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Study of Ti/4H-SiC Contact by Using Soft X-ray Florescence Spectroscopy

Masaaki HIRAI*[1], Joselito P. LABIS[2], Akihiko OHI[2], Yuhji MORIKAWA[2],
Masahiko KUSAKA[1] and Motohiro IWAMI[1]
[1]Research Laboratory for Surface Science, Faculty of Science,
[2]Graduate School of Natural Science and Technology,
Okayama University, Okayama 700-8530, Japan

Introduction

Silicon carbide (SiC) is a candidate material for hard electronics such as high-temperature, high-radiation, high-power and high frequency 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 Ti/4H-SiC(0001) Si-face contact system is studied by soft X-ray florescence spectroscopy.

Experimental

The samples were prepared as follows.

(i) A wafer of 4H-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)Ti metal was evaporated on the surface of this substrate by heating of tungsten boat with Ti wires.

(iii)The sample of Ti/4H-SiC(0001) contact system was Joule-heated under UHV at 1000°C for 5 minuets.

The film thickness of evaporated Ti was about 50nm.

The soft X-ray florescence spectroscopy (SXFS) was studied by using a beamline of BL-19B at the SR facility of Photon Factory in KEK. The Si $L_{2,3}$ and C *1s* SXF spectra of the sample, obtained using photon energy of 145eV and 350ev, respectively, were recorded by grating monochromator with a curvature of 5m and position sensitive detector. This SXFS is characterized considering partial density of states in the total energy states due to dipole selection rule of electron transitions.

Results and Discussion

The Si $L_{2,3}$ florescence spectra from Ti/4H-SiC(0001) Si-face contact system is shown in Fig. 1, where the reference spectra from (a) 4H-SiC(0001) Si-face and (d) pressed powder of Ti_5Si_3 are also shown. The angles of (b) 45° and (c) 75° is the take-off angle with respect to the normal of the sample surface. The spectrum of (a) is characterized by a hump of 86eV, a main peak of 91.3eV as shown by dashed lines in the figure and a shoulder with a hump over 94eV. The spectrum of (b) has the similar characteristics of the hump, peak energy and shoulder as (a). Therefore, it is considered that this spectrum mainly contains the information from the substrate SiC because of deep sampling depth for take-off angle of 45°. The spectrum of (c) is different from that of (a), i.e., no hump at 86eV and the shift of peak energy toward 92eV, which is considered to be due to the surface sensitiveness for the take-off angle of 75°. By comparing the spectrum (c) with (a) and (d), it can be concluded that the spectrum (c) includes the information of Ti_5Si_3. The spectra of C *1s* SXFS are described elsewhere [1], [2].

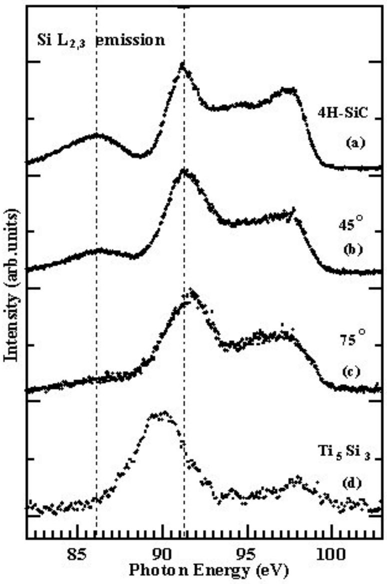

Fig. 1. Si $L_{2,3}$ emission spectra from Ti/4H-SiC(0001) Si-face sample; (b) take-off angle of 45°and (c) 75°, respectively, and reference ones from (a) 4H-SiC and (d) pressed powder of Ti_5Si_3 [1], [2].

Summary

These results are summarized as follows.

(1) The SFX spectra depend on the take-off angle.

(2) The interface reacted region is composed of Ti_5Si_3 and TiC with excess C near the surface region.

References

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* hirai@science.okayama-u.ac.jp