SPELEEM Study on Growth of Sb on In/Si(111) Surfaces

T.Yasue[1], F.-Z.Guo[2], A.Nakaguchi[1], M.Hashimoto[1], M.Ueda[1], T.Matsushita[2], Y.Tamenori[2], M.Oura[3], T.Takeuchi[3], Y.Saito[4], S.Shin[3], T.Kinoshita[2], K.Kobayashi[2] and T.Koshikawa[1]

[1]Fundamental Electronics Research Institute, Osaka Electro-Communication University, 18-8 Hatsu-cho, Neyagawa, Osaka 572-8530, Japan
[2]SPring-8/JASRI, 1-1-1 Kouto, Sayo, Hyogo 679-5198, Japan
[3]RIKEN SPring-8 Center, 1-1-1 Kouto, Sayo, Hyogo 679-5198, Japan
[4]Synchrotron Radiation Research Center, JAEA, 1-1-1 Kouto, Sayo, Hyogo 679-5198, Japan

InSb is one of typical compound semiconductors, and several applications to the infra-red devices, quantum devices and so on are expected because of its narrow band gap and high electron mobility. The lattice mismatch between InSb and Si, however, is rather large (~19%), so that the satisfactory hetero-epitaxial growth of InSb on Si substrate would be quite difficult. In the present study, the detailed growth processes of Sb on two different structures of √3x√3 and √31x√31 of In/Si(111) were investigated by using LEEM, selected area LEED and XPEEM at SPring-8.

The √3x√3 and √31x√31 mixed surface was prepared initially and Sb was deposited onto this surface at about 300 ^{o}C. Fig. 1(a) shows LEEM image of Sb/In/Si(111), (b) and (c) show the XPEEM images taken for In 3d and Sb 3d photoelectrons, respectively. The contrast seen in (b) and (c) is reversed. The dark region in (a), where was initially In/Si(111) √3×√3 surface, shows much higher In 3d intensity than the bright region, and vice versa for Sb 3d photoelectrons. The In/Si(111) √3×√3 surface contains less In atoms than that in the In/Si(111) √31×√31 surface. The In 3d intensity distribution in XPEEM image is opposite against the initial In/Si(111) surface. This indicates that the removal of In atoms from √31×√31 takes place much more than that from √3×√3 and the diffusion of In atoms on √3×√3 is enhanced. Finally the coalescence of In atoms takes place and 3D In islands form.

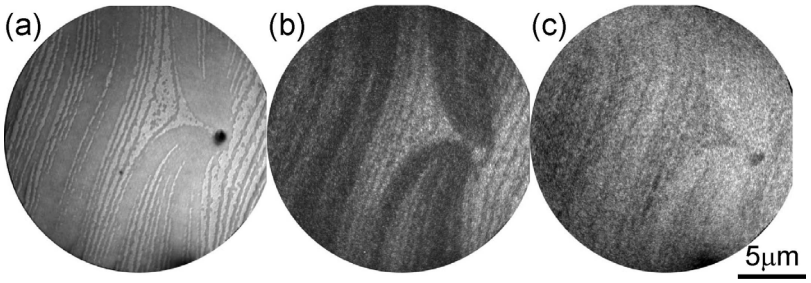

Fig. 1 (a) LEEM image of Sb/In/Si(111) surface. The bright area is the initially √3×√3 area and the dark area the initially √31×√31 area. (b) and (c) XPEEM image of In 3d and Sb 3d core electron, respectively.