Photoelectron measurement of extremely uniform Si nano-islands on Si(111) 7×7 substrate

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Introduction

Photoelectron spectroscopy (PES) has been widely used to determine the electronic states of low-dimensional structures, such as two-dimensional quantum-wells and one-dimensional chains. However, the investigation of the electronic states of zero-dimensional quantum dots such as nano-islands by PES has hardly been reported. This is because the information about nano-islands is overwhelmed by the background as a result of the very low density and irregularity in size of the nano-islands.

In this report, we show PES and STM/STS results on size-selected Si nano-islands nucleated on Si(111)[1-3], which are formed by a fine control of growth temperature, T_g , and annealing temperature, T_g .

Experiment

The STM measurements were performed in an ultrahigh-vacuum STM chamber (base pressure: 2×10^{-8} Pa) equipped with reflection high-energy electron diffraction (RHEED) and an electron beam evaporation source. STM images were observed with an STM head (ULVAC Japan), controlled by Topsystem 3 (Oxford instruments). The PES measurements were performed by using synchrotron radiation on the beam line BL-7B. The experimental chamber, whose base pressure is about 6×10^{-8} Pa, is equipped with an angle-resolved photoelectron spectrometer (ARPES), an evaporation source, a quartz crystal thickness monitor and a sample manipulator with a cryostat.

Results and discussion

Figure 1(a) shows a typical STM image for the fabricated surface with a $\theta = 0.07$ bilayer (BL: 1 BL corresponds to 1.57×10^{15} atoms/cm²). Almost all nanoislands have a rounded shape composed of 162 atoms (Risland), as indicated by an arrow. The enlarged image of the R-island is also shown in the inset in Fig. 1(b). The number density of R-island reaches about 65 %[4].

Figure 2 displays a set of PES spectra for a clean 7×7 surface, the fabricated surface ($\theta = 0.07$ BL) and an STS spectra, (dI/dV)/(I/V), obtained at the adatom on the R-island[3,4]. A characteristic state LS_R of the R-islands in STS can be observed in the PES from the fabricated surface.



Fig.1. (a) STM image of Si nano-islands. (b) Size distribution of the islands.



Fig.2. PES from (a) a clean Si(111) surface and the fabricated surface. (c) STS from the R-islands[3,4].

References

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