§67. Development of Low Z Ceramics for Divertor Plate

Matsushita, J., Fukushima, N., Ushijima, K., Nishi, Y., Tonegawa, A., Oguri, K. (Tokai Univ.),
Inoue, N., Kubota, Y., Noda, N., Motojima, O.

The carbon for diverter material of the thermal conductivity decreased with increasing temperature. However, the titanium boride (TiB_2) ceramics as the boron (B) compound that a thermal conductivity improves caused with increasing temperature shows the thermal conductivity, which is superior, the graphite material at high temperature. And, TiB_2 ceramics has various desirable properties, including a high melting point (3253 K), a high degree of hardness (Hv = 32 GPa), excellent electrical conductivity (10^7 S/m), and chemical stability[1]. It can be used for cutting tools, wear-resistant parts, electrodes for aluminum electrolysis, cathodes for MHD power generation, boats and crucibles for vapor deposition, etc.[2)-4)] The dense sintered TiB_2 material was developed in Tokai University.

In this study, it was made that it constructed the database on characteristics at high-temperature condition for divertor plate and examines the application to fusion device to be a purpose in order to apply the TiB_2 ceramics with this excellent characteristics to fusion science. Then, the research was carried out in fusion science and cooperation in respect of the examination for applying the above-mentioned and excellent material features to fusion device using active cooling test equipment (ACT) of National Institute for Fusion Science. The monolisic TiB_2 powder made by Idemitsu Materials Co., Ltd., Japan was enclosed with the carbon jig, and the TiB_2 sintered body was prepared by using hot-pressing method. The relative density of the TiB_2 sintered body was obtained by the Archimedes' measurement. Using the laser flash equipment made by Sinku Riko (ULVAC) Co., Ltd., Japan, thermal diffusivity and specific heat of the samples were measured from room temperature to 1273 K in vacuum atmosphere, and the thermal conductivity was calculated. The Relative density of the samples by hot pressing was 99 %. The thermal conductivity of the TiB_2 sintered body at room temperature to 1273K shown in figure 1. The tendency that thermal conductivity increased with increasing measurement temperature, and it was found out more than this figure that high value was shown in 1273 K of about 75 W/m·K. The sample of 20 × 20 × 10 mm in size produced by wire electric discharge machining (wire-EDM) was set and done to the coppered attachment for the ACT mounting in the silver solder, and thermal load evaluation test was carried out using the ACT. Then, the ACT test was also carried out on the isomorphic carbon sample in the silver solder in the similar attachment for the comparison. As the result, the TiB_2 sample could get a good result to 4MW thermal load. By the heat load test to 4MW, temperature increment quantity of the TiB_2 sample decreased, as it becomes high temperature, and the tendency in which thermal conductivity of the sample improved was recognized (Figure 2). In the condition over 5MW, the sample temperature rose over 1373K, and there was the welding of K-type thermocouple installed in inside of sample. And, the welding of thermocouple and sample could not be recognized to 10MW in the carbon sample.

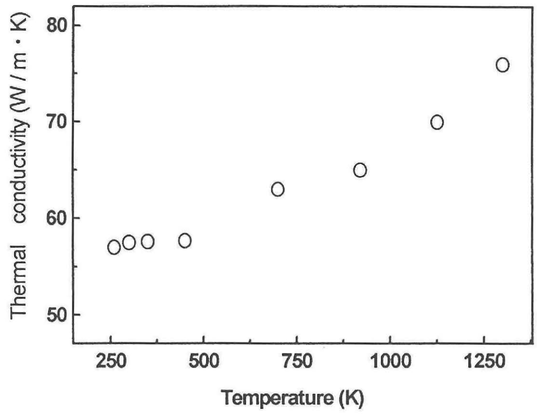

FIG. 1. Thermal conductivity of TiB_2 sintered body as a function of measurement temperature.

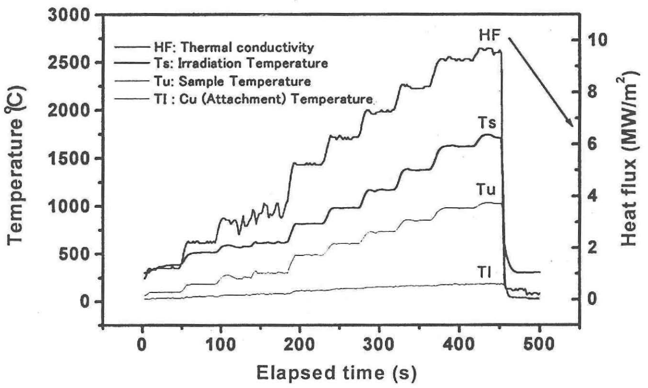

FIG. 2. Sample temperature and heat flux of TiB_2 sintered body as a function of elapsed time by ACT.

References

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