Practical Field Ion Microscopy

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Field ion microscopy is an important step that is almost always used at the start of an atom probe experiment to produce an atomically clean specimen with a well developed end form. The formation of a field ion image is a multi-step process. As the field on the specimen is increased, the image gas atoms in the vicinity of the apex of the needle become polarized and attracted to the specimen. Because of the polarization forces, the gas atoms acquire kinetic energies that are significantly higher than $k_B T$. Most of these atoms rebound from the surface without being ionized. The remaining atoms become thermally accommodated to the cryogenic temperature. This process occurs by a series of collisions during which a small amount of kinetic energy is lost each time the atom strikes the surface and rebounds. The overall rate of ionization depends on the time spent in the critical ionization zone, which increases as thermal accommodation progresses. If the field is high enough, the image gas atoms on the surface of the specimen can be field ionized by an electron tunneling process. These ions are then repelled towards the phosphor screen where they produce a spot of light. This process occurs over the entire apex region of the specimen. The resulting distribution of light on the phosphor screen is the field ion image. Field ion microscopy is also used to examine and characterize the microstructural features present in the specimen, and to select the initial area on the surface of the specimen for analysis in the atom probe. Field ion microscopy is often used during and at the end of an atom probe experiment to check the progress of the experiment and to determine certain experimental parameters.

Research at the Oak Ridge National Laboratory SHaRE User Facility was sponsored by the Division of Materials Sciences, U.S. Department of Energy, under contract DE-AC05-96OR22464 with Lockheed Martin Energy Research Corporation.