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STM and AFM; Which is Better for Surface Structural Analysis? Non- contact AFM Studies on Ge/Si(105) Surface

YUKIO HASEGAWA, Institute for Solid State Physics, The University of Tokyo

Scanning tunneling microscopy (STM) has been utilized to determine surface atomic structure with its highly resolved images. Probing surface electronic states near the Fermi energy (E_F), STM images, however, do not necessarily represent the atomic structure of surfaces. It has been believed that atomic force microscopy (AFM) provides us surface topographic images without being disturbed by the electronic states. In order to prove the surpassing performance, we performed noncontact (nc) AFM on the Ge/Si(105) surface [1], which is a facet plane of the ?hut? clusters formed on Ge-deposited Si(001) surface. It is found that STM images taken on the surface, either filled- or empty-state images, do not show all surface atoms because of the electronic effect; some surface atoms have dangling bond states below E_F and other surface atoms have states above E_F. [2]. In a nc-AFM image, on the other hand, all surface atoms having a dangling bond are observed [3], directly representing an atomic structure of the surface. Electronic information can also be obtained in AFM by using a Kelvin-probe method. From atomically resolved potential profile we obtained, charge transfer among the dangling bond states is directly demonstrated. These results clearly demonstrate that highly-resolved nc-AFM with a Kelvin-probe method is an ideal tool for analysis of atomic structures and electronic properties of surfaces. This work was done in collaboration with T. Eguchi, K. Akiyama, T. An, and M. Ono, ISSP, Univ. Tokyo and JST, Y. Fujikawa and T. Sakurai, IMR. Tohoku Univ. T. Hashimoto, AIST, Y. Morikawa, ISIR, Osaka Univ. K. Terakura, Hokkaido Univ., and M.G. Lagally, University of Wisconsin-Madison.

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[2] Y. Fujikawa et al., Phys. Rev. Lett. 88, 176101 (2002).
[3] T. Eguchi and Y. Hasegawa, Phys. Rev. Lett. 89, 256105 (2002)