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Metal nanowires formed on high-index Si surfaces: Bi/Si(5 5 12) vs Ag/Si(5 5 12)

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High-index Si surfaces between (001) and (111) have one-dimensional symmetry along [1 -1 0]. Their reconstructed surfaces have usually 1-D features such as honeycomb chain, rebonded-rest-atom row, dimer-row, and tetramer row. Therefore, they can be potential templates for fabricating self-assembled nanowires with regular spacings of nanometer scale, if the deposited atoms preferentially react any of those 1-D features. Hence, in the present study, two kinds of metals, Ag and Bi, which are known not to form any silicide, had been chosen as depositing species, and Si(5 5 12), which is known to be reconstructed as a relatively planar surface with 5.3 nm periodicity, had been selected as a substrate in order to understand the mechanism of self-assembled nanowire fabrication through in-situ STM studies. There were two striking differences in two cases as follows: First, Ag selectively adsorbs on the tetramer sites without disturbing the substrate periodicity, while Bi induces faceting to a more stable surface, (337), after depositing critical amount Bi atoms. The difference originates from the reactivity difference between substrate and deposited atoms, that is, Bi atoms replace loosely-bonding Si atoms and generate the stress to induce faceting, while Ag is relatively inert. Second, the Ag-induced nanowire has 3x periodicity along [1 -1 0] relative to 2x periodicity of the substrate. On the other hand, Bi atoms adsorb in the unit of Bi-dimer and keep the same 2x periodicity as the substrate. In the presentation, the roles of substrate symmetry, possible adsorption sites, and the adsorbate-induced stress will be discussed as determining factors for fabrication of 1-D metal nanowire.