Atomic Structure of the In-Bi Bilayer on the Si(111) Surface

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Recently, several 2D III-V materials, such as GaBi, InBi, TlBi, TlSb, and TlN are predicted to be topological insulators. In this study, the synchrotron radiation core-level photoemission spectroscopy and scanning tunneling microscopy (STM) has been utilized to explore the film formation, the interface and surface atomic structure evolution during the two-step sequential growth of In and Bi on the Si(111) surface by molecular beam epitaxy.

Growth of 1.0-ML Bi on In/Si(111)-(4 × 1) at room temperature result in the BiIn-(4 × 2) structure with post annealing below 400 ˚C. A phase transform to $InBi_{0.5}$-(2 x 2) is observed following annealing at 460 ˚C, in which In atoms move to the top layer. With reverse growth sequence, *i.e.* the growth of 1.0-ML In on β-Bi/Si(111)-($\sqrt{3} \times \sqrt{3}$) surface following by 460 ˚C annealing leads also to the same $InBi_{0.5}$-(2 x 2) structure, but with reduced coverage. However, the surface morphology for the two growth and annealing processes are very different. The apparent height between $InBi_{0.5}$-(2 x 2) and β-Bi/Si(111)-($\sqrt{3} \times \sqrt{3}$) is 2.0 Å; the height difference between $InBi_{0.5}$-(2 x 2) and In/Si(111)-(4 × 1) is 2.7 Å.

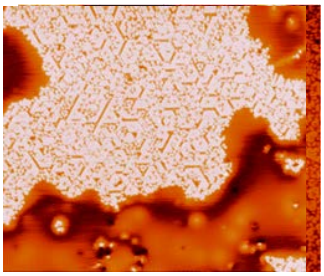

Fig. 1 The STM images for the $InBi_{0.5}$-(2 x 2) surfaces formed in two-step growth processes
Left: 1.0-ML Bi on In/Si(111)-(4 × 1); Right: 1.0-ML In on β-Bi/Si(111)-($\sqrt{3} \times \sqrt{3}$).

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