19A/2002P002

Development and Research of Synchrotron Radiation Light-illuminated Scanning Tunneling Microscope

Takeshi MATSUSHIMA*[1], Taichi OKUDA[1], Toyoaki EGUCHI[1], Masanori ONO[1], Ayumi HARASAWA[1], Takanori WAKITA[1], Takahide TOHYAMA[2], Masayuki HAMADA[1], Yukio HASEGAWA[1], Toyohiko KINOSHITA[1]

[1]Institute for Solid State Physics, the University of Tokyo, Kashiwa, Chiba 277-8581, JAPAN

[2]Graduate School of Science and Technology, Chiba University, Chiba, Chiba 263-8522, JAPAN

Introduction

Scanning Tunneling Microscope (STM) is one of the most useful techniques for surface investigation. But it has a disadvantage of impossibility of element specific research. To solve this problem, there have been several attempts to detect photoemitted electrons by STM [1-4]. In these studies, X-ray [1] or laser [2-4] was used to illuminate the sample during STM observation. However, to identify the sample elements, we have to tune the energy of light to excite the core electrons of the particular element and detect photoemitted electrons. Synchrotron Radiation (SR) light is suitable for the purpose. We have designed the new system of SR light-illuminated STM (SR-STM), and estimated the performance of this system.

Experimental

The SR-STM measurements have been done at the beamline BL-19A. We have used n-type Si(111) wafer (~2 Ωcm) as a sample. The Si(111) surface was cleaned by resistive flashing about 1500 K. The light incident angle between the light axis and the sample surface was 4°. We have operated the STM with Constant-Current-mode and recorded the change of the STM tip height as scanning the incident photon energy around the Si 2*p* absorption edge (~101 eV).

Results and Discussion

Figure 1 shows the STM image of the Si(111) 7×7 clean surface. The image was recorded when the STM chamber was connected with the beamline. It indicated that this SR-STM system has been designed to have enough performance to achieve the atomic resolution during connected with the beamline. Figure 2 shows the STM image of the Si(111) clean surface with illuminated with the SR light. The photon energy was scanned by 1 eV step during operating the STM. The sample had not been illuminated during each changing of the photon energy. The profile of the STM tip height along the direction of scanning the photon energy is presented in Figure 3. The tip was retracted clearly when illuminated with over the photon energy of 101 eV which is the threshold energy of Si 2*p* absorption edge. It implies that we have achieved to get X-ray Absorption Spectra (XAS) of very small area with the STM tip, and that this method holds the promise of obtaining the 2D XAS mapping.

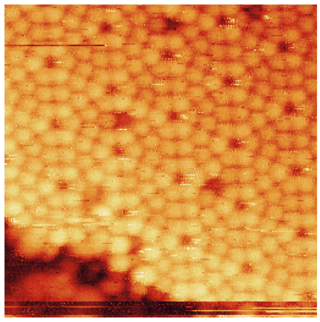

Fig.1 The topographic image of the Si(111) 7×7 clean surface. (10.2 nm×10.2 nm, -1.500 V, -0.10 nA)

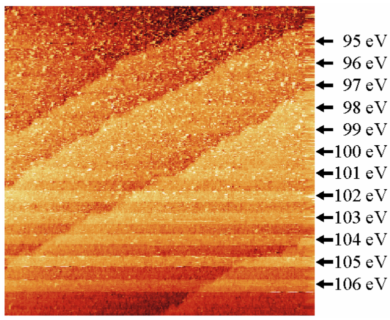

Fig.2 The STM image of the Si(111) surface. The surface was illuminated by the SR light (from 106 eV to 95 eV). (500 nm×500 nm, -2.000 V, -2.0 nA)

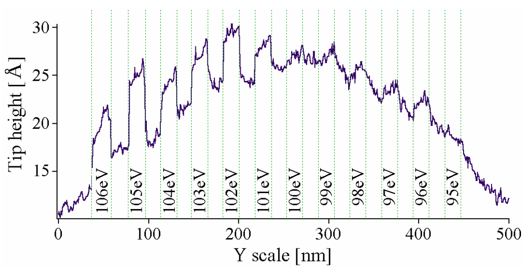

Fig.3 The profile of the STM tip height along the direction of scanning the photon energy in Fig.2.

References

[1] K. Tsuji *et al.*, Jpn. J. Appl. Phys. **37**, L1271 (1998).
[2] S. M. Gray, J. Electron Spectrosc. Relat. Phenom. **109**, 183 (2000).
[3] A. Hida *et al.*, Sol. St. Phen. **78-79**, 419 (2001).
[4] K. Takada *et al.*, Jpn. J. Appl. Phys. **41**, 4990 (2002).

* matutake@issp.u-tokyo.ac.jp