【S-06】

Steps on Si(5 5 12)-2x1: competing between external stress and substrate strain

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Since the STM has been invented, it has been dreamed to fabricate the nano-scale device using the knowledge on the atomic-scale surface structure. Recently the high-index Si surface such as Si(5 5 12) attracts much attention[1]. Since the reconstructed Si(5 5 12)-2x1 has a single-domain terrace, it can be a template to grow 1-dimensional nano-scale wire with a high aspect ratio through depositing noble metals. Although Si(5 5 12) can have an ideal terrace without steps, the steps are always detected from the reconstructed surface and they are not easily controlled. If the step direction is perpendicular to the row direction of Si(5 5 12), the wire is cut and the aspect ratio is reduced. Up to now the mechanisms of the step generation and the step-shape change of Si(5 5 12) are not clear. In the present study the step of the reconstructed Si(5 5 12) has been studied in order to understand how its shape is changed and furthermore to control its density, which is critical in applying this surface to the device. The wafer was cut and mounted on the sample holder for the row direction ([-1 1 0]) to be either parallel or perpendicular to the current-flowing direction (which is the same direction as that of Ta holders). The mounted sample direction was confirmed by the STM images. It has been found that the bending steps are always detected when the row direction is parallel to the holding direction (that is, the direction of line connecting two holding Ta). On the other hand, most of steps were straight when the row direction is perpendicular to the holding direction. This contrasting result clearly implies there are two critical factors determining step shapes, that is, one is the substrate strain preferring to have parallel steps to the row direction and the other is an external stress exerted by the fixed holder during substrate-heating process for surface reconstruction. Especially, when the tangential angle of the bending step approaches from the right angle relative to the row to [10 2 5] direction (which is 120 degree off from the

row direction [-1 1 0]), the step abruptly changes to saw tooth-like shape consisting of two directions, [10 2 5] and [-1 1 0]. Finally it merges to the straight step parallel to the row direction. From the present study it can be concluded that the steps of Si(5 5 12) surface is sensitively affected by the external stress as well as the substrate strain which drives one-dimensional symmetry. Therefore, to achieve the template for growing the nanowire with high aspect ratio, the direction of external stress should be aligned to that of the substrate strain.

1. A.A. Baski, S.C. Erwin and L.J. Whitman, Science 269, 1556-1559 (1995); A.A. Baski, K.M. Jones and K.M. Saoud, Ultramicoscopy **86**, 23-30 (2001).