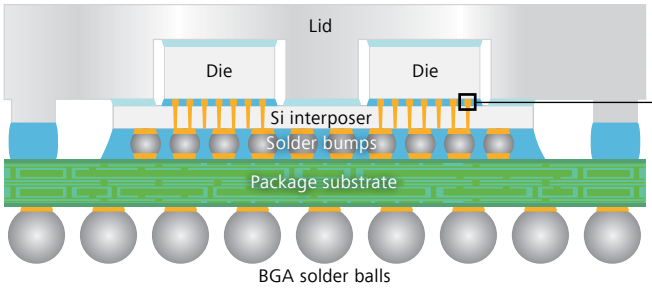
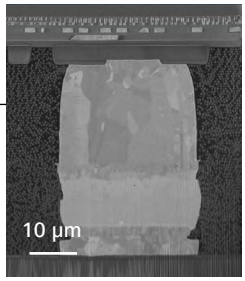
ZEISS Crossbeam Laser FIB-SEM

for process development and failure analysis





Imaging microbumps buried 860 µm deep in <1 hour

ZEISS Crossbeam laser FIB-SEM is a site-specific cross-section solution enabling faster package failure analysis and process optimization.

ZEISS Crossbeam laser integrates a fs-laser for speed, a Ga+ beam for accuracy, and a SEM for high-resolution imaging to enable the fastest workflows. The isolated laser chamber prevents contamination of the electron column and detectors, while ensuring sample integrity with easy transfer between the SEM and laser chamber under vacuum.

Fastest access to site-specific buried structures

The fs-laser removes one cubic millimeter of Si with minimal artifacts in 30 minutes, compared to the days it would take other commonly used approaches. For low-current fine polishing, the Ga+ beam has 25x higher current density than an equivalent plasma-FIB beam.[1] Integration of the laser and FIB into a single system and correlated workflows provide the fastest results and highest success rates.

Minimal to no artifacts and the best specimen quality

The Crossbeam laser workflow avoids mechanical polish artifacts such as delamination or cracks in fragile and stressed materials, while providing higher cross-section accuracy than mechanical cross sections.

Fs-laser ablation is athermal[2] so the laser affected zone (LAZ) is minimal, and it is often possible to image package interconnects immediately after laser ablation, without a need for FIB polish.

Highest imaging performance with ablation contaminants segregated

The well-known imaging quality obtained with ZEISS Gemini I and II electron columns are combined with an EsB detector for unique compositional contrast. The Crossbeam laser family has available charge control solutions for high quality analysis of insulating and low-contrast materials.

Optimal imaging quality via high vacuum and clean chamber conditions is enabled by isolating laser ablation in a segregated chamber.

Samples can be easily shuttled back and forth under vacuum between the imaging and ablation chambers, ensuring a pristine sample protected from exposure to oxygen throughout the entire preparation and analysis sequence.

Crossbeam laser FIB-SEM provides the fastest time to results for cross-sectional analysis of deeply buried features at nanoscale resolutions.

References

[1] I. MacLaren et al., 2019; doi:10.1017/S1431927618016239

[2] K. Sugioka et al., doi:10.1038/lsa.2014.30

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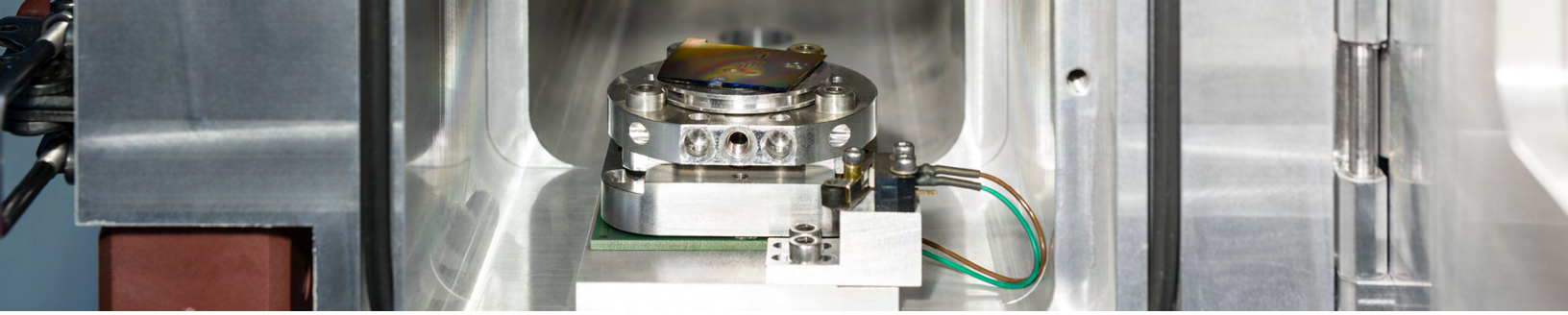
Seeing beyond



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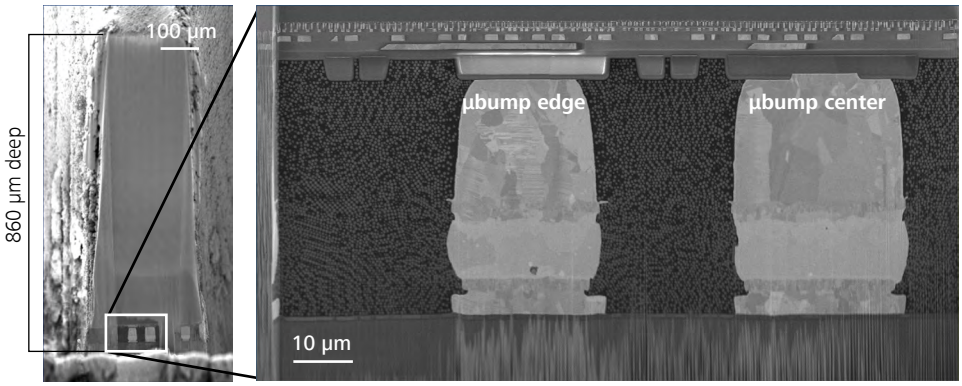
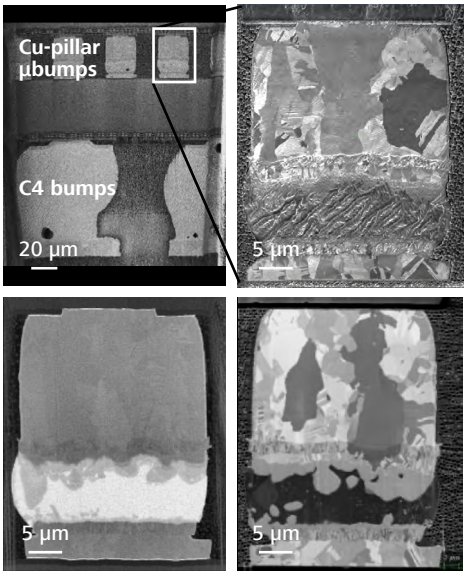


High quality imaging of microbumps and BEOL structures buried 860 µm deep in a 3D package; <1 hour total laser + FIB time.

A new approach for better and faster cross sections

- Rapid site-specific sample preparation
- Large-volume removal for large cross sections
- Fast milling through packages and stacked dies for failure analysis on interconnects, TSVs, BEOL and FEOL structures
- Suitable for many materials including SiC and glass

Crossbeam fs-laser System Data	
Ablation Rate	15 Mio. µm³/s (for Si)
Scan Speed	0.1–9000 mm/s
Scan Field Sizes	40 x 40 mm
Max Sample Sizes	■ For 8 mm sample height (mounted directly on laser holder): 30 x 30 mm squared / 75 x 20 mm rectangular / Ø 32 mm circular ■ For 4.8 mm sample height (mounted on 3.2 mm high standard stub): 36 x 36 mm squared / 75 x 26 mm rectangular / Ø 39 mm circular
Laser Safety Class	1
Optics	
Focal Length	f = 100 mm (telecentric)
Laser	
Type	Diode pumped solid state (DPSS) laser, crystal fiber
Average Laser Power	10 W @ 1 MHz
Peak Power per Pulse	>29 MW (at nominal energy)
Max Pulse Energy	10 µJ @ 1 MHz
Pulse Duration	<350 fs (at nominal energy, sech2-fit)
Wavelength	515 nm (green)
Pulse Repetition Rate	0.1 kHz–1 MHz
Focus Diameter	<15 µm
Rayleigh Length	150 µm
Beam Quality	$M^2 < 1.2$
Max Focal Point Adjustment	6 mm (±3 mm)
Laser Positioning on Sample	
Calibration Process	Dedicated sample holder with high precision markers to define common coordinate system between SEM and laser ablation system. A semi-automatic registration process of marker positions ensures calibration between SEM and laser.
Accuracy	<20 µm in the centered scan field size of 25 x 25 mm



Cu-pillar microbump SEM images after <1 hour total laser and FIB time. (top line: images after fs-laser preparation; bottom line: images after FIB polish.)

ZEISS Process Control Solutions (PCS)
Carl Zeiss SMT, Inc.
4385 Hopyard Road
Pleasanton, CA 94588
USA
www.zeiss.com/pcs
info.pcs@zeiss.com

Seeing beyond