Polycrystalline diamond sintered from ultradispersed nanodiamonds

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NPD is a binder-less nanodiamond aggregate (~50 nm) synthesized by direct conversion of graphite under high pressure and temperature [1]. Although NPD has extremely high hardness exceeding that of single-crystalline diamond, it is difficult to obtain the large size of the NPD above 1 cm^3, because extreme high pressure conditions are required. Here we show nanodiamond polyclystalline sintered from ultradispersive nanodiamond under relatively moderate pressure and temperature conditions.

We used a multi-anvil apparatus to sinter the nanodiamonds at 8-15 GPa and 1600-2300˚C, where the diamond is thermodynamically stabilized. The starting materials were enclosed in metal capsules. The microstructures and chemical compositions of the recovered samples were examined using a field-emission scanning electron microscope with energy-dispersive X-ray spectroscopy. Well-sintered polycrystalline were subjected to the Knoop indentation test to evaluate its hardness.

We succeeded in recovering the well-sintered polycrystalline diamonds with grain size of ~10-30 nm in some runs (Figure 1). Full width at half maximum of XRD peaks decreased with increasing temperature due to the grain growth of diamond particles. The color, hardness, and grain size of the sintered polycrystalline changed depending on the capsule materials as well as the pressure and temperature conditions. These features might be affected by the porosity, the grain size, and the impurities. Further studies are required to synthesize the polycrystalline with high hardness comparable to NPD.

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Keywords: multianvil apparatus, nanodiamond, NPD

