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Determination of the precise surface direction in the nanometer scale using a stable Si(6 9 17) facet existing on Si(5 5 12): Nanoscale Metrology

Y. Z. Zhu and Jae M. Seo
Department of Physics, Chonbuk National University

From the topographic scanning tunneling microscopy(STM) image obtained from the reconstructed Si(5 5 12)-2x1, it has been found that there exists a stable facet which does not belong to a group of high-index Si surfaces between (001) and (111). Such a non-parallel (in the sense that 1-D structures, such as dimer-row, tetramer row, and honeycomb chain, appearing in the reconstructed Si(5 5 12)-2x1, are parallel to [1-1 0] direction) facet is inevitable due to the limit of aligning (5 5 12) surface through x-ray diffraction. Furthermore, surface anisotropic-stress generated by local defects can change the surface average-direction in the nanometer scale. One of interesting points is that this non-parallel facet is unique and stable so that its ratio to parallel facet, (113), represents the average direction of the local surface in the nanometer scale. In the present studies, the precise direction of this non-parallel facet has been estimated using the topographic STM image and it has been turned out to be (6 9 17). From the detailed STM image, it has been found that this (6 9 17) composed of narrow (3 3 7) facet and a single step of (0 1 1) facet. Therefore, in the present studies, it has been checked that (5 5 12) employed in the present study has original misalignment toward the direction between [1 1 3] and [6 9 17] so that the reconstructed surface is always surrounded by three faces, (5 5 12) terrace, (1 1 3) parallel facet, and (6 9 17) non-parallel facet. Due to the plane-symmetry of (5 5 12) relative to (1 1 0), the present deduction on (6 9 17) induces one more deduction that the (9 6 17) face is another facet when the original misalignment is toward the direction between [1 0 1] and [1 1 3]. It has been concluded that the present metrology using STM provides a quantitative method for determining the direction of nanoscale area.