

## X-ray photoelectron spectroscopic observations on ultra-thin SiC films

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### Introduction

As a wide-gap electronic and optoelectronic material, SiC has excellent potentials such as high thermal conductivity and chemical stability at high temperature. It is known that SiC films can be deposited on solid surface by CVD and ion beam deposition using organic silicon compounds as source materials. The structures of bulk SiC produced by these methods were extensively investigated. A bulk SiC crystal is composed of only  $sp^3$  bonds, so the SiC films deposited on solid surface tends to form three-dimensionally spreading lattice. Thus it is hard to produce ultra-thin SiC films (ca. thinner than a few monolayers), and their electronic structures have not been elucidated. In this report, we present the results for the X-ray photoelectron spectroscopic observations on ultra-thin SiC films deposited by low-energy ion beam deposition on highly oriented pyrolytic graphite (HOPG).

### Experimental

The experiments were performed at the BL-27A station. Tetramethylsilane vapour was discharged by cold-cathode ion gun, and ions were bombarded on an HOPG. The discharge voltage was 100 V and the accelerating voltage was almost 0 eV. After the ion-beam deposition, the surface was heated by YAG laser up to 850°C. The surface temperature was monitored by optical pyrometer. The Si 1s-XPS was taken with hemispherical electron energy analyser (VSW Class-100) using 2200 eV photons.

### Results and discussion

Figure 1 shows the X-ray photoelectron spectra around the Si 1s region for the films after ion beam deposition. The spectra (a) and (b) represent the films at low fluence ( $3.8 \times 10^{14}$  ions/cm<sup>2</sup>) and high fluence ( $1.1 \times 10^{15}$  ions/cm<sup>2</sup>), respectively. The spectrum (c) displays the sample (b) after annealing at 850°C. At low fluence, the Si 1s peak splits into two components labelled A and B, but the peak B almost disappears at high fluence. The binding energy of the peak A is close to that of the bulk  $\beta$ -SiC (upper figure). Also it is almost the same as the reported value of the bulk SiC [1]. This result shows that the bulk SiC-like phase with  $sp^3$  bond is produced at high fluence. After annealing, the total intensity of the Si 1s peak decreases, and again becomes similar to the low-fluence sample (spectrum (c)). This suggests that the film again converted to sub-monolayer. It should be noted that the intensity of the peak B relative to the peak A grows upon annealing, and its energy shifts

to slightly higher-energy side. Also the peaks become sharp upon annealing. We consider that the peak B is not due to the adsorbed TMS, because organic silicon compounds do not adsorb on graphite at room temperature. The high binding energy feature of the peak B suggests that the silicon atoms in the ultra-thin films are more positively charged than those in the bulk-SiC. We consider that the peak B is due to the low-dimensional SiC of which configuration is different from that of the bulk SiC.

### References

- [1] L.I. Johansson et al., Surf. Sci. 529, 515 (2003).

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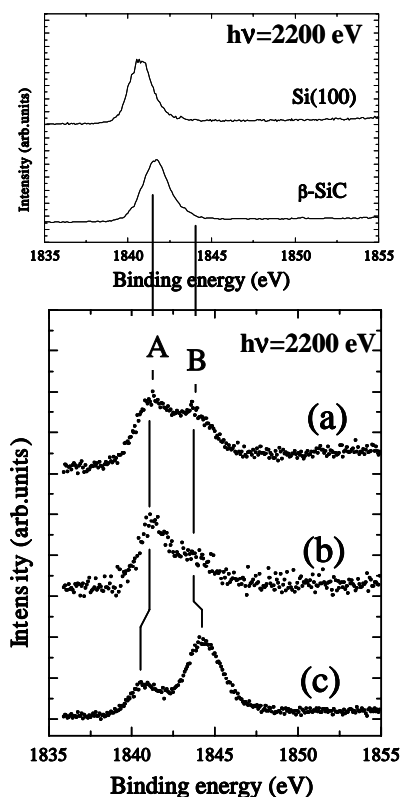


Fig.1 XP spectra around Si 1s region excited by 2200 eV photons. The spectra (a) and (b) represent the films at low fluence ( $3.8 \times 10^{14}$  ions/cm<sup>2</sup>) and high fluence ( $1.1 \times 10^{15}$  ions/cm<sup>2</sup>), respectively. The spectrum (c) displays the sample (b) after annealing at 850°C. For comparison, the XP spectra for standard materials of Si(100) and  $\beta$ -SiC are shown in the upper figure.