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Study of Atomic Force Microscopy Probes Using a Local Electrode Atom Probe Microscope

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The atom probe microscope (APM) is a powerful tool to investigate atomic level structure of materials. Samples have specific geometrical requirements and must generally be conical in shape with a tip radius on the order of 100nm. Atomic force microscopy uses probes that are already in a geometry that is suitable for atomic probe tomography. Atomic force microscope (AFM) probes consist of a conical tip with a tip radius ranging from a few tens of nanometers to a few hundreds of nanometers affixed to the end of a cantilever, see Figure 1. While it is necessary for cantilever bending to occur during AFM measurements, this poses a problem under the high electric field experienced during APM experiments. Preliminary studies indicate that cantilevers with a spring constant of 40N/m or higher exhibit minimal bending for APM field conditions and may be suitable for APM experiments. By mounting an AFM probe on a suitable holder the probe can be analyzed in the APM quickly and consistently without any need for modification. An advantage of using the AFM probe is there are well established ways to determine the tip radius of an AFM probe by using a characterization grating in an AFM [1]. This allows for quick and accurate characterization of the tip radius without the need for a scanning electron microscope or transmission electron microscope. The tip radius can then be used to improve the accuracy of the reconstruction of the APM data [2]. APM experiments in a Local Electrode Atom Probe (LEAP) have been carried out on both uncoated and thin film coated AFM probes. For uncoated Si (100) probes, the data is compared to that obtained from Si (100) microtips more routinely used in the APM. An initial representative reconstruction and mass spectrum of an uncoated Si AFM probe are shown in Figure 2a and 2b respectively and highlight the validity of studying AFM probes using an APM. One area of interest is analyzing transfer films that appear on the AFM probes in friction and wear studies conducted by atomic force microscopy. Another is investigating thin films deposited onto the AFM probes for use in specific applications of the AFM like magnetic imaging.

References

[1] P. M. Williams et al., J. Vac. Sci. Technol. B. 14(2) (1996) 1557.
[2] M. K. Miller, *Atom Probe Tomography*, Plenum, New York, 2000.
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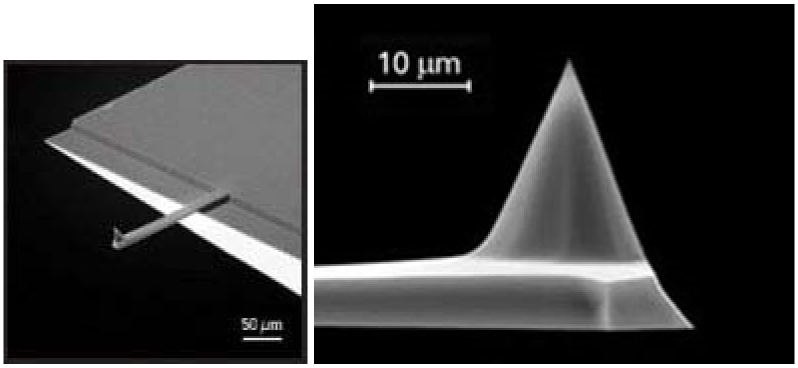

FIG. 1. Scanning electron microscope images of an AFM probe.

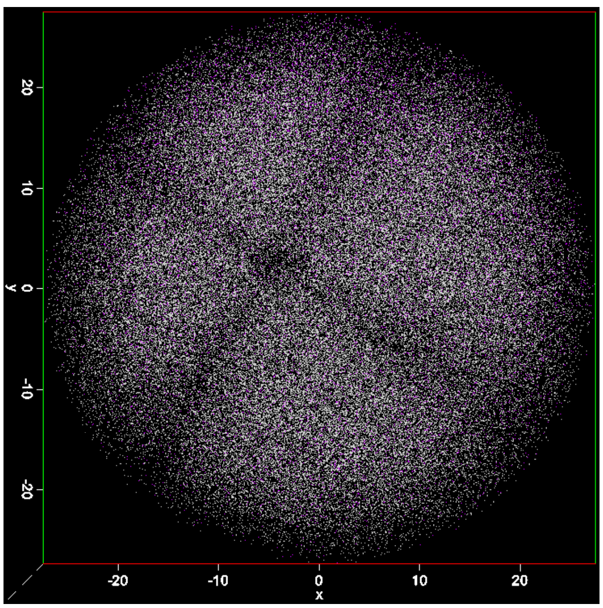

FIG. 2a. A reconstruction of a Si AFM probe analyzed in a LEAP that shows the (100) pole.

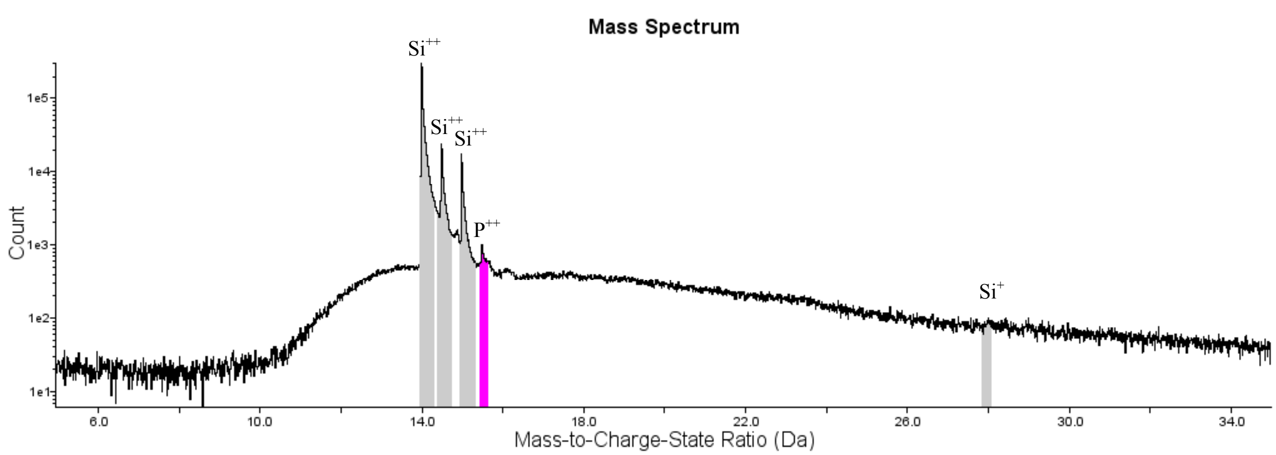

FIG. 2b. The mass spectrum from the reconstruction shown in Figure 1a showing Si peaks and the dopent P peak.

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