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Novel Growth Mode in the Homoepitaxy of Si(5 5 12) -2×1: Cyclic Mutation of One-dimensional Structures

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The homoepitaxy of Si(5 5 12) has been studied by STM under UHV. The Si dimer turns out to be a basic building block, and selectively adsorbs on the dimer facing adatom(D/A) sites of reconstructed Si(5 5 12). The dimer adsorption on the specific sites(i.e., D/A) also induces the tensile stress to the neighboring tetramer(T) to be split and become a new dimer facing adatom(D/A), which will provide another dimer adsorption sites. After saturating these adsorption sites with dimers, the additional Si-dimers arriving at these sites induce line-transformation to a honeycomb(H) chain and breaking the neighboring honeycomb(H) chain to a new tetramer row(T) which can also be split by the external tensile stress. Through such mutual transformations among the honeycomb chain(H), the tetramer(T), and the dimer facing adatom(D/A), the facet has been grown from the (113) seed inside of (225) unit of reconstructed Si(5 5 12), and finally become a sawtooth-like facet composed of (113) facet of four periodicities and (112) facet of three periodicities. The facet height from the bottom of valley turns out to be 2.34 Å. On the verge of completion of facet, the valley is filled with added Si in the same way as the previous transformation, and eventually the uniform and reconstructed Si(5 5 12) terrace is recovered. After one cycle of homoepitaxy, the unit cell of Si(5 5 12) shifts by 3.04 Å toward [$\bar{6}\bar{6}5$] direction from the original substrate. The effective layer thickness to recover the uniform overlayer is 1.36 Å, which needs 28 atoms per unit cell of Si(5 5 12). It has been concluded in the homoepitaxy on Si(5 5 12) at 500 C that the exact growth direction is toward [$\bar{1}\bar{1}2$] and the new layer is formed through adding a cell-unit composed of two dimers from the direction of [$\bar{1}\bar{1}2$], to each of seven (111)-bilayer-step-edges existing in the (5 5 12) surface and grows in the step-flow mode in the same way as that on the (111) surface.