Ion Microscopy, Machining, and Elemental Analysis with the Cesium Low Temperature Ion Source (LoTIS)

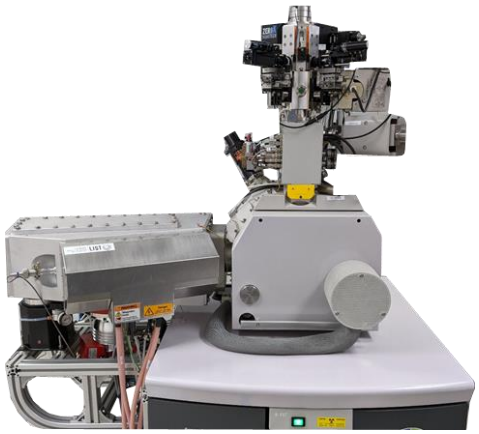
A.V. Steele, A. Schwarzkopf, B. Knuffman
zeroK NanoTech Corporation, Gaithersburg MD 20879
adam@zerok.com

We present the latest results from focused ion beam systems employing a Cs^+ Low Temperature Ion Source (LoTIS). When compared with other ion sources, LoTIS can deliver very small spot sizes, high sputter rates, high yields of secondary ions, and a wide range of beam currents from pA to many nA. It excels at both nanomachining and elemental analysis via SIMS. A FIB equipped with LoTIS and a SIMS spectrometer is shown in Fig 1A.

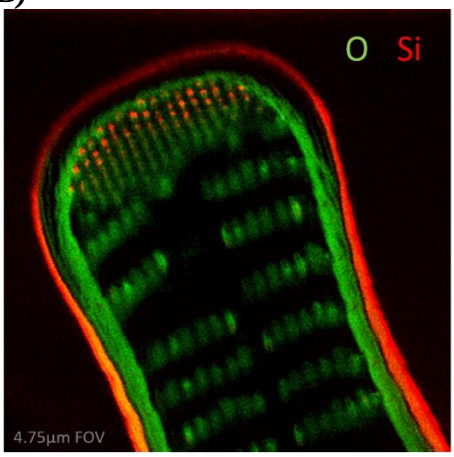
In the first half, FIB applications of LoTIS will be reviewed. These include high resolution imaging, successful circuit edit operations on 10 nm node integrated circuits, high-precision machining of gold (Fig 1C), and demonstrations of the high grain-visibility imaging in copper and steel.

The talk's second half will show how LoTIS can be paired with a Secondary Ion Mass Spectrometer (SIMS) to provide elemental composition information (Fig 1B). Because LoTIS's beam can be focused tightly this system can provide high-resolution elemental maps. Also, since Cs^+ generates orders-of-magnitude more secondary ions than other ion beams (for many target materials) LoTIS-based SIMS also has high sensitivity. Additionally, SIMS can see light elements like lithium that are hard to find with other techniques like EDX. Finally, because LoTIS can provide over 100x more current into a given spot than alternative Cs^+ ion sources, it allows for more rapid sample analysis.

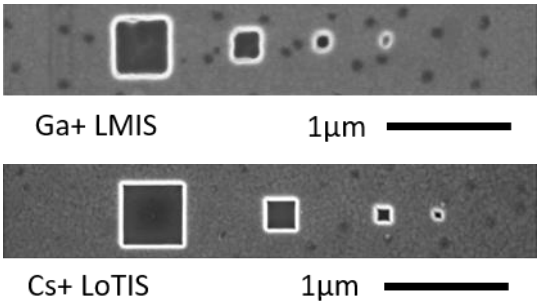
(A)



(B)



(C)



(A): FIB/SIMS instrument "SIMS:ZERO" equipped with a Cs+ Low Temperature Ion Source and a compact magnetic sector mass spectrometer for SIMS; ***(B)*** SIMS image of oxygen and silicon distributions in a diatom. Acquired with SIMS:ZERO – credit J. Audinot & O. de Castro, Luxembourg Institute of Science and Technology; ***(C)*** Comparison of FIB milling in Au film by a Ga+ LMIS (***Left***) and a Cs+ LoTIS (***Right***) – credit T. Loeber, Technical University Kaiserslautern