STM Study for Local Atomic Migration on Au(111) surface

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A scanning tunneling microscope (STM) is well known as a unique tool to probe geometric and electronic structures on solid surfaces with the atomic scale. Moreover, the STM provides the capability to manipulate individual atom or molecule, as well modify a surface structure. The STM manipulations have been done by using the tip-sample interaction, basically electric field by applying a voltage pulse or atomic force depending on the tip-sample distance. In reported several atomic-scale deformations on an Au(111) surface, such as fingerlike stripes, the tip-sample interaction during scanning was not taken as the major reason of them [1, 2]. In this study, we investigate a local Au atomic migration induced by the tip-sample interaction during tip scanning on the Au(111) surface.

The Au(111) surface was prepared by the fire-fusion method. The STM system used for this experiment was a PicoSPM from Molecular Imaging Corp. The sample was observed in air at room temperature with a mechanically cut tip.

Using an Au tip, small atomic migration on the Au(111) surface was observed only after applying a voltage pulse. The migration showed as the shape of fingerlike stripes, which was grown parallel to a step along the [1 -2 1] direction from a terrace edge. In case of a Ni tip, enhanced large migration was observed on the Au(111) surface even without a voltage pulse. The removal of an Au atomic mono-layer in the scan area was successfully done by controlling a tunneling current, because the depth of migrated area was proportional to logarithmic function of tunneling current. All observed atomic migration was followed by the scan direction, meaning induced by the tip-sample interaction during tip scanning. In the STM configuration, the tip-induced local atomic migration would be explained by the electric field effect Movable Au surface atoms were swept by tip-scan in the local area where a voltage pulse was applied. In other words, activation energy for an Au atom migration could be reduced in the local area where multi-vacancies were created by an applied voltage pulse. The tip-sample interaction while scanning induced the atomic migration in the local area where surface potential was changed by the applied voltage pulse. Therefore, the applied voltage pulse acted as a trigger for the atomic migration via the field gradient effect. Closer tip-sample distance could be interpreted for the larger atomic migration by the Ni tip than by the Au tip. In STM experiments, the tip-sample interaction during tip scanning should be considered for morphological changes on the surface.

References

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