1C/2002S2-002

Anisotropic conductivity of quasi one-dimensional Si(557)-Au surface

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Introduction

Vicinal surfaces have been used to produce a quasi one-dimensional (1D) structure. For example, Au adsorptions on Si(557) surface is famous for its 1D metallic character[1-3]. This facet structure consists of periodic array of identical metallic atom chains over the sample surface, which is suitable for photoemission experiments.

In spite of plenty of works about electronic structures, the interpretation of them is still under debate. Therefore, researches from transport aspects are wanted. Measuring the surface 2D conductivity of semiconductor crystal is not a simple way because the measuring current penetrates into the substrate bulk region. By using a surface inversion layer[4], we measured the surface 2D conductivity by 4-point probe method. The measured conductivity includes surface-state conductivity and space charge layer conductivity. In order to evaluate the space charge layer conductivity, the amount of band bending is needed. We obtained the amount of band bending from core-level photoemission spectroscopy.

Experimental

The Si 2*p* Core-level spectra were taken at the beamline BL-1C of the Photon Factory in KEK. A vicinal Si crystal (15×3×0.525mm^3, P-doped, 1~10Ωcm at RT) with a miscut of 9.45°toward the [-1-12] direction from (111) surface was used as a substrate. 0.20 monolayer Au was evaporated from a hot alumina basket onto the substrate held at a temperature T=700°C. Surface super structure was checked by low energy electron diffraction pattern.

Results

Figure 1 shows bulk sensitive Si 2*p* core-level spectra obtained at photon energy of 108 eV. Fermi level position with respect to the valence band maximum E_F-E_V was estimated by comparing with a reference value of 0.63 eV for the Si(111)7×7 surface. For Si(557)-Au surface, E_F-E_V value is 0.38 eV. This indicates a formation of a very weak inversion layer under the surface on an n-type Si crystal.

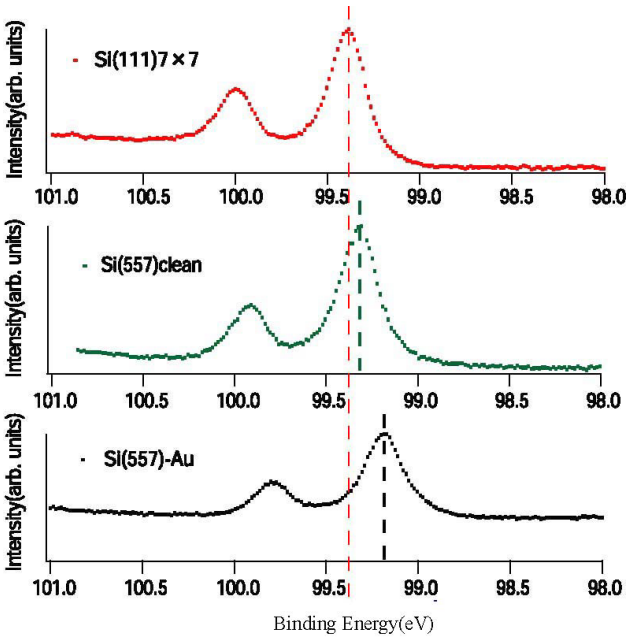

FIG.1. Si 2*p* core-level spectra recorded from Si(111)7×7 surface, Si(557) clean surface and Si(557)-Au surface at normal emission. All spectra were obtained with a photon energy of 108 eV.

Surface 2D conductivity parallel to the chain and perpendicular to the chain was obtained to be ~10 (μS/□) and ~3 (μS/□), respectively. The anisotropy is much smaller than other quasi 1D system.

References

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