【S-10】

Novel Growth Mode in the Homoepitaxy on Si(5 5 12) : Critical Thickness Limited by Substrate Facet Height

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Prior to applying the high-index Si(5 5 12) to the nano-scale devices, preparation of atomically clean and flat surface is so critical that the homoepitaxy of Si(5 5 12) has been studied by STM under UHV. In the present studies, the atomic-structure of Si(5 5 12) was firstly determined, and then the fine evolution of Si-deposited surface was monitored. The following points were sequentially observed with increasing Si coverage :

1. A Si-dimer is the basic building-block and preferentially adsorbs on the unique site, that is, the Si-dimer/rest-atom site at the (3 3 7) subsection in the Si(5 5 12) unit cell.
2. The Si(5 5 12) unit cell is facetted to 3×(3 3 7) subsections filled with Si-addimers and 1×(1 1 3) subsection. In this step the tetramer in another (3 3 7) section is transformed to dimer/rest-atom site which can accepts Si-dimers.
3. Each (3 3 7) section is facetted to 1×(1 1 2) and 1×(1 1 3), and then finally the unit cell of Si(5 5 12) is facetted to 3×(1 1 2) and 4×(1 1 3). In this step, mutual transformation between the honeycomb chain wall and the dimer/rest-atom site alternatively occur.
4. The valley between the unit cell facets is filled until the height reaches 2.36 Å, the height of substrate-unit-cell facet.

When the last step is completed, the uniform and planar Si(5 5 12) terrace is recovered. From the present studies, therefore, it can be concluded that the homoepitaxy on Si(5 5 12) is periodically achieved and such growth mode is quite unique since facetting of the substrate-unit-cell plays a critical role for limiting the film thickness resulting in the uniform overlayer.