

Growth of Fe silicide films on Si(111)7x7 and Si(111)1x1-H surfaces

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Introduction

Formation of Fe silicide films on silicon surfaces has been extensively studied by various experimental methods from both fundamental scientific and technological points of view. Upon deposition of Fe atoms at room temperature and sequential annealing, the system will evolve toward formation of certain stoichiometric film corresponding to the temperature and the initial thickness of Fe film [1]. For relatively low reaction temperature, the dominant process in the silicide film evolution is the diffusion of atoms through the interface. The process is closely concerned with the diffusion and redistribution of electrons at the interface, that is, chemical reaction. It will be strongly affected by passivation of the surface prior to Fe deposition. A different initial electron distribution at the interface may stabilize unusual structure or stoichiometric film. In this study, we have investigated the Fe silicide film formation on a bare surface (Si(111)7x7), and a passivated surface (Si(111)1x1-H) by photoemission spectroscopy (PES).

Experiments

PES measurements were performed on the beamline 18A at PF in KEK. Commercial *n*-type Si(111) wafer was used as sample substrates. A clean Si(111)7x7 surface was prepared by heating the sample up to 1520 K for 3 s repeatedly. A Si(111)1x1-H surface was prepared by chemical etching in aqueous NH₄F solution. Fe atoms were deposited from electron-beam-bombarded Fe rod. All measurements were carried out at room temperature.

Results and Discussion

Fig. 1(a) shows angle-resolved photoemission spectra (ARPES) of the valence band for an Fe silicide film on Si(111)7x7 surface as a function of emission angle along the $\bar{\Gamma}$ \bar{K} line in the surface Brillouin zone. The photon energy is 21.2 eV and the incident angle is 45 degree. The initial thickness of Fe film is 8 ML. The sample was annealed at 570 K for 5min. Additional annealing at the same temperature leads no difference in the spectra. A dependence on the emission angle is clearly seen. Fig. 1(b) shows ARPES spectra for Fe silicide films on Si(111)7x7 (lower) and Si(111)1x1-H (upper) surfaces at $\bar{\Gamma}$ (left) and \bar{K} (right), respectively. The latter sample was obtained after annealing at 570 K for 15 min. No difference was observed upon further annealing. The spectra for both samples exhibit the same angle-dependence. However, Si 2*p* spectra for these samples are strikingly different from each other as shown in Fig. 2. The photon energy is 130 eV. The bulk component is assigned to black one from energy dependence of the

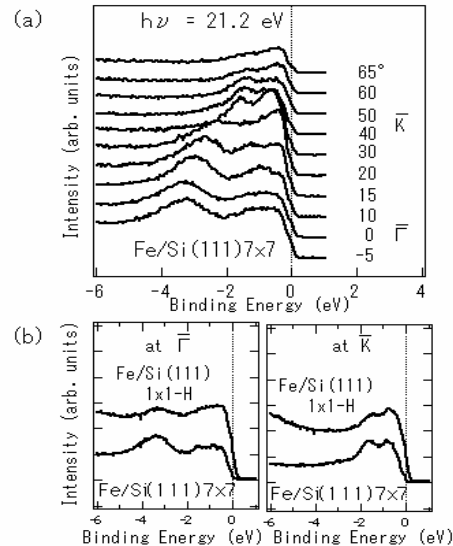


FIG. 1. (a) ARPES spectra for an Fe silicide film on Si(111)7x7 surface as a function of emission angle along the $\bar{\Gamma}$ \bar{K} line. (b) ARPES spectra for Fe silicide films on Si(111)7x7 (lower) and Si(111)1x1-H (upper) surfaces at $\bar{\Gamma}$ (left) and \bar{K} (right), respectively.

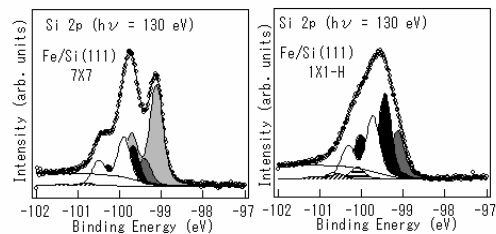


FIG. 2. Si 2*p* core-level PES spectra for Fe silicide films on Si(111)7x7 (left) and Si(111)1x1-H (right) surfaces, respectively.

intensity. The strong component colored light-gray in left panel is considered to be originated from excess surface Si atoms on the silicide film since the photon energy resides in the surface sensitive region. These results indicate that H atoms at the interface produce a different equilibrium concentration of Si surface atoms, although the electronic structures within the silicide films are the same for both samples obtained after annealing at 570 K.

References

[1] J. J. Hinarejos, *et al.*, Phys. Rev. B **55**, R16065 (1997)

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