High-Resolution FIB-SIMS Platform for Advanced Semiconductor Process Control and Correlative 3D Nano-Analysis

P. Gnauck, T. Richter, A. Ost, F. Nouvertné
[1]*Raith GmbH, Konrad-Adenauer-Allee 8, 44263 Dortmund, Germany*
peter.gnauck@raith.com

Advanced material characterization with high spatial resolution and sensitivity is crucial for analyzing nanoscale materials and their 3D transformation processes. A novel Focused Ion Beam-Secondary Ion Mass Spectrometry (FIB-SIMS) platform delivers cutting-edge 2D/3D nano-analysis capabilities, driving advancements in semiconductor process control and materials science.

This innovative system incorporates a Liquid Metal Alloy Ion Source (LMAIS), a magnetic sector SIMS unit, and a laser interferometer stage (Fig 1). LMAIS technology emits multiple ion species simultaneously, separated by a Wien filter, allowing rapid switching between heavy ions (e.g. Bi^+, Au^+) for precise delayering and light ions (e.g. Li^+, Si^{2+}) for high-resolution imaging. These capabilities support semiconductor applications such as failure analysis, defect review, and overlay metrology. Heavy ions provide excellent depth resolution, while light ions enable precise lateral imaging for identifying nanoscale features.

The magnetic sector SIMS unit includes a retractable extraction optic, mass analyzer, and focal plane detector for parallel acquisition of full mass spectra at each pixel. This setup allows detailed chemical-spatial correlation, critical for understanding defects and process variations. The system also optimizes ionization modes (positive or negative) based on primary ion species, enhancing versatility across various materials and applications.

A laser interferometer-controlled stage ensures precise alignment during 3D reconstructions, enabling accurate correlative imaging of buried structures. CAD-based navigation and automated workflows improve operational efficiency, making the platform ideal for advanced semiconductor process control. The combination of topographic and chemical imaging provides comprehensive insights into failure mechanisms, defect origins, and layer alignment. Importantly, the platform will integrate seamlessly with complementary process control tools like the Raith Vector Scanning Electron Microscope (SEM). This connectivity allows workflows that combine high-resolution ion microscopy and SIMS nano-analysis with SEM imaging and lithography capabilities. For example, Raith Vector SEM can guide precise FIB-SIMS analyses, improving defect localization, patterning precision, and correlative imaging workflows.

This FIB-SIMS platform improves nano-analytics, combining LMAIS technology, magnetic sector SIMS, and a laser interferometer stage for unmatched resolution and flexibility (Fig. 2). Integration with other process control tools expands its functionality, offering a comprehensive solution for semiconductor process control and advanced materials research.

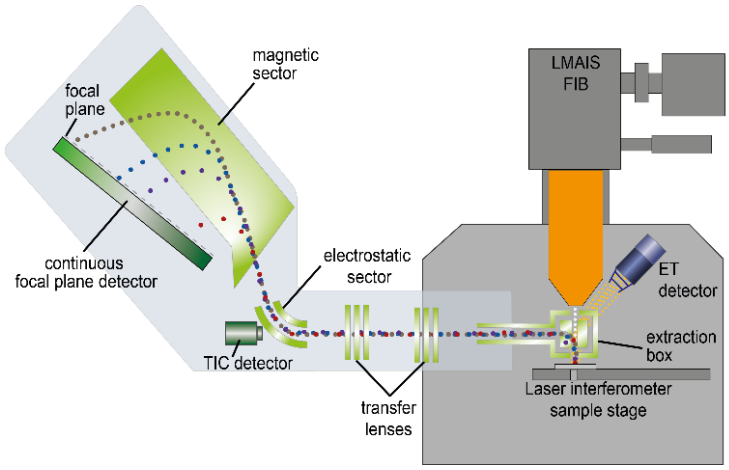

Figure 1: Schematic setup of the FIB-SIMS system

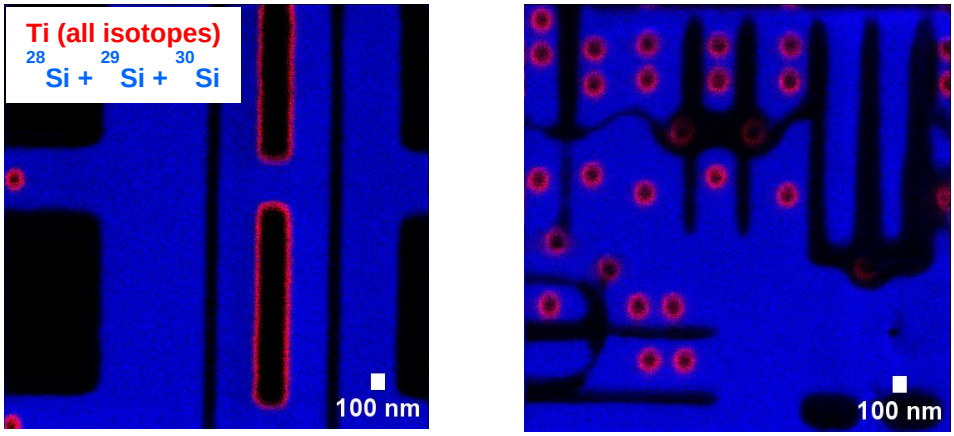

Figure 2: High resolution SIMS mapping of a microchip sample