Opening the Third Dimension to Your SEM

ZEISS LaserSEM

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Seeing beyond

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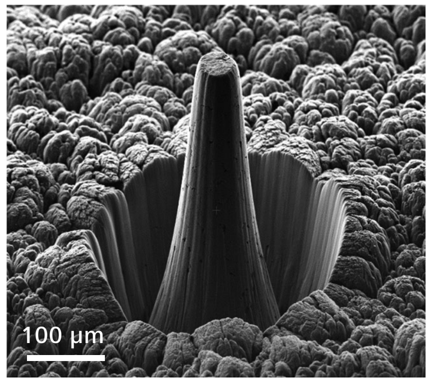
Your solution for site-specific preparation from the meso- to the microscale – a femtosecond laser integrated into a ZEISS FE-SEM

Materials researchers who want to characterize surfaces and bulk material comprehensively require imaging and analytical tools capable of spanning dimensions from 2D to 3D covering the meso- to the nanoscale. SEM (scanning electron microscope) and correlated XRM (X-ray microscope) data enable these multi-modal workflows. However, the first step in any analysis is always sample preparation and therefore has a significant impact on the quality of results.

Conventional sample preparation methods utilize standalone laser tools or FIB-SEMs with additional xenon plasma beams. But it is often overlooked that you will have to deal with time-consuming experiments, accept having to work with limited sample sizes and penetration depths or with tedious mechanical polishing often providing only poor end-pointing accuracy. Additionally, these methods may cause sample damage and contamination, which can impact instrument uptime and produce suboptimal results. You might even face insufficient sample quality for high resolution imaging and EDS and EBSD analytics.

What if you could perform site-specific large array sample preparation in 2D or 3D and achieve high resolution and optimal contrast with FE-SEM (field emission SEM) imaging, all in one instrument? Imagine you could get to millimeter- wide cross-sections and trenches in seconds or minutes instead of hours or days, and relocate ROIs (regions of interest) deeply buried in your volume that have previously been identified with an XRM. Even when aiming to achieve precision and speed in preparing large cross-sections, specimen arrays, or TEM lamellae, you could do that easily. And move directly to 3D tomography on large sections and EDS or EBSD analysis without losing time for additional FIB fine-polishing steps.

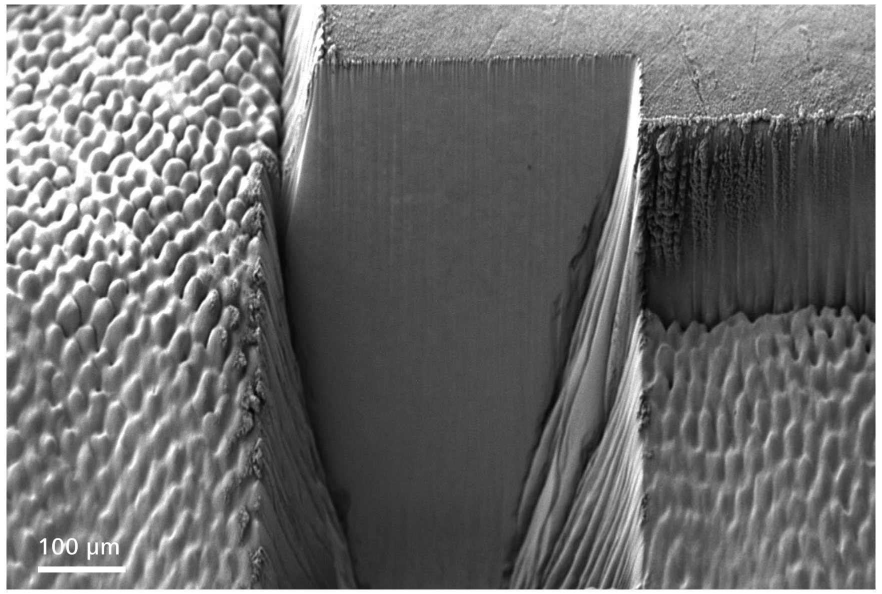


Nuclear graphite, free standing pillar prepared for nano X-ray tomography, top diameter 50 µm, height 300 µm, laser machining time 20 min

Opening the Third Dimension to Your SEM With an Integrated Laser

ZEISS LaserSEM is your fast and cost-effective solution for large array site-specific cross-sectioning and sample preparation from the meso- to the microscale. Rapidly prepare samples with a laser for massive material removal integrated into a ZEISS FE-SEM. Take advantage of the ZEISS Gemini electron optics tailored for the highest demands in imaging and analytics now combined with an integrated femtosecond (fs) laser. On top, LaserSEM offers the ability to automate your processes, and to correlate to other modalities like XRM.

- Perform site-specific cuts with the fs-laser in 2D and 3D with unprecedented speed and precisely relocate deeply buried sites.
- Image cross-sections or trenches with high resolution and optimal contrast.
- Analyze huge sections or deep trenches directly after a fast laser polish resulting in surfaces suitable for EBSD mapping.
- Accelerate workflows such as targeted EBSD on huge sections, preparation of arrays of TEM lamellae or pillars for micromechanical testing or even multi-modal workflows e.g. correlative experiments between XRM and SEM.
- Maximize your throughput by benefitting from automation, and pre-installed recipes to name only a few advantages of the LaserSEM.
- Invest in a future-proof modular platform: LaserSEM frees up FIB capacity for other FIB-SEMs in your lab, plus: it can be field upgraded with a gallium column if future needs might require it.



Copper, laser polished trench, sample preparation executed with preinstalled recipes enabling efficient laser processing with suitable parameters.

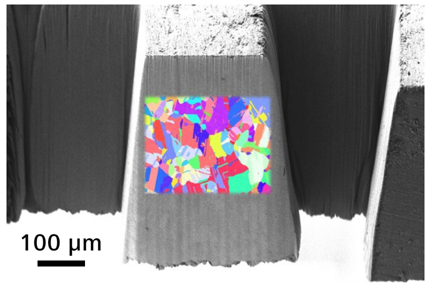
The fs-laser of the LaserSEM is set up on an airlock, a dedicated laser preparation chamber, that avoids contamination of the main instrument chamber and guarantees seamless shuttling between the two. It is optionally available with a semi-automated device for processes requiring high repeatability and throughput. The seamless integration of SEM and laser gives researchers in academic or industry R&D labs direct and simultaneous access to high resolution imaging and all analytical capabilities configurable with an FE-SEM, such as EDS or EBSD, no matter if they are interested in engineering, energy, or nanomaterials applications.

Highlights

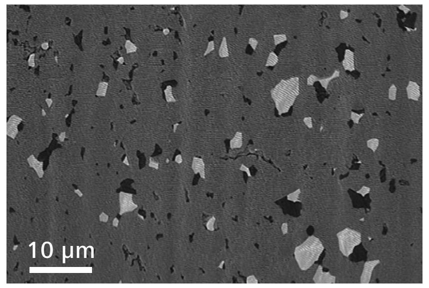
Cut, Image, and Analyze

Prepare massive cross-sections for EDS and EBSD analysis

- Benefit from fs-laser technology incorporated into your FE-SEM.
- Combine the imaging and analytical performance of a high resolution FE-SEM with an integrated fs-laser for massive material ablation.
- Remove millimeter-sized volumes of material with high accuracy and unprecedented speed.
- Create large cross-sections and directly acquire EDS and EBSD maps on areas of a size up to 1 mm × 1 mm.
- Protect your SEM column by ablating material only in a separate chamber equipped with a laser window and a protective gas jet.
- Make fresh cuts into air- and nitrogen-sensitive samples using high vacuum or a protective Argon atmosphere in the laser chamber.
- Connect your LaserSEM to a glove-box with an inert shuttle transfer compatible with the laser chamber.



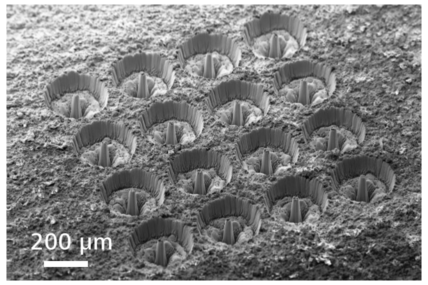
Laser-prepared surface of an alloy 600 sheet with overlaid EBSD map obtained on the laser-cut surface.



Ablation of 7 mm³ Ceramic (SiC-ZrB2), imaged direcly on the laser ablated surface, no polishing was necessary.

Maximize Throughput with Your LaserSEM

Easily perform mesoscale sample preparation



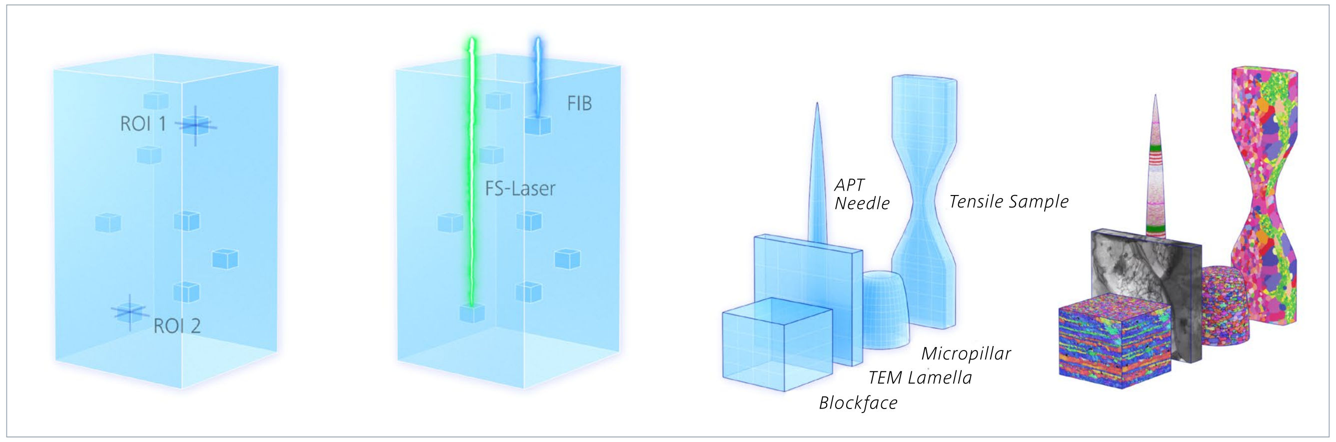
Array of 16 pillars for micro-mechanical testing prepared with the fs-laser in Ti6Al4V alloy, pillar diameter at the top 30 µm, 55 µm at the bottom, 2.5 min preparation time.

- Rapidly remove large volumes of material and get access to deeply buried structures easily.
- Be more efficient and increase your processing accuracy. Create arrays of pillars and cantilevers for micromechanical testing.
- Enjoy TEM lamella preparation by producing multiple TEM-suitable windows spread over a large area.
- Precisely remove defined layers of materials rapidly and benefit from debris handling in a separate chamber, protecting the SEM from damage.
- Save time and increase your processing accuracy with automated shuttling and preinstalled recipes.
- Get access to a wide range of high-performance applications by combining material removal with imaging and analytics all in one instrument.
- Save operating costs by avoiding the usage of one more instrument just for sample preparation.

LaserSEM Enables Accelerating Workflows

Access deeply buried regions of interest with high precision

- Identify, access, prepare, and analyze deeply buried sites with precise navigational guidance using the Sample-In-Volume-Analysis Workflow, enabling the correlation between X-ray and electron microscopes from ZEISS.
- Speed up all your workflows for the preparation of sample arrays.
- Remove massive material to access deeply buried region-of-interest for further analytical analysis.



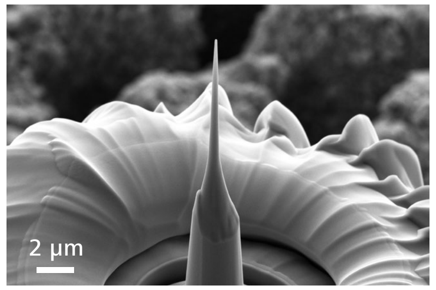
The Sample-In-Volume Analysis Workflow from ZEISS enables you to identify, access, prepare and analyze your samples with precise navigational guidance.

A Modular Concept

Invest in a future-proof platform

- Extend your possibilities: Upgrade your LaserSEM with a semi-automated device for sample shuttling tailored to processes requiring high repeatability and throughput.
- Combine your LaserSEM with the Oxford Unity detector and perform live EDS analysis and backscatter imaging even at the bottom of deep trenches without shadowing.
- Upgrade to a full LaserFIB: Take advantage of the only platform that can be upgraded with a gallium column in the field in case future needs in your lab might require it.
- Then, you can benefit from the capability of a complete FIB-SEM and perform e.g. FIB polishing, high quality TEM lamella preparation for atomic resolution, or 3D tomography with market leading voxel resolution.
- Use your LaserSEM and a FIB and produce APT (atom probe tomography) samples.

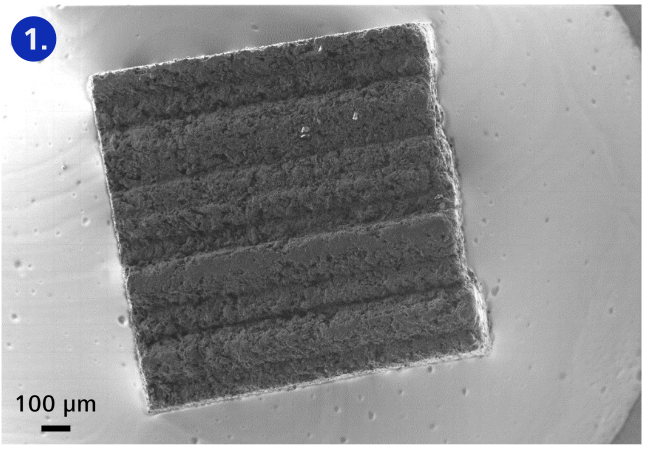
The full LaserFIB: ZEISS Crossbeam laser with the Ion-sculptor FIB. Maximize your sample quality and throughput.



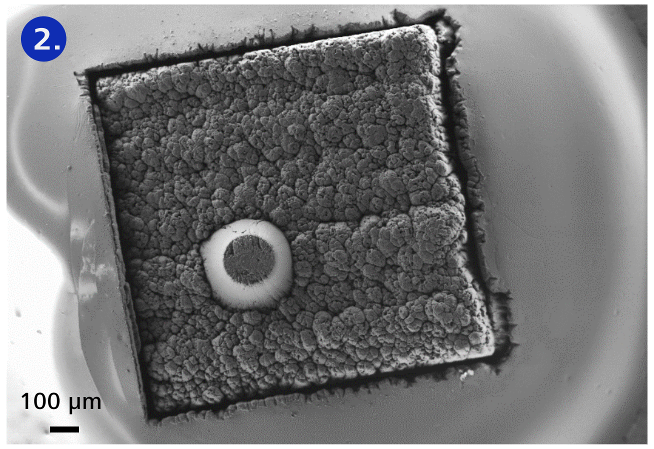
APT sample, silicon, prepared with LaserFIB. A specific site was marked by an ion beam induced deposition. Next, a pillar was isolated form the bulk by laser machining. Then, the tip was shaped by FIB milling.

LaserSEM At Work
Examples

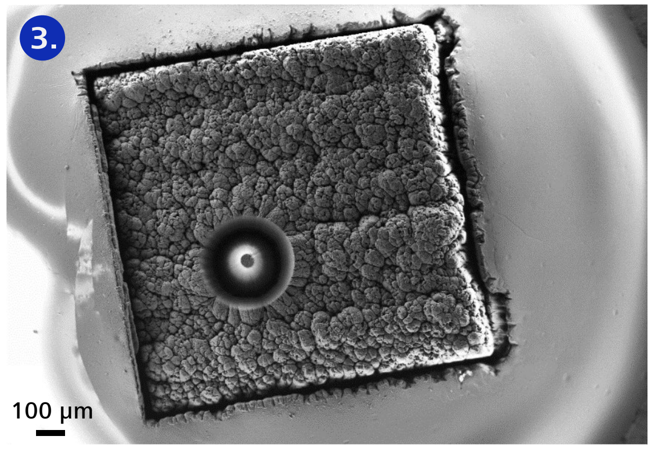
Energy Materials – Nuclear Graphite



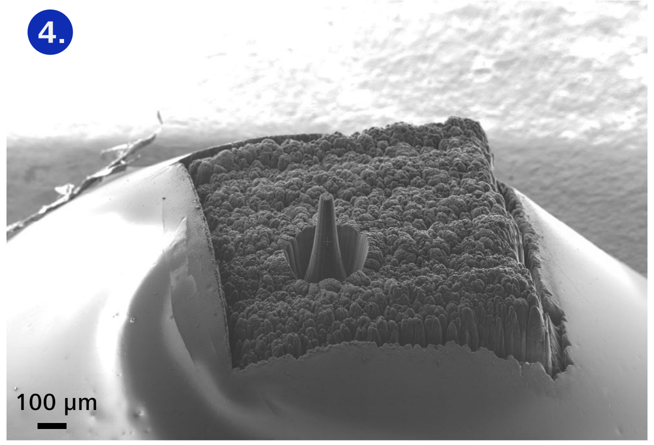
Nuclear graphite cube, top view



Prepared rough pillar, top view



Polished pillar, top view



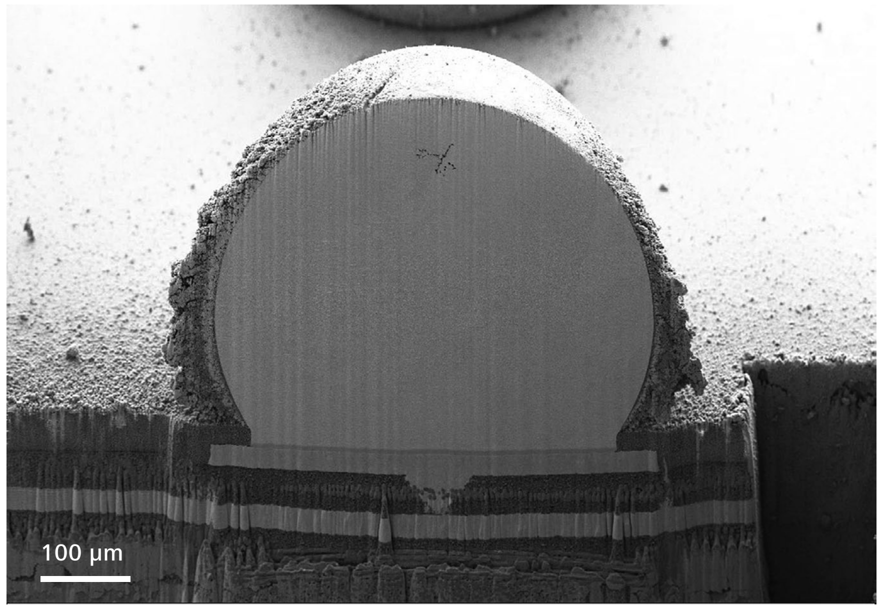
Polished pillar, side view

Sample preparation for nano X-ray tomography. This workflow prepares a free-standing pillar in nuclear graphite with less than 65 µm in diameter and sufficient height to avoid shadowing. Here, in about 20 minutes, the laser ablates challenging carbon-based material where conventional FIB milling may cause artefacts like curtaining.*

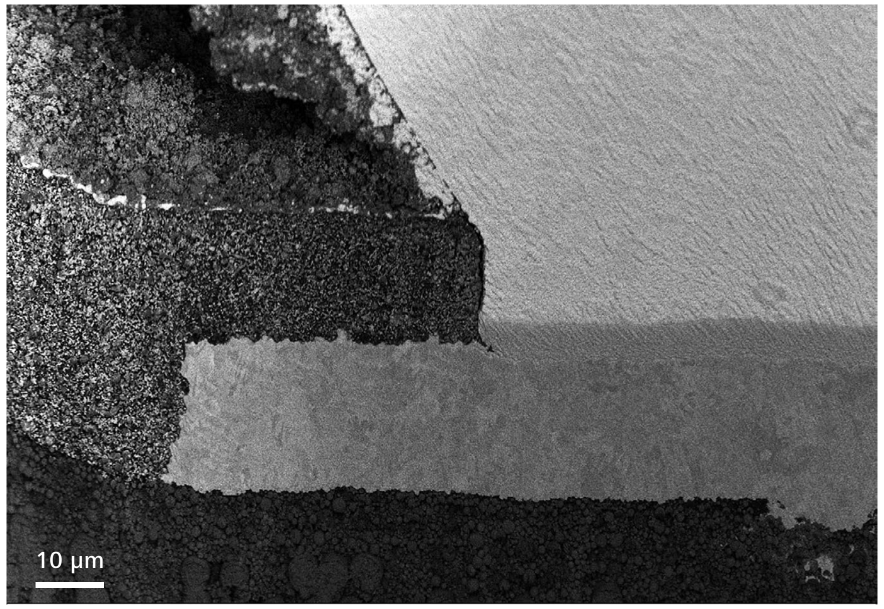
** Compare image of completed pillar on page 2.*

Nanomaterials – Electronics Research

High-quality fs-laser processing through a ca. 450 µm-diameter C4 bump and SEM imaging takes only minutes. The layer of interconnections is located ca. 700 µm below the top surface of the IC (interconnect) package. The LaserSEM enables efficient package characterization and failure analysis via rapid access to deeply buried interconnects and interfaces in 2.5/3D packages.



Defect analysis in a package interconnect. The target preparation of this C4 bump is done only by laser milling.



Detail of the package interconnect immediately after laser processing with its microstructure clearly visible. Image aquired with Inlens EsB detector.

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