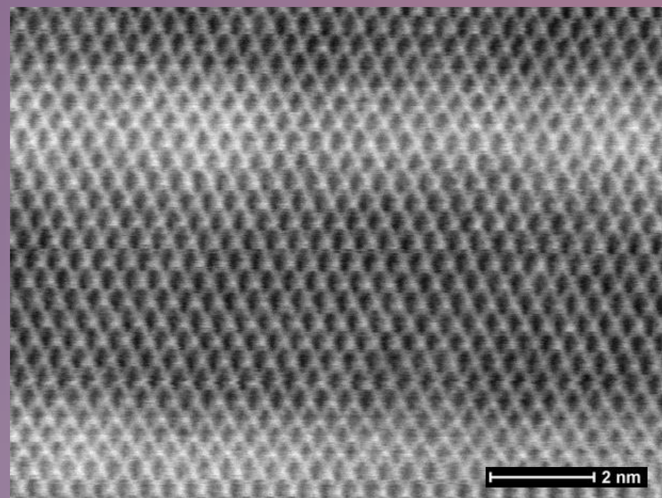
- Identifying dopant distribution in semiconductor materials.
- Detecting contamination or unintended elements.
- Understanding diffusion processes at interfaces.

Crystallographic Analysis Selected Area Electron Diffraction (SAED) is a tool for investigating the crystallographic structure of semiconductor lamellae.

- Determination of grain orientation and phase identification.
- Detection of strain and defects in crystal structures.
- Correlation between microstructure and electronic properties.







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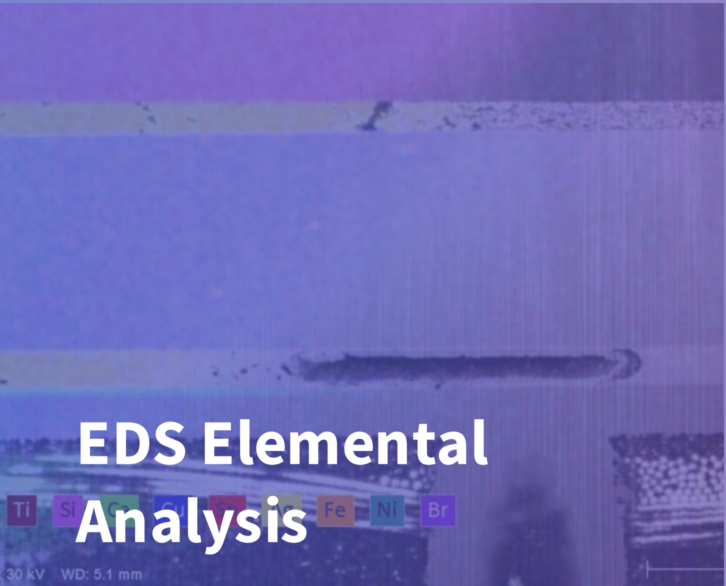
OTHER TECHNIQUES



EDS Elemental Analysis

The Phenom Elemental Mapping Software from Thermo Scientific provides fast and reliable information on the distribution of chemical elements within a sample.

Micro- and nanocomponents production

The manufacture of components at the micro- and nano-scale is a subject of the increasing interest around the world, both in academia and industry. Such components require high precision, repeatability and thorough quality control already at the production stage. Using the high-class equipment, methods and experience of our experts, we are able to manufacture precise components for such industries as: electronics and photonics, optics, automatics, MEMS and many others.

Femtolaser workstation

The unique laser workstation constructed by our team from independent elements consists of a femtosecond laser, a five-axis head (operating, among others, in the trepanation mode) and a movable table increasing the production capacities of even very complex geometries.

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Contact our specialist to receive this offer tailored to your needs.

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