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Electronic States of Co/6H-SiC Interface by SXFS

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Introduction

Silicon carbide (SiC) is a candidate material for electronic devices to operate upon crucial environment such as high-power, high temperature and high-radiation field because of high electric breakdown field, high saturation electron velocity and tolerance to high-temperature and radioactive field compared with silicon (Si). For the application of electronic devices it is necessary that the physical properties of metal-SiC contact system are clarified.

In this report the electronic states for Co/6H-SiC(0001) Si- and C-face contact system is studied by soft X-ray florescence spectroscopy (SXFS). The SXF spectra have characteristics to give information of partial density of states in the valence band density of states (VB-DOS) because different wave functions for each element in a material under study can be separated due to the dipole selection rule of electron transitions. Therefore, we can obtain a specific signal for an element which can be used as a finger print, otherwise it is difficult.

Experimental

The samples were prepared as follows.

(i) A wafer of 6H-SiC(0001) Si- and C-face was cleaned by being rinsed in ethyl alcohol, dipped in 5% HF solution and flashed under ultra-high vacuum (UHV) condition.

(ii) Co metal was evaporated on the surface of this substrate by heating of alumina-coated tungsten basket within Co wires.

(iii) The samples of Co/6H-SiC(0001) contact system were thermally treated with an electric furnace in flowing H_2 gas at 650 and 900°C for 1 hour.

The film thickness of evaporated Co metal was about 50nm. The SXF spectra were obtained in an SXFS apparatus, which is installed to a beamline BL-19B at synchrotron radiation facility of Photon Factory (PF) in High Energy Accelerator Research Organization (KEK).

Results and Discussion

A shape and peak energies of the Si $L_{2,3}$ florescence spectra obtained from (a) thermal-treated specimens in 650 and 900°C for Co/6H-SiC(0001) Si- and C-face contact systems were compared with reference ones obtained from specimens of (b) a polycrystal of $CoSi_2$ and (c) a 6H-SiC(0001) substrate. The spectrum of (c) is characterized by a hump of 86.5eV, a main peak of 91eV and plateau region from 92eV to 97.5eV including a small peak at 97eV. The spectrum of (b) has two peaks at ~90.5 and ~97eV with the different intensity. The spectrum obtained from thermal-treated specimen at 650°C for Co/6H-SiC(0001) Si-face contact system in samples (a) has the similar characteristics as (c), but is not identical for spectrum shape and peak energies. Further this spectrum is quite different from ones of (c). Therefore it may be suggested for this sample that the product due to solid phase reaction is materials such as silicide-like from the spectrum shape and peak energy. However, the spectra obtained from other samples are quite different from ones of (b) and (c). So, we could not identify from the Si $L_{2,3}$ SXF spectra how materials are produced by solid phase reaction for other samples to the exclusion of the thermal-treated specimen at 650°C for Co/6H-SiC(0001) Si-face contact system.

Next, the C K SXF spectra obtained from (a) the same specimens as the Si $L_{2,3}$ SXF spectra were compared with reference ones obtained from specimen of (b) a 6H-SiC(0001) substrate and (c) a graphite plate. The each spectrum of (a) is characterized by a main peak at 280.7eV, a small peak at 270.7eV and a shoulder at 275.7eV. The spectrum of (b) has a main peak at about 281eV and a shoulder around 276eV. The spectrum of (c) has a single peak at 278eV and a shoulder around 282eV. The all spectra (a) have the similar characteristics to one of (c) in respect of spectrum shape and peak energies. However, considering from the results of the Si $L_{2,3}$ SXF spectra, it is concluded that C K SXF signals cannot be distinguished possible formation of graphite from adsorbed carbon contamination because of passing atmosphere environment of specimens.

Summary

These results are summarized as follows. The Si $L_{2,3}$ SXF spectrum obtained from the thermal-treated specimen at 650°C for Co/6H-SiC(0001) Si-face contact system shows the silicide-like product. Other spectra could not be identified.

References

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