Boron doped diamond heater in the Kawai-type apparatus

*Longjian Xie[1], Akira Yoneda[1], Eiji Ito[1]

1.Institute for Study of the Earth Interior , Okayama University

Boron doped diamond (BDD) heater has attracted special attention because of its high melting point and X-ray transparency. In the previous studies, graphite boron composite (GBC) was usually used as a precursor of BDD. In the present study, we firstly investigated the application of pre-synthesized BDD cylinder and BDD powder as cylindrical heaters in the Kawai-type apparatus at 15 GPa. BDD with 0.5 and 3.0 wt % was synthesized at 15 GPa and 2100 °C. The BDD powders were grinded from BDD blocks by using Nano Polycrystalline Diamond mortar at GRC, Ehime Univ.; SEM image showed that the grain size of diamond is about 1 μm. Both kinds of heaters showed good stability and high reproducibility. The BDD heater with 0.5 wt % boron (resistivity:~0.001Ω.m at 1500 °C) showed semi-conductive behavior, i.e. decreasing resistance with increasing temperature. However, the BDD heater with 3.0 wt % boron showed lower resistivity (about 0.00016 Ω.m at 1500 °C) and metallic behavior, i.e. increasing resistance with increasing temperature. This electrical characteristic enables us to adjust the boron concentration of BDD to get the desired resistivity. We succeeded to generate temperature about 3500 °C by using small heater (1.5 mm outer diameter, 1 mm inner diameter, 6 mm length) with TiC electrode. Temperature higher than 1800 °C was estimated by input power according to its temperature-power relationship. The pressure generation efficiency by assembly using BDD heater was checked by *in-situ* X ray experiments at SPring-8. Compared with assembly using GBC heater, the use of BDD heater has lower efficiency of pressure generation in the beginning stage of compression, while has higher efficiency in the later stage. It is obvious that the BDD heater is more advantageous than GBC heater, because it is free from the complicated temperature-power relationship and pressure drop associated with graphite to diamond conversion.

Keywords: Diamond synthesize, Boron doped diamond heater, Ultrahigh temperature, Multi-anvil apparatus

