§29. Development of SiC Material for Flow Channel Insert in Liquid Blanket System

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Silicon carbide fiber reinforced silicon carbide matrix (SiC/SiC) composites are considered as functional-structural materials for advanced energy systems, because of their excellent thermal, mechanical and chemical stability, and the exceptionally low radioactivity following neutron irradiation. In particular, flow channel inserts (FCIs) made of SiC/SiC composites were proposed as a means for thermal-electrical insulation (< 2W/mk, < 100S /m) between the flowing liquid metal and the load-carrying channel walls to reduce the MHD pressure drop in the dual-coolant lead lithium blanket channels of fusion reactors [1,2].

In the collaborative study, SiC/SiC composites were fabricated by NITE method (NITE: Nano-Infiltration and Transient Eutectic-phase) at Kyoto university. The NITE-SiC/SiC composites consist of three constituents: SiC fiber, SiC matrix and carbon interface layer. In the previous study, electrical conductivity of the NITE-SiC/SiC composites has been examined focusing on their anisotropic of SiC fiber. The SiC fibers were oriented as two-directional (2D) in the NITE-SiC/SiC composites and its volume fraction was approximately 40%. The two-terminal method was used for electrical conductivity measurement of the NITE-SiC/SiC composites. Figure 1 shows results of this experiment, the electrical conductivity of the NITE-SiC/SiC composites showed difference between in-plane and through-thickness. The electrical conductivity of in-plane was 3.1 × 10^3 S/m and 5.1 × 10^2 S/m for through-thickness.

In this work, effect of carbon interface thickness on

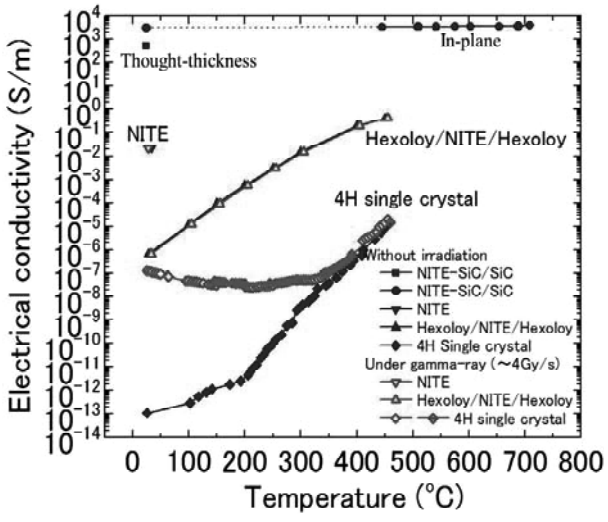

Fig. 1. Electrical conductivities of various SiC materials

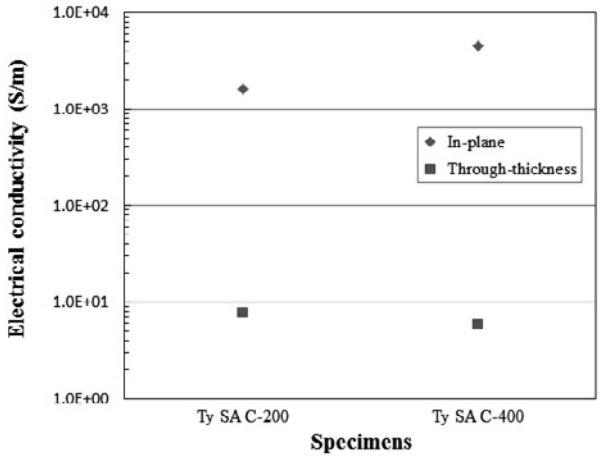

Fig. 2. Electrical conductivities on thickness of carbon interface layer of SiC fiber

electrical conductivity of NITE-SiC/SiC composites was investigated. Uni-directional (UD) SiC fibers were used for fiber reinforcement. The SiC fibers used were Tyranno SA fibers with a carbon coating by CVD method. Two specimens with different carbon coating thickness were used. The thickness was 200nm (Ty SA C-200) or 400nm (Ty SA C-400), respectively. The NITE-SiC/SiC composites were sintered by Hot Press at 1850°C with 20MPa sintering pressure.

Electrical measurements were performed for the in-plane and through-thickness directions. Gold electrodes were put and connected to a current source and voltmeter. In this work, four-terminal method was applied to measure electrical conductivity.

Figure 2 shows the electrical conductivity of NITE-SiC/SiC composites measured in this work. The electrical conductivities for in-plane direction were 1.63 × 10^3 S/m for Ty SA C-200 and 4.47 × 10^3 S/m for Ty SA C-400, respectively. In through-thickness direction, electrical conductivities were 7.68 S/m for Ty SA C-200 and 5.78 S/m for Ty SA C-400, respectively. The electrical conductivity for in-plane direction was higher than that for through-thickness direction. The results for in-plane direction were close to previous results. It was assumed that the electrical conductivities were affected by the carbon interfacial layers. The electrical conductivity increased with the increase of carbon interface layer thickness in in-plane direction. In through-thickness direction, the trend shown for in-plane direction wasn't observed. The material used in this work was UD composites. SiC matrix which separate fibers with carbon coating might exist and play as the role of an insulator.

1) S. Smolentsev, : Fusion Engineering and Design 81 (2006) 549-553.
2) S. Smolentsev, : Fusion Science and Technology 50 (2006) 107-119.