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

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A diamond has attracted much attention as a substrate for electronic devices. In order to efficiently obtain a flat surface of diamond, many polishing procedures have been performed. Among them, an ultraviolet-ray aided machining (U-RAM) [1] is a promising procedure to obtain a flat surface of diamond 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. Previous work on the U-RAM of Al has revealed the oxidation of the Al surface [2]. Although applying the U-RAM to diamond improves a polishing rate, it is not clear how the surface of diamond is oxidized. 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 six different types of the U-RAM procedures, as shown in Table 1. Sample 0 is Commercial diamond. Sample 1 is an U-RAM diamond. An U-RAM of diamond 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 (= 253.7 nm) with a diamond grit. Without UV or Cathilon or TiO_2, a commercial diamond was polished, referred as sample 2 to 6.

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 ~1×10^{-7} Pa. The incident angle of SR with respect to the surface normal was set to 0°.

As a result, it was found that a mixed compound on the diamond surface by the U-RAM. We think that polishing efficiency of U-RAM is better than ordinary mechanical polishing because of generating the mixed compound of C, O, Ti, and N on the surface.

Table 1 Sample names and slurry conditions

name	slurry (H_2O + diamond)	UV
Sample 0	Commercial diamond	
Sample 1	+ TiO_2 + cathilon	ON
Sample 2	+ TiO_2 + cathilon	OFF
Sample 3	+ TiO_2	ON
Sample 4	+ TiO_2	OFF
Sample 5	+ cathilon	ON
Sample 6	+ cathilon	OFF

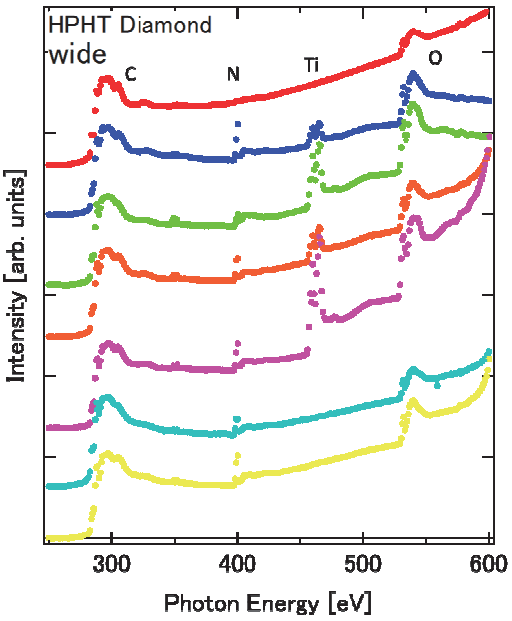

Fig. 1 Wide region TEY XAFS spectra of commercial diamond. (Sample 0 to 6)

References

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