Four-Probe Scanning Tunneling Microscope with True Atomic Resolution

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SUMMARY:
We developed four-probe scanning tunneling microscope (4-probe STM) with atomic resolution.

INTRODUCTION:

Although 4-probe STM is a great tool to study electric properties of nanomaterials, there are few working systems with true atomic resolution in the world. We collaborated with a domestic STM provider to develop a state-of-the-art 4-probe system.

EXPERIMENTALS:

Our system consists of an ultra high vacuum (UHV) chamber, the 4-probe STM, an UHV scanning electron microscope (SEM), an in-vacuum vibration isolation system, a liquid helium cryostat and STM electronics that can control the four STM probes simultaneously, independently and cooperatively from one personal computer.

RESULTS AND DISCUSSION:

Figure 1 shows the clean Si(111)-7x7 surface measured by our 4-probe STM system. Its atomic scale resolution was confirmed by resolving the characteristic six adatoms in each half unit cell. The result of I/V measurement shown in Fig. 2 demonstrates the ability of the system to make tunneling spectroscopy measurements. The low frequency oscillation visible in the dI/dV curve that was obtained by numerical derivative of the I/V curve is due to the resonance of the in-vacuum vibration isolating system. Besides the on-going improvement of the resonance dumping, the system is equipped with the ability of lockin measurement that enables a sinusoid modulation of the bias voltage or the piezo voltage and a lock-in detection of tunnel current, by software signal processing without any additional hardware. Such modulation measurement is very helpful and almost necessary to eliminate the small unfavorable deviation of tunnel current during the tunnel spectroscopy.

CONCLUSIONS:

In this study, our system was confirmed to have true atomic resolution and to be ready for applications to studying the electric properties of interesting nanomaterials.

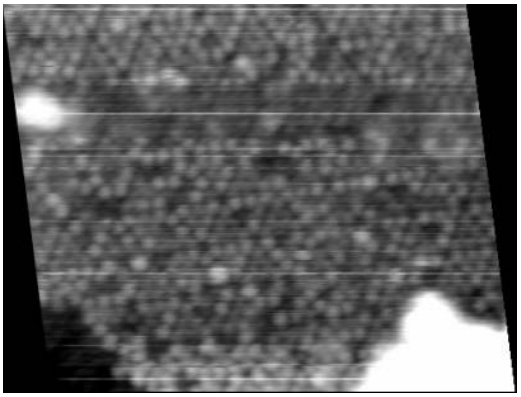

Fig1: Si(111)-7x7

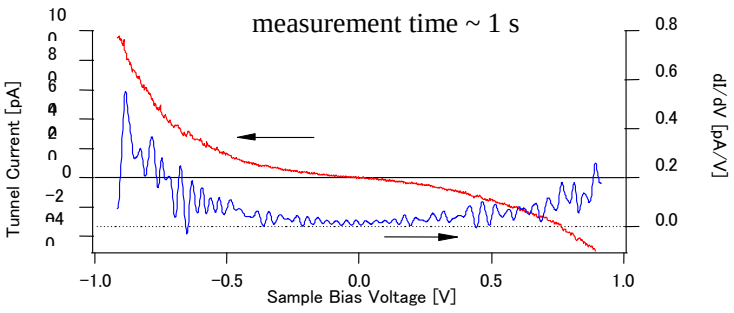

Fig2: Si(111) I-V & dI/dV curve