# FIB-SIMS Applications with a Cs+ Low Temperature Ion Source

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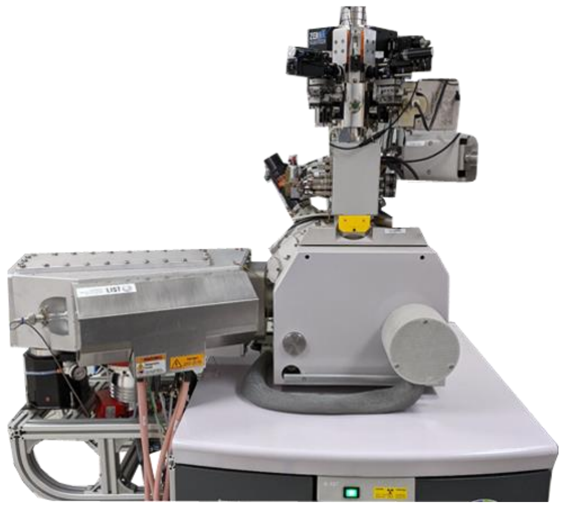
Advances in ion source technology and secondary ion mass spectroscopy (SIMS) instrumentation have motivated renewed interest in FIB-SIMS techniques. Compared to EDX, SIMS offers superior detection limits, surface sensitivity / depth resolution, and light-element (e.g., Li, B) detection. In this presentation, we discuss recent developments in FIB-SIMS using the Cs+ Low Temperature Ion Source (LoTIS) [1], which produces a high-brightness ion beam with a very low energy spread (< 1eV). The superior ion optical properties makes it a capable source for FIB nanomachining tasks, sample preparation, and secondary electron imaging; in addition, the reactive cesium ions greatly increase the secondary ion yield of many elements compared to non-reactive sources (like gallium), which improves sensitivity and imaging resolution in concentration-limited samples. This combination enables variety FIB-SIMS techniques, including high-resolution elemental mapping, integrated sample preparation, and SIMS-enabled nanofabrication process control.

To explore FIB-SIMS applications, we have constructed an instrument based on a Cs+ LoTIS integrated with a focused ion beam platform and a magnetic sector SIMS spectrometer developed at the Luxembourg Institute of Science and Technology (LIST). The FIB platform can achieve very fine focused beams and can operate at beam energies from 2 kV to 16 kV. The spectrometer has a mass-resolving power of ~400 and is equipped with a continuous focal plane detector, capable of acquiring the entire mass spectrum over ~300 a.m.u. in real time.

Here, we present an overview of results that highlight the versatility of FIB-SIMS instrumentation. For samples with flat surfaces that mill homogeneously, straightforward depth profiling and 2D/3D SIMS imaging techniques can be very effective. To address the challenges presented by rough, inhomogeneously milling samples or to achieve the highest-lateral-resolution SIMS imaging of sub-surface features, we employ FIB sectioning techniques to prepare flat samples with high elemental contrast. Finally, we present the use of SIMS signals for nanomachining process control in a high-aspect-ratio milling application.

References

[1] A. V. Steele, A. Schwarzkopf, J. J. McClelland, and B. Knuffman. *Nano Futures*. **1**, 015005 (2017)



SIMS instrument featuring the Cs+ LoTIS developed at zeroK and the SIMS spectrometer developed at LIST.