

Advantages of using Plasma FIB Over a Gallium LMIS Source

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For over 20 years, gallium liquid metal ion source (LMIS) technology has been the workhorse charged particle beam for the focused ion beam (FIB) industry. In recent years the gas field ion source (GFIS) and plasma field ion source (PFIB) are gaining in popularity as an alternative to LMIS. One of the driving forces is the gallium implantation into the material and the artifacts one must deal with.

In our experiments we are exploring the interaction with the gallium source and xenon plasma source has on the CO₂ reaction on olivine minerals.

Fayalite, the iron-rich end member of the olivine series (Mg,Fe)₂SiO₄, occurs in abundance in the Earth's upper mantle and it can be a significant constituent of basaltic rocks. The isolated tetrahedral structure of fayalite can breakdown during reaction with aqueous solutions and it is known that the dissolution of fayalite is accelerated if high temperatures, acidic solutions and far from equilibrium conditions are present. During fayalite dissolution its constituents (Fe²⁺ and silica) will be released from the structure and can participate in precipitation reactions with nearby anions to form secondary minerals: (hematite, goethite, sulfites, carbonates, amorphous silica). In this study we will present the new methods for determining the spatial distribution of the light elements (Na, Li, and Ca) within the mineral fayalite. These elements may play a role in carbonation reactions of fayalite under super critical CO₂ conditions.

High Resolution Scanning Transmission Electron Microscopy (STEM), a highly-focused electron probe is raster-scanned across the material, and various types of scattering are collected as a function of position. The transmitted electrons at high scattering angle can be collected to form high-resolution, chemically sensitive, atomic number (Z-) contrast images. The x-rays generated can be collected using an energy-dispersive X-ray spectroscopy (EDS) detector and used to form high spatial resolution compositional maps. Electron energy losses can be detected using a Gatan image filter (GIF) to map the compositional and electronic properties of materials.

Atom Probe Spectroscopy (APT), is a state-of-the-art analytical method that allows for three-dimensional elemental mapping with near atomic resolution. It is a powerful tool that can provide unique compositional information on a variety of materials systems such as complex alloys, semiconductor materials and devices, and ceramic material.

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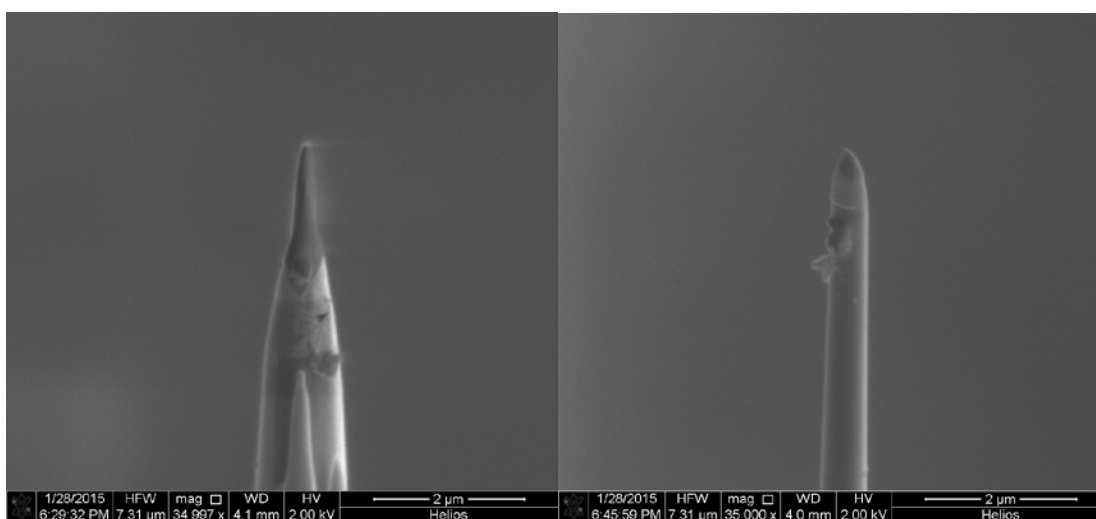


Figure 1: Ga APT after reaction with CO₂; Figure 2: Xe APT after reaction with CO₂