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Study of Ni/4H-SiC contact by using soft X-ray florescence spectroscopy

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Introduction

Silicon carbide (SiC) is one of hopeful 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 Ni/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)Ni metal was evaporated on the surface of this substrate by heating of tungsten boat with Ni wires.

(iii)The sample of Ni/4H-SiC(0001) contact system was thermally treated with electric furnace in flowing H_2+N_2 gases at 600 °C~950 °C for 30 minuets.

The film thickness of evaporated Ni 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 Ni/4H-SiC(0001) Si-face contact system is shown in Fig. 1, where the reference spectra from (e) 4H-SiC(0001) Si-face and (d) Ni_2Si are also shown. The spectra of (a) 600 °C, (b) 800 °C and (c) 950 °C are obtained from thermal-treated samples. The spectrum of (e) is characterized by a hump of 86eV, a main peak of 91.3eV, plateau region from 93eV to 96eV and a hump of 97eV. The spectrum of (d) is characterized by a main peak of 90eV and a shoulder from 93eV to 98eV with undulation. The spectra of (a), (b) and (c) has the similar characteristics of the main peak energy and shoulder as (d), but different from the spectrum of (e). Therefore, it is considered that the product of thin film on 4H-SiC mainly contains the Ni_2Si.

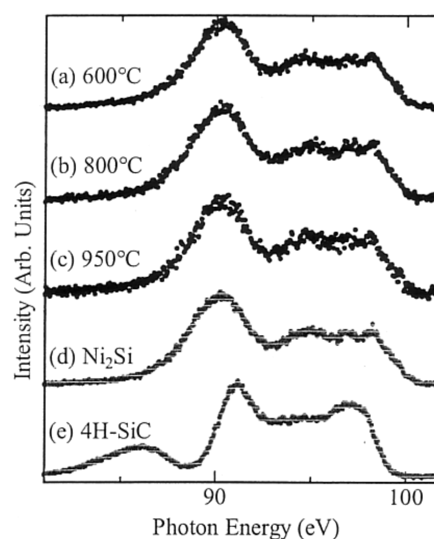

Fig. 1. Si $L_{2,3}$ emission spectra from Ni/4H-SiC(0001) Si-face sample; heated at (a) 600 °C , (b) 800 °C and (c) 950 °C reference ones from (e) 4H-SiC and (d) pressed powder of Ni_2Si [1].

By comparing the spectrum (d) with (a), (b) and (c), it can be concluded that these spectra include the information of the density of states from Ni_2Si. The spectra of C *1s* SXFS are described elsewhere [1].

Summary

These results are summarized as follows.

(1) The interface reacted region is composed of Ni-Si compound silicide and cabide with excess C near the surface region.

(2) The reacted product does not depend on the thermal-treated temperatures.

References

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