Hopping Al atom on the Si(111)7×7 surface studied by scanning tunneling microscope

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We studied adsorption and diffusion of Si atoms inside a unit cell of a Si(111)7×7 surface [1, 2]. To investigate adsorption of an Al atom with three valence electrons, and to compare it with adsorption of the Si atom with four valence electrons is an interesting subject in surface physics and chemistry. In this report, we study behaviour of adsorbed Al atom on the Si(111)7×7 surface by using a scanning tunneling microscope (STM).

Experiments were made using a hand-made UHV-STM with a base pressure of 1×10^{-10} Torr. Samples cut from a wafer of P-doped Si(111) were cleaned in UHV by repeated flash heating to 1200 °C. A tip was a W wire with a diameter of 0.3 mm sharpened by electrolytic etching.

Fig. 1 shows sequential STM images at same area of the Si(111)7×7 surface after evaporation of Al atom at room temperature. An adsorbed Al atom inside a triangle of a half unit cell was brighter than other Si adatoms (Fig. 1(a)); an expelled Si atom by the Al atom diffused inside the half unit cell of the surface as a noise-like diffusing Si atom. In addition, the adsorbed Al atom shows bias voltage dependency in the STM images, that is, at a large bias voltage of +1.8 V (Fig.1(a)) or +1.2 V (d) the adsorbed Al atom was bright, but the Al atom was dark when the sample bias was small like +0.6 V (b) or +0.4 V (c). Furthermore, the adsorbed Al atom hopped among three center adatom sites of the half unit cell; hopping event is numbered in the images sa shown in Fig. 1.

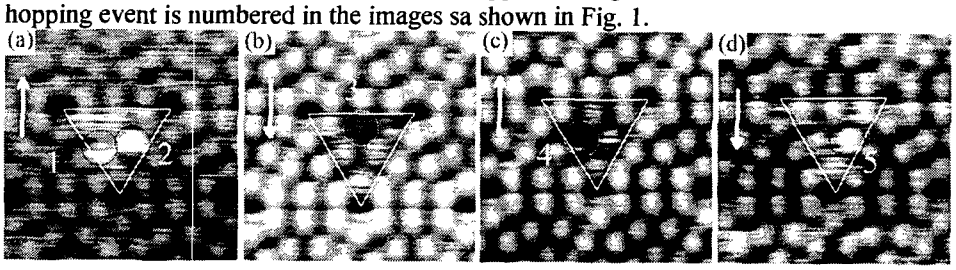

Fig.1. Sequential STM images of hopping Al atom inside a half unit cell of the Si(111)7x7 surface. Sample bias: (a) +1.8 V, (b) +0.6 V, (c) +0.4 V, (d) +1.2 V. A scanning direction of slow rate is shown with an arrow. The adsorbed single Al atom is indicated by a circle

References

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[2] H. Uchida, S. Watanabe, H. Kuramochi, M. Kishida, J. Kim, K. Nishimura, M. Inoue and M. Aono, Surf. Sci. 532-535, 737 (2003).