Development of Metal AFM Probe for High Spatial Resolution

Kotone Akiyama[1,2,3], T. Eguchi[1], T. An[1,3], Y. Hasegawa[1,3], T. Sakurai[2]
[1]Institute for Solid State Physics, The University of Tokyo, Kashiwa, 277-8581 JAPAN
[2]Institute for Materials research, Tohoku University, Sendai, 980-8577 JAPAN
[3]PRESTO, Japan Science and Technology Corporation, JAPAN

Atomic force microscope (AFM) is a unique microscope with versatility for characterization of not only conductive materials, which can also be analyzed with scanning tunneling microscopy (STM), but also insulating materials. However, its spatial resolution is still limited and has not reached the level of STM. It is found that the shape of the probe tip in the nanometer scale is critical to obtain AFM images with high resolution [1].

In order to characterize and control the shape of the tip in an atomic scale, we developed a new type of AFM probe by attaching a tungsten tip to a cantilever. A tungsten tip has been commonly used for ultrahigh vacuum (UHV) STM, and the shape at its apex can be characterized and controlled in an atomic scale by using field ion microscopy (FIM) [2]. A tungsten wire with a diameter of 5μm was attached to the edge on a commercially available cantilever using a micromanipulator. The wire was then sharpened by focused ion beam (FIB). A SEM image shown in Fig. 1 indicates sharpness of the new tip. After introducing the tip into our UHV-AFM chamber, we annealed the tip by electron-beam heating. A non-contact AFM image of the Si(111)-7x7 surface taken with the tip, shown in Fig. 2, demonstrates its capability for high resolution imaging by showing the adatoms on the surface .

We have attached an FIM port to our AFM system. By using FIM, the oxide layer covering the tip apex can be removed in more controlled manner than e-beam heating. Performance of FIM will be discussed at the presentation.

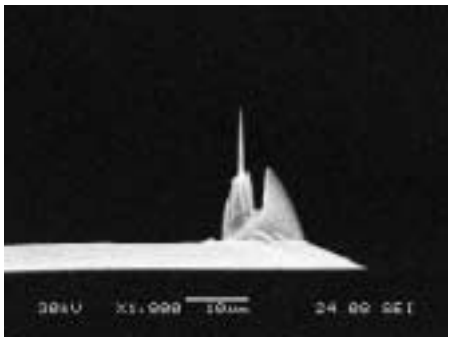

Fig.1: SEM image of the W tip attached to a cantilever

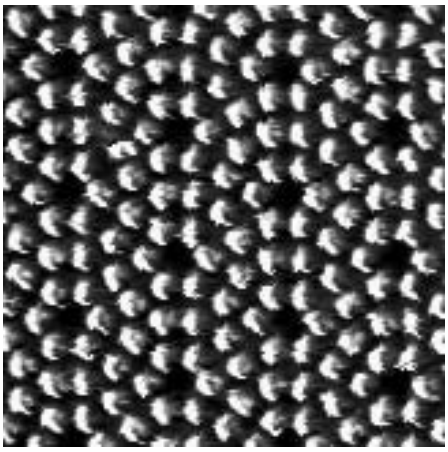

Fig. 2: nc-AFM image of the Si(111)- 7x7 surface obtained with a W tip attached to a commercial Si cantilever

[1] T. Eguchi and Y. Hasegawa, Phys. Rev. Lett. **89**, 266105 (2002).
[2] T. Sakurai *et al.* Progress in Surf. Sci. **33**, 3 (1990).