

MOTIS-Based Focused Ion Beams in Two Flavors

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With the goal of exploring the capabilities of the new magneto-optical trap ion source (MOTIS) we have recently implemented high resolution focused beams of both lithium and chromium ions. The MOTIS uses photoionized laser-cooled neutral atoms to create an isotopically pure beam of ions whose calculated ion optical properties are comparable to or better than those of liquid metal ion sources[1]. The MOTIS paradigm can be extended to create ion sources from any atomic species that can be laser-cooled, i.e., Li, Na, K, Rb, Cs, Fr, Mg, Ca, Sr, He, Ne, Ar, Kr, Xe, Al, Ag, Cr, Er, Cd, Hg, and Yb. This flexibility would allow the atomic species of the source to be tailored to the specific application, e.g., microscopy with light ions, milling with heavy ions, and nanoscale implantation of a variety of elements.

In this poster we will provide a technical overview of the apparatus (Figure 1) needed to implement a MOTIS-based FIB including the geometry of laser beams and magnetic fields necessary to implement a cold atom trap, the relative advantages of two different ionization beam orientations, and the electrode structure we used to accelerate a beam to high energy with a very low chromatic spread. We will present results of microscopy using chromium and lithium beams (Figure 2) and a characterization of focal spot sizes. We will also discuss physical characteristics of the source, in particular how the initial temperature of the laser-cooled gas and ion-ion Coulomb interactions affect beam performance.

[1] J. L. Hanssen, S. B. Hill, J. Orloff, and J. J. McClelland, Nano Letters 8, 2844 (2008).

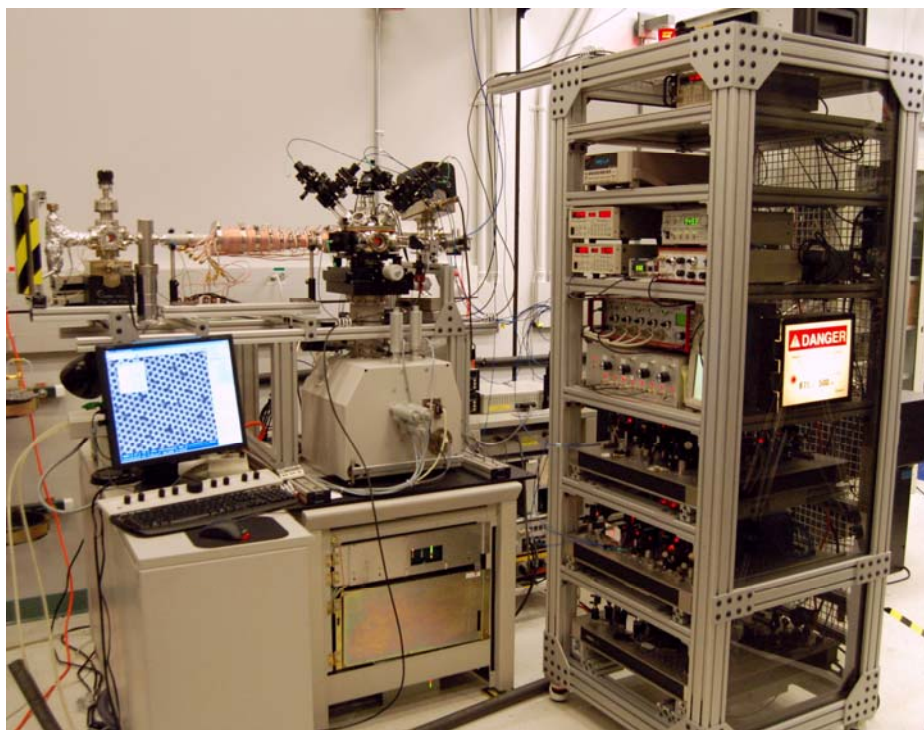


Figure 1: Lithium focused ion beam system composed of a magneto-optical trap ion source integrated with a conventional ion optical column.

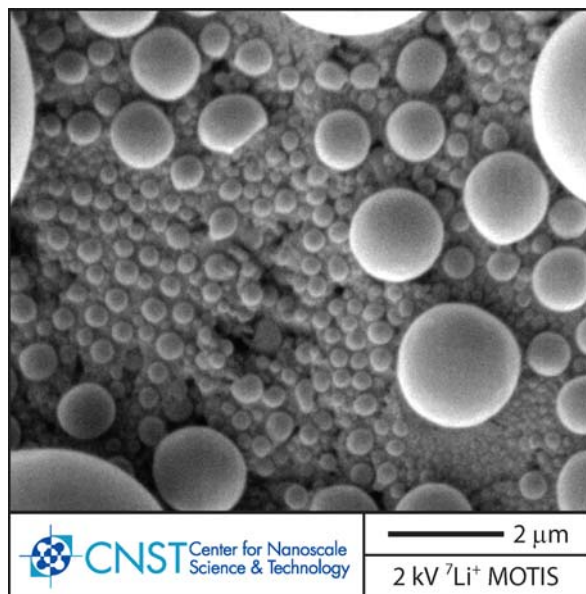


Figure 2: Secondary electron image of tin spheres on carbon generated by a $^7\text{Li}^+$ focused ion beam operated at 2 kV.