Chemical state analysis of 4H-SiC surfaces polished under ultraviolet-ray excitation

Akihiro Hata[1], **Masaru Takizawa**[1], **and Takeshi Tanaka**[2]

1) Department of Physical Sciences, Faculty of Science and Engineering, Ritsumeikan University, Kusatsu, Shiga 525-8577, Japan

2) Research Organization of Science and Technology, Ritsumeikan University, Kusatsu, Shiga 525-8577, Japan

A SiC has attracted much attention as a substrate for electronic devices. In order to efficiently obtain the flat surface of SiC, many polishing procedures have been performed. Among them, an ultraviolet-ray aided machining (U-RAM) [1] is a promising procedure to obtain the flat surface of SiC in a short time, where an irradiated photocatalyst and fluorescent substance would provide an electron and a hole to act as oxidation/reduction reactions to the surface and a photocatalyst would also scratch the surface mechanically with abrasive grit. X-ray absorption fine structure (XAFS) measurements are very useful to study a surface chemical state. In this study, we have investigated the surface chemical states of SiC during each U-RAM procedure.

We have prepared 3 SiC samples; as received SiC, SiC immersed with TiO_2-Cathilon dye under UV irradiation, and U-RAM SiC. An URAM of SiC was performed using a TiO_2 particle (~7 nm) as a photocatalyst and a Cathilon dye as a fluorescent substance under the irradiation of UV lamp (λ = 253.7 nm) with a diamond grit. Applying this U-RAM, a polishing rate was improved as shown in Table 1.

Table 1 Polishing results.

Slurry condition: TiO_2 + Cathilon + Diamond + H_2O	Polishing rate [μm/min]	Roughness before polishing, Ra [nm]	Roughness after polishing, Ra [nm]
UV OFF	0.227	3.05	2.16
UV ON (U-RAM)	0.313	3.13	1.99

XAFS measurements were performed at the BL-8 of SR Center at Ritsumeikan University, equipped with a grazing incidence monochromator with a varied-line-spacing plane grating. Si *L*-edge XAFS spectra of the samples were measured in partial electron yield by a micro-channel plate detector with retarding grids. The retarding voltage was set to -50 V. The incident angle of SR with respect to the surface normal was set to 0°. As a reference, a SiO_2/Si sample was also measured.

Figure 1 shows the Si *L*-edge spectra of the samples. As seen in the spectrum of SiO_2/Si, the structure around 101 eV comes from Si and the structures around 106 eV and 108 eV come from SiO_2. For SiC samples, the structures appear around ~103 eV and ~105 eV, different from Si and SiO_2. The immersed SiC spectrum hardly changes compared with as received SiC spectrum. This indicates that the surface chemical state of SiC hardly changes only under UV irradiation. However, U-RAM SiC spectrum shows slight difference compared with the immersed SiC spectrum, probably due to the slight oxidation of SiC.

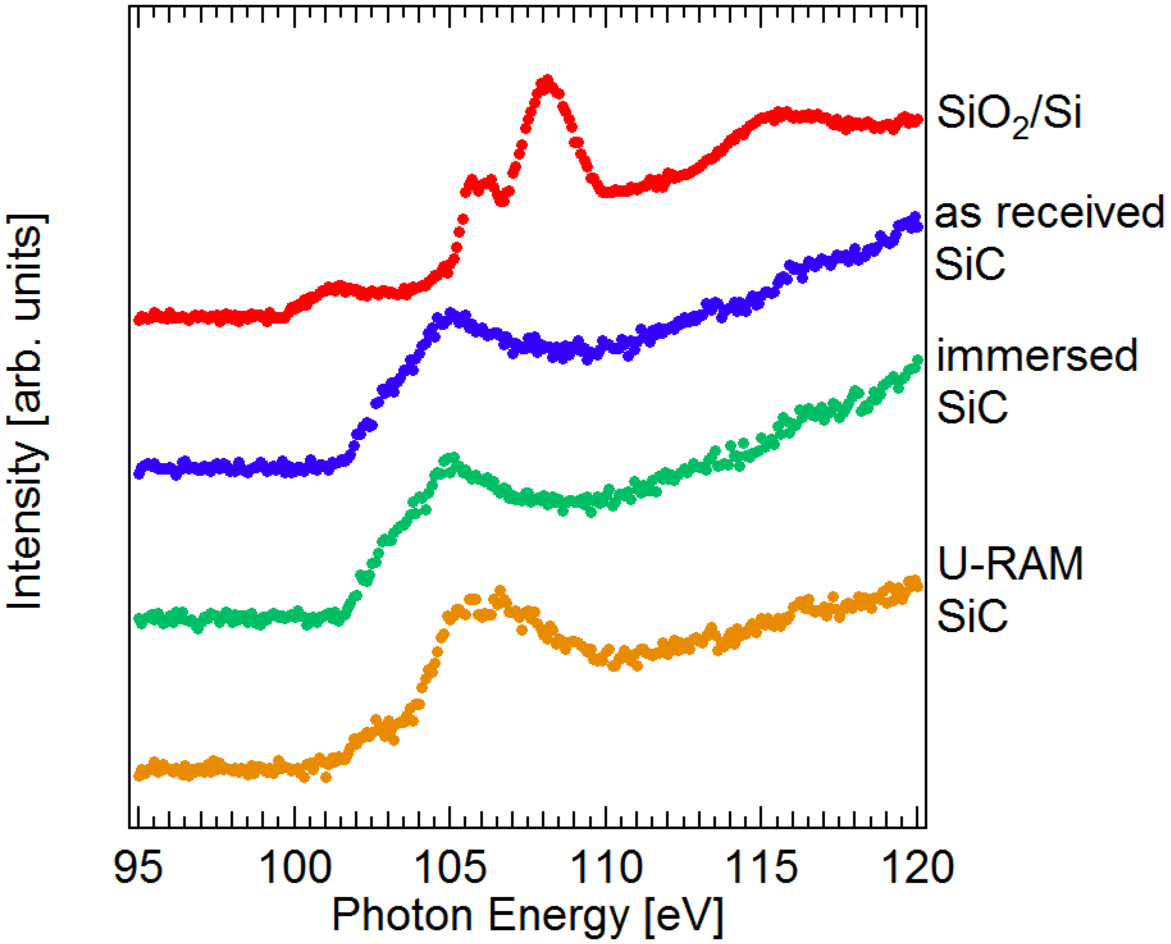

Fig. 1 Si *L*-edge spectra of SiC.

In summary, we have found that the U-RAM process leads the surface of SiC not to SiO_2, but to slightly oxidized SiC.

References

[1] Takeshi Tanaka, Mem. SR Center Ritsumeikan Univ., **17**, 95 (2015).