

## Chemical state analysis of diamond surfaces polished under ultraviolet-ray excitation

Dan Saito<sup>1</sup>, Akihiro Hata<sup>1</sup>, Kei Mitsuhashi<sup>1</sup>, Masaru Takizawa<sup>1</sup>, and Takeshi Tanaka<sup>2</sup>

- 1) Department of Physical Sciences, Faculty of Science and Engineering, Ritsumeikan University, Noji-higashi 1-1-1, Kusatsu, Shiga 525-8577, Japan
- 2) Research Organization of Science and Technology, Ritsumeikan University, Noji-higashi 1-1-1, Kusatsu, Shiga 525-8577, Japan

A diamond has attracted much attention as a substrate for electronic devices. In order to efficiently obtain a flat surface of a hard diamond, an ultraviolet-ray aided machining (U-RAM) is a promising procedure, where an ultraviolet-ray (UV;  $\lambda = 253.7$  nm) irradiated photocatalyst ( $\sim 7$  nm  $\text{TiO}_2$  particle) and fluorescent substance (cathion dye) 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. Although applying the U-RAM to diamond improves a polishing rate, it is not clear how the surface of diamond is modified. In order to study the chemical state changes, we have performed X-ray absorption fine structure (XAFS) measurements of diamond for each U-RAM procedure.

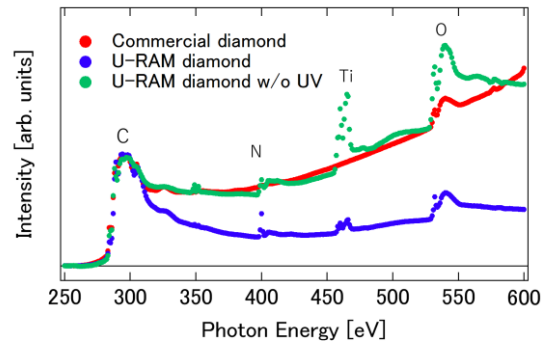
We prepared a commercial diamond synthesized by high-pressure high-temperature method. Then, the commercial diamonds were polished by either the U-RAM procedure or the procedure without UV (U-RAM without UV).

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. XAFS spectra of the samples were collected by total electron yield (TEY) through a sample drain current. The measurements were performed at room temperature under ultrahigh vacuum of  $\sim 1 \times 10^{-7}$  Pa. The incident angle of SR with respect to the surface normal was set to  $0^\circ$ .

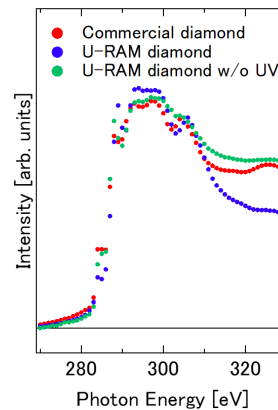
Figure 1 shows the wide range (250 - 600 eV) of TEY XAFS spectra for the commercial diamond, the U-RAM diamond, and the U-RAM diamond without UV. For the commercial diamond, C  $K$ -edge of diamond and O  $K$ -edge due to the surface contaminations are seen. For the U-RAM diamond and sample 2, on the other hand, Ti  $L$ -edge and N  $K$ -edge also appear. It is found that Ti atoms and N atoms remain on the diamond surface irrespective of UV, maybe due to the  $\text{TiO}_2$ , water, and cathion.

Figure 2 shows the C  $K$ -edge TEY XAFS spectra of the samples. We focus on the depression around  $\sim 300$  eV peculiar to diamond which is not found in other carbon based species such as graphite and polyethylene. For the U-RAM diamond, it is the same degree of

depression as that for the commercial one. For the U-RAM diamond without UV, on the other hand, the depression is not clearly visible.



**Fig. 1** Wide region TEY XAFS spectra of the commercial diamond, the U-RAM diamond, and the U-RAM diamond without UV.



**Fig. 2** C  $K$ -edge TEY XAFS spectra of the commercial diamond, the U-RAM diamond, and the U-RAM diamond without UV.

We have found that the structure peculiar to a diamond becomes difficult to see after polishing with (un-irradiated) cathion, which makes the diamond surface covered with other carbon based materials. Furthermore, polishing with UV irradiated cathion would remove the other materials on the surface then leads to the diamond surface.