STM and Non-Contact-AFM observation of Si(111)
by a self-made qPlus sensor at low temperatures

T. Tomaru, H. Hidaka, A. Kouchi, N. Watanabe

Institute of Low Temperature Science /Hokkaido University

In recent years, many laboratory experiments have been performed to simulate chemical reactions on the surfaces of interstellar ice dust. In those experiments, amorphous ices were formed by water vapor deposition onto the low-temperature substrate under an ultra-high vacuum condition as an analogue of ice dust. The morphology of such amorphous ices strongly depends on the various experimental conditions like deposition angle, growth rate, and the deposition temperature when ices were formed. Because the morphology would affect chemical processes occurring on the surface, direct observation of ice morphology is essentially important to understand the simulation experiments appropriately. Therefore, to observe the surface morphology of amorphous ice under various formation conditions, we are developing a new device. To perform nondestructive real-space measurements of the nanoscale structure of the amorphous ice surface, an ultra-high vacuum low-temperature scanning probe microscope (SPM: INFINITY, Scienta Omicron) with a non-contact atomic force microscope (nc-AFM) mode is used. Although this device is powerful tool for our purpose, the probe generally used in this type of SPM, named qPlus sensor, is not sufficiently sharp for measuring the fine surface structure of amorphous ice. Therefore, the ultra-sharp qPlus sensor (the tip curvature radius of ~ 1 nm) is required. In this presentation, we introduce the present status of the production of the ultra-sharp qPlus sensor.

For a Si cantilever, which is conventional type of the SPM probe, many commercial products with the ultra-sharp shape are available because the manufacturing technology with a tip curvature radius of ~ 1 nm is well established. Therefore, we tried to construct the ultra-sharp qPlus sensor by using the tip of an ultra-sharp Si cantilever instead of the conventional tungsten wire tip. As the tentative production, the qPlus sensor using the tip of an inexpensive Si cantilever (the tip curvature radius of ~ 10 nm) was produced. To test the self-made qPlus sensor, STM (scanning tunneling microscope) and nc-AFM measurements of Si(111)-7×7 were conducted. Figure 1 shows the results of observations at 10 K using (a) Pt/Ir tip for STM and (b) the self-made qPlus sensor for STM and nc-AFM. We confirmed that the self-made qPlus sensor could obtain the Si(111)-7×7 structure in STM and AFM.

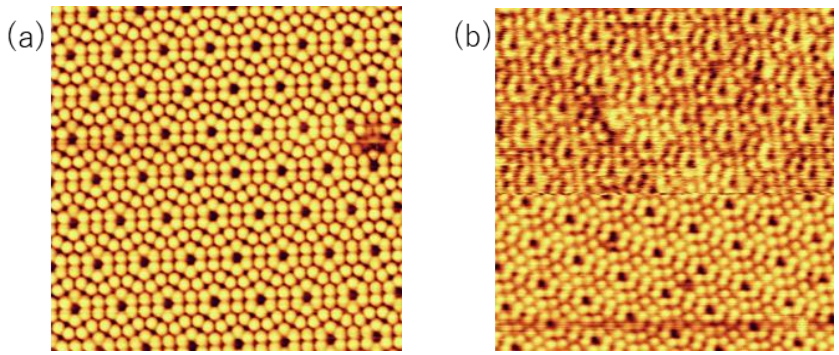

Figure.1 (a)STM image scanned by Pt/Ir tip at 10 K. (b) Image scanned by the self-made qPlus sensor at 10 K. The upper and lower sides are nc-AFM and STM images, respectively. Scan areas of both images are 20 nm×20 nm.