Observation of surface reconstructions and nanometer sized structures formed on In/Si(311)

M. Xu, A. Okada, S. Yoshida, K. Kanazawa, N. Ookawa, O. Takeuchi and H. Shigekawa

Institute of Applied Physics, CREST-JST, University of Tsukuba, Ibaraki 305-8573, Japan

High index Si(311) surface has attracted many attentions as a promising substrate to assemble low-dimensional nanostructures due to its thermal stability and structural anisotropy. The adsorption of other chemical species on Si(311) is found to give rise to a variety of surface superstructures. Self-assembled Ge nanowires were grown by taking advantages of the anisotropic growth kinetics and strain relaxation relevant to the substrate. Using scanning tunneling microscope (STM), we studied the growth of In on Si(311). A number of surface reconstructions were observed. Furthermore, triangular islands and 1D nanowires were grown at specified growth conditions.

Experiments were carried out in ultra-high vacuum system with base pressure of 1.5×10^{-8} Pa. Clean Si(311) surface was obtained after outgassing the sample below 600 °C overnight, followed by slowly heating to 850~900 °C and quickly flashing above 1200 °C. In deposition was performed by using a resistant-heating evaporator at a flux of 6 ML/min (1 ML = 4.08×10^{14} atoms/cm^2).

Figure 1(a) shows an STM image of 5×1 reconstructed structure grown at 0.25 ML In coverage and growth temperature of 250 °C. Figure 1(b) shows 2×2 reconstructed surface formed at 0.75 ML coverage and substrate temperature of 350°C. Other reconstructions like 3×2 structure are also observed, depending on the coverage and growth temperature. Possible structure models are proposed for the observed reconstructions. The deposition of ~2.0 ML at 200~250 °C was found to give rise to the formation of triangular islands (see Fig. 1(c)). When the temperature was kept at 50-200°C, a single nanowire was formed along the upper step edge of the triangular island (see Fig. 1(d)). The formation process of triangular island and nanowire is discussed.
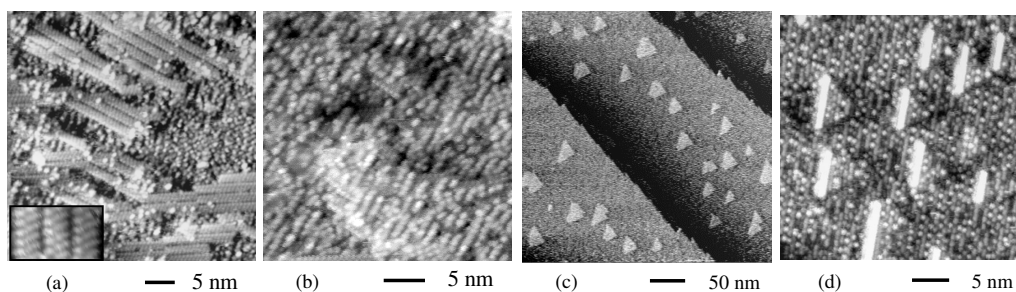
Contact: http://dora.ims.tsukuba.ac.jp

(a) ⎯ 5 nm   (b) ⎯ 5 nm   (c) ⎯ 50 nm   (d) ⎯ 5 nm

Fig. 1 STM images of (a) surface morphology with 5×1 reconstructed structure (V_S = -3 V, I_t = 0.2 nA), the inset showing a high-resolution image (b) surface morphology with 2×2 reconstructed structure (V_S = -3 V, I_t = 0.2 nA), (c) triangular islands (V_S = -2.0 V, I_t = 0.2 nA), and (d) nanowires on top of triangular islands (V_S = -2.0 V, I_t = 0.2 nA).