19B/2006G009

Electronic States of V/6H-SiC Contact System by SXFS

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Introduction

Silicon carbide (SiC) is one of attractive materials in hard electronics such as high-power, high-frequency, high-temperature and high-radiation field because of high saturation electron velocity and high breakdown electric 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 partial density of states for Vanadium (V) metal/6H-SiC(0001) Si-face contact system is studied by soft X-ray florescence spectroscopy (SXFS).

Experimental

The samples were prepared as follows.
(i) A wafer of 6H-SiC(0001) Si-face was cleaned by being rinsed in ethyl alcohol, dipped in 5% HF solution and flashed under ultra-high vacuum (UHV) condition. (ii) V metal was evaporated on the surface of this substrate by heating of tungsten boat with V wires. (iii) The samples of V/6H-SiC(0001) contact system were thermally treated with direct Joule heating at 850-1000°C for 10 minuets. The film thickness of evaporated V was about 50nm. X-ray florescence spectra were obtained in an SXFS apparatus, which is installed to a beamline BL-19B at synchrotron radiation facility of Photon Factory in KEK [1]. Si $L_{2,3}$ and C K emissions were induced by 135 and 350eV photons, respectively. The incident photon beam angle to the specimen surface normal is 45°. Photon energies were calibrated against 4f signals and Fermi edge of Au. This SXFS is characterized by considering partial density of states in the total energy states due to dipole selection rule of electron transitions.

Results and Discussion

A shape and peak energies of the Si $L_{2,3}$ florescence spectrum obtained from (a) thermal-treated specimens in 850°C for V/6H-SiC(0001) Si-face contact system was compared with reference ones obtained from specimens of (b) a pressed powder of VSi_2 and (c) a 6H-SiC(0001) Si-face as shown in Fig. 1. The spectrum of (c) is characterized by a hump of 86.5eV, a main peak of 90.7eV and plateau region from 92eV to 98eV including a small peak at 97eV. The spectrum of (b) has two peaks at ~91.3 and ~97eV with the shoulder of ~89eV. The spectrum of (a) has the similar characteristics as (b) except for peak energy and intensity ratio of two peaks, but is entirely different from one of (c) for spectrum shape and peak energies. Therefore, it is considered that surface layer may be covered by thin reacted materials. A component of reacted products may be vanadium silicide. However, considering to be different peak energy

between (a) and (b) and to be existence of the shoulder at ~89eV, ternary compounds also may be constructed.
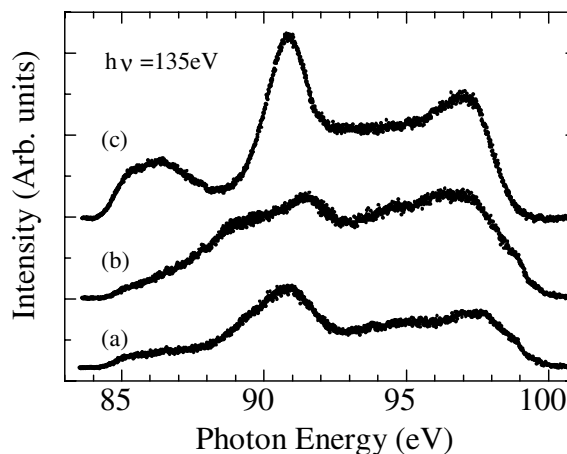

Fig. 1. The Si $L_{2,3}$ florescence spectra; (a) thermal-treated specimens at 850°C for V/6H-SiC(0001) Si-face contact system, (b) a pressed powder of VSi_2 and (c) a 6H-SiC(0001) Si-face, where the incident photon energy was 135 eV.

A spectrum shape and peak energies of the C K florescence spectrum obtained from (a) thermal-treated specimens at 850°C for V/6H-SiC(0001) Si-face contact system was compared with reference ones obtained from specimens of (b) a 6H-SiC(0001) Si-face, (c) a pressed powder of vanadium carbide and (d) a graphite plate without no figure. The spectrum (a) has the similar characteristics to one of (d) in respect of spectrum shape and peak energy. But it is different from one of (b) and (c) for spectrum shape. Therefore, it is concluded from a comparison with characteristics of these spectra that C K SXF signal does not indicate possible formation of carbide.

Summary

These results are summarized as follows. The Si $L_{2,3}$ SXF spectrum obtained from thermal-treated specimen at 850°C for V/6H-SiC(0001) Si-fase contact system is the similar one as the vanadium silicide of VSi_2 except for peak energy and intensity ratio at peaks.

Reference

[1] Y. Harada, et al., J. Sync. Rad. 5, 1013 (1998).

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