§26. Thermal Diffusivity Measurements of Candidate Ceramic Materials for Shielding Blankets

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Some carbides and metallic hydrides are considered as candidate materials of thermal shield of the blanket system for Force Free Helical Reactor (FFHR). These materials are expected to have some advantages from the viewpoints of nuclear properties and thermophysical properties. The reliable thermophysical properties of these materials are necessary For thermal design of the fusion reactor. Unfortunately, there are few published data on thermophysical properties, for example, thermal conductivity, thermal diffusivity, and specific heat capacities of carbides and hydrides.

Thermal conductivity is the most popular quantity to express the property of heat conduction. In the case of bulk material, thermal conductivity is often calculated from thermal diffusivity, heat capacity and density because thermal diffusivity can often be measured easier than thermal conductivity.

Thermal diffusivity is often measured by the flash method[1)]. The method is one of the most popular methods to obtain thermal diffusivity of mm order thick solid materials in the temperature range from room temperature to over 1000 K. National Institute of Advanced Industrial Science and Technology (AIST) has investigated the flash method to develope the standard of thermal diffusivity measurement[2)]. We established a technique to obtain thermal diffusivity value that is traceable to the SI unit and intrinsic as the physical property.

In this study, we measured thermal diffusivity of Tungsten Carbide (WC) and Boron Carbide (B_4C) using the flash method in order to investigate thermal property of these materials.

The disc shaped samples with 10 mm diameter and different thicknesses of WC and B_4C were prepared for this study as shown in Fig. 1. Especially, two kinds of B_4C were given which consist of enriched boron and natural boron. These specimens were coated by Au sputtering thin film and graphite spraying in order to absorb pulsed laser beam and to avoid transparent for wave lengths of the laser beam and the infrared radiometer. We measured thermal diffusivity of these specimens from room temperature to 1000 K.

As shown in Fig. 2, thermal diffusivity values of two WC specimens show good agreement each other independent of specimen thickness. The measured result on WC is confirmed of its repeatability. The uncertainty of these data estimated about 10 %.

We measured thermal diffusivity of B_4C specimens after heat treatment. Comparing the data before heat treatment which are measured last year[3)], there is no significant difference between them. It is indicated that B4C specimens are stable for heat treatment in this temperature range. Thermal diffusivity values show good agreement independent of specimens consists of enriched and natural boron before and after heat treatment.

From the literature survey, data of thermal diffusivity (or thermal conductivity) of carbides are not enough. Especially, there are few data in the case of WC. Consequently, our results are useful for the thermal design of shielding blankets. We have a plan to publish the results of this study through the Network Database System for Thermophysical Property Data developed by AIST[4)] after our scrutiny in the future.

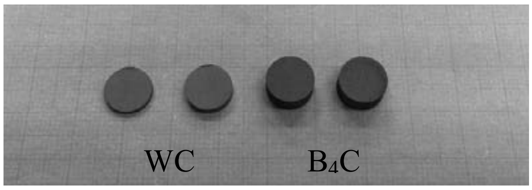

Fig. 1. WC and B_4C specimens for thermal diffusivity measurements. The B_4C specimens in this photo are coated by Au sputtering thin film and graphite spraying.

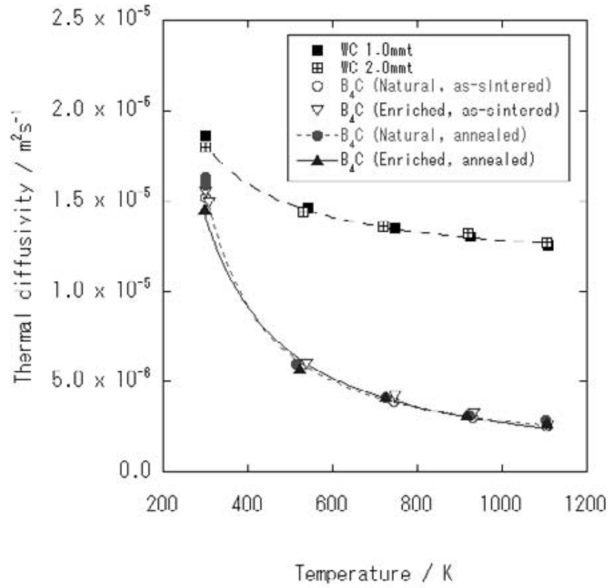

Fig. 2. Temperature dependence of thermal diffusivity of WC and B_4C

1) Parker W. J., Jenkins R. J., Butler C. P., Abbott G. L.: J. Appl. Phys. **32**, 1679 (1961).
2) Akoshima M., Baba T., Int. J. Thermophys., **27**, 1189 (2006).
3) Hishinuma, Y., Akoshima, M., Yamashita, Y., Tanaka, T., Sagara, A., Muroga, T., 23rd International Toki Conference (ITC-23), Toki, Japan 18-21. Nov. (2013)
4) http://tpds.db.aist.go.jp/