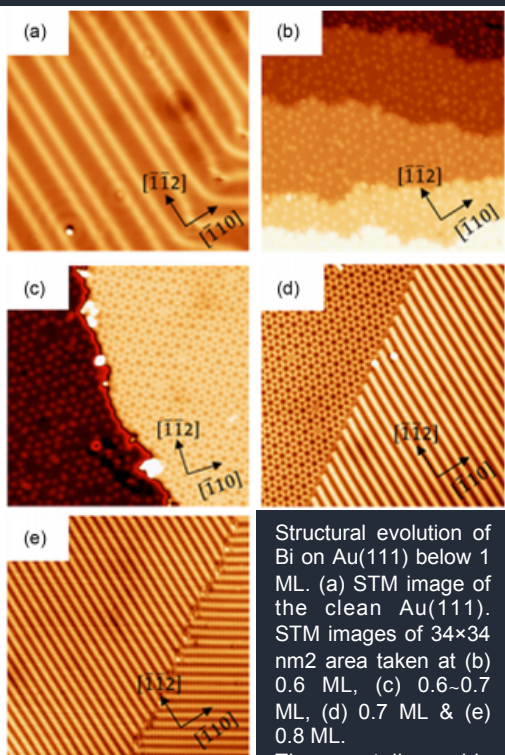


Structural evolution of Bi thin films on Au(111) revealed by scanning tunneling microscopy



Structural evolution of Bi on Au(111) below 1 ML. (a) STM image of the clean Au(111). STM images of 34×34 nm² area taken at (b) 0.6 ML, (c) 0.6–0.7 ML, (d) 0.7 ML & (e) 0.8 ML.

The crystallographic orientations of the Au(111) substrate are shown in each STM image.

Sample Preparation

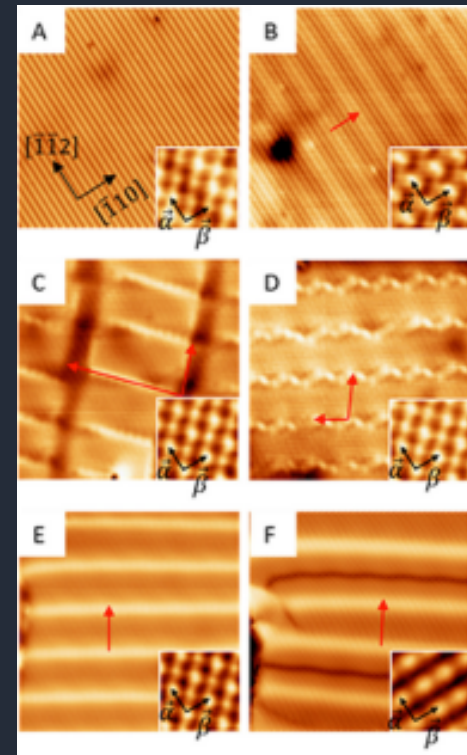
All STM experiments were performed under UHV conditions with the base pressure below 2.0×10^{-10} Torr. A single-crystal Au(111) surface was cleaned with several cycles of Ar⁺ sputtering and annealing at 770 K and was used as a substrate for the growth of Bi films. Bi atoms were deposited onto the Au(111) substrate kept at RT by heating a cell of Bi. The surface coverage of Bi was controlled by the deposition time. The deposition rate was calibrated to be 0.06 ± 0.02 monolayer/min by observing the structural transition of Bi on Si(111) with reflection high-energy electron diffraction.

Differential conductance spectra were measured with a lock-in technique. All STM measurements were performed at 4.7 K.

Analytical Results

STM imaging with high resolution provides the atomic arrangement of the sixfold structure by combining DFT calculations.

Three phases were found for Bi < 1 ML: the cluster array with (5×5) periodicity, and $(\sqrt{37} \times \sqrt{37})R25.3^\circ$ and $(p \times \sqrt{3})$ structures. Above 1 ML, the Bi(110) films form and grow stably above 60 ML. Electronic structure is correlated with the layer number. The structural transition from Bi(110) to Bi(111) occurs by heating at 470 K. It is difficult to realize the thick Bi(110) films and thus the present system would provide a proper stage for investigating the peculiar electronic characteristics of Bi(110).



High-resolution images of the regions marked by A–F. The insets show atom-resolved images of regions A–F. Crystallographic orientations of the Au(111) substrate are shown in image A and are common in images B–F. Red arrows in B–F indicate the unit vector of long-range patterns.