Evaluation of Precipitation Hardened Alloys as GFIS for FIB Applications

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Gaseous field ion sources (GFIS) have the advantages of small energy spreads (~1 eV) and a virtual source size of ~2 nm. A GFIS can be operated with inert gases such as argon or neon and therefore has potential applications in mask repair applications. However, gaseous field ion sources have rarely been employed in focussed ion beam systems due to their relatively low angular current densities. The angular intensity of a GFIS may be increased by confining the ion emission to a small area on the emitter surface.

In this project, a new approach of producing high current densities is under development in which an ion beam is confined to the region above an ultrafine precipitate on the surface of a needle-shaped tip. In this approach, the base of the emitter is used to attract and thermally accommodate atoms from the gas over the tip surface. However, the experimental conditions are selected to ensure that no ion emission occurs from the base of the tip. These gas atoms then are drawn over the surface to the high field region above the precipitate where they are ionized and produce the ion beam. The extent of the precipitate exposed on the surface of the emitter may be manipulated by field evaporation thereby providing a simple method of optimizing the source size.

A precipitation hardened alloy has been designed and fabricated that contains a high density of ultrafine refractory precipitates in a B2-ordered NiAl matrix. The sources are produced from this alloy by cutting the bulk material into 0.25 mm square bars and electropolishing these bars into needle-shaped tips. Field ion microscopy has determined that the average size of these precipitates is ~5 nm. Atom probe analysis has revealed that the refractory precipitates are WC and W_2C carbides. Experiments are in progress to measure the emission characteristics of these sources.

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