1C/2002S2-002

Band bending of a quasi- one-dimensional Si(553)-Au surface

H. Okino[1], I. Matsuda*[1], S. Yoshimoto[1], J. Okabayashi[1],
S. Toyoda[1], K. Ono[2], M. Oshima[1], and S. Hasegawa[1]
[1]The University of Tokyo, Tokyo 113-0033, JAPAN, [2]KEK-PF, Ibaraki 305-0801, JAPAN

Vicinal Si surfaces, *e.g.* Si(557), have been templates for one-dimensional (1-D) atomic structures and there have been many reports on the Au adsorbed systems, exhibiting intriguing physical properties such as Peierls instability.[1] Because of interests in their atomic scale transport phenomena, recently, we have performed conductivity measurement on Si(557)-Au with state-of-the-art micro-four-point probes.[2] Although the photoemission spectroscopy studies have found one-dimensional bands crossing the Fermi level,[1,3] the measured surface-state conductivity has become large with temperature, showing non-metallic nature in transport. Through the STM and Si 2p core-level experiments, we have figured out that the surface state electrons are strongly scattered by defects on 1-D structure, resulting in the hopping conduction.[2] The research has demonstrated importance of these two experimental results for proper interpretation of surface transport phenomena.

In the present research, we have extended our research to the other Au covered vicinal Si surface, Si(553)-Au. The surface has three 1-D metallic bands at room temperature [3] and, contrary to Si(557)-Au, the defect density is significantly small (inset of Figure). Therefore, it is a good candidate for studying intrinsic transport properties of a quasi-1-D system. In transport measurements performed on semiconductor surfaces, electric current flows through surface states and bulk states of space-charge layers (and possibly bulk Si). In order to extract the surface states conductivity from a measured value, the space-charge layer contribution must be considered. Therefore, we performed Si 2*p* core-level photoemission spectroscopy measurement on Si(553)-Au at BL-1C (KEK-PF) to determine the band bending, which determines the space-charge layer carrier density.

Figure shows bulk sensitive Si 2*p* core-level spectra of Si(553)-Au and Si(111)7×7. Fermi energy (E_F) of Si(111)7×7 is pinned and the energy difference between E_F and valence band maximum (E_V) is 0.63 eV [4]. Using this reference value, $E_F - E_V$ of Si(553)-Au is 0.56 eV. Since the Si band gap is 1.12 eV, the space-charge layer of Si(553)-Au forms a depletion layer, indicating that the current flows only through the topmost surface atomic layer in the transport measurements. The conductivity measurement has now been underway.

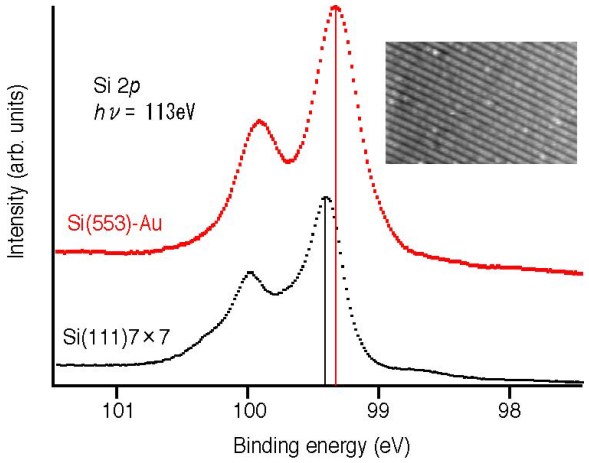

Figure Bulk sensitive Si 2p core-level photoemission spectra of Si(553)-Au and Si(111)7×7.
The inset is an STM image of the Si(553)-Au surface.

References

[1] J. R. Ahn, *et al.*, Phys. Rev. Lett. **91**, 196403 (2003).
[2] H. Okino, *et al.*, Phys. Rev. B **70,** 113404 (2004).
[3] J. N. Crain, *et al.*, Phys. Rev. B **69**, 125401 (2004).
[4] F. J. Himpsel, *et al.* Phys. Rev. B **28**, 7014 (1983).

*matsuda@surface.phys.s.u-tokyo.ac.jp