

Observation of the Si(111) 7×7 and the quenched Si(111) 1×1 surface with the small amplitude of the second flexural resonance

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The atomically resolved constant frequency shift images of the Si(111) 7×7 reconstructed surface and the quenched Si(111) surface from around 1250 degree C were obtained with the small amplitude of the second flexural resonance of a commercial stiff cantilever. The usage of the second mode enabled imaging of disordered surfaces with high stability, due to the detection of the interaction force gradients at relatively long distance from the sample surface, compared with the usage of the fundamental mode [1].

Figure 1 shows the distance between the tip and the Si(111) surface versus the second resonance frequency shifts curves with the amplitude of 0.4 nm and 0.8 nm. The small amplitude operation enables localized force measurements and can detect the interaction force gradients with higher sensitivity.

Figure 2 shows an atomically resolved constant second resonance frequency shift image of the Si(111) 7×7 reconstructed surface. The resonance frequency, the frequency shift, and the amplitude were 1.6 MHz, -125 Hz, and 0.12 nm.

The STM has revealed that the quenched Si(111) surface has highly disordered 1×1 phases, as 2×2, (root3 × root3)-R30, and c(2×8), with a large number of the "magic clusters" [2]. Figure 3 shows the atomically resolved DFM image of various phases observed on the quenched surface with the 1×1'.

The advantages of small amplitude operation with the second resonance mode will be demonstrated through various observations.

- [1] S. Kawai, S. Kitamura, D. Kobayashi, S. Meguro, and H. Kawakatsu, *Appl. Phys. Lett.* (to be published).
 [2] R. S. Becker, J. A. Golovchenko, G. S. Higashi, and B. S. Swartzentruber, *Phys. Rev. Lett.* **57**, 1020 (1986).

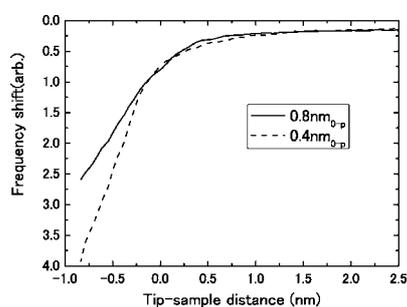


Fig. 1. Distance between the tip and the Si(111) surface versus the second resonance frequency shift curve.

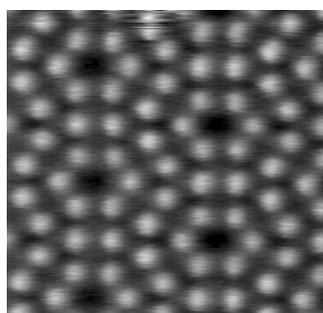


Fig. 2. Constant second resonance frequency shift image of Si(111)7×7 reconstructed surface.

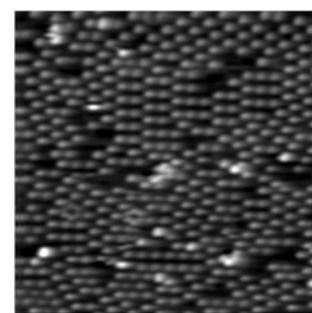


Fig. 3. Atomically resolved constant frequency shift image of the 1x1 phase obtained with the second resonance mode.