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Synthesize of boron-doped diamond cylinder as a heater in Multi-anvil apparatus

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Diamond is the hardest known material in the world. It is the first time to report synthesize of semi-conductor boron-doped diamond cylinder in the Kawai-type multi-anvil apparatus at 15 GPa and 2100^{o}C. The dimension of the cylinder is 2.6 mm outer diameter, 1.5 mm inner diameter and 3.35 mm length. SEM image shows that the grain size of diamond is about 1 micrometer.

Those cylinders have been used for extremely high temperature generation (~3000^{o}C) in a large sample volume (~0.1mm^{3}) in the Kawai apparatus; the sample volume is ~1000 times larger than that in diamond anvil cell. High X ray transparency of boron-doped diamond is optimum as well for in-situ synchrotron X ray analysis. Although there have been several reports on boron-doped graphite heater, the present study is the first report on pure boron-doped diamond heater in Kawai-type apparatus. The reversibility of the heater was confirmed well through three times of repeated cycle of heating and cooling. The boron-doped diamond heater with 3 wt.% boron shows metallic behavior, i.e. increasing resistance with increasing temperature. This electrical characteristic is beneficial for stably generating temperature as high as 2700^{o}C; the heating for higher temperature was failed because of failure of electrode. Therefore, succeeding optimization is required for higher temperature generation with this new heating element. Boron-doped diamond heater is more advantageous than B-doped graphite heater, because it is free from complicated power-temperature relationship and pressure drop associated with graphite to diamond conversion.

Keywords: diamond synthesize, B-doped diamond heater, ultrahigh temperature, Multi-anvil apparatus