§36. Pulse Heat Load Test of Tungsten (W) Coated Ceramic Composites for Advanced Divertor by Plasma Gun

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R&D and technology integration of high performance materials for plasma facing components (PFCs) and first wall are inevitable for the early realization of fusion reactor. Tungsten (W) is becoming a prime candidate as armor material for protecting high heat flux and suppressing plasma contamination. Although ITER is preparing to use full W divertor, many issues are still remaining. Bonding technology R&D of the W coated SiC/SiC or graphite for high heat flux component is ongoing at OASIS, Muroran Institute of Technology. The application of SiC/SiC composites or graphite to divertor as a substrate to W will be a potential solution to the current concepts of W divertor in fusion reactor. SiC/SiC composites fabricated by Nano-Infiltration and Transient Eutectic phase (NITE) method have various advantages compared with the others (low cost, high shape and size flexibility, etc.). In addition, small mismatch in coefficient of thermal expansion between W and SiC is a great advantage in configuring the divertor system. Graphite is also candidate material of divertor and there are many research results have been reported. However, there only limited data were reported on W coated ceramic material. Further studies are needed to apply W coated ceramic material to divertor. Especially thermal property data of W coated ceramic material is strongly required, because of their severe service environment including extremely high heat flux. This report describes R&D status of high performance HHFC materials and provides the preliminary test results of the thermal durability test of W-SiC plate at OASIS.

W-SiC dual plate and W-C dual plate were fabricated by hot pressing, where sample was W plate bonded on SiC plate or graphite plate. Thermal durability test was conducted only W-SiC dual plate. The dimension of test specimen is 2 x 2 x 3mm. Then, it has been kept for 1 hour at 1500 ^{o}C in an argon atmosphere. Microstructure of specimen after the thermal durability test has been observed by FE-SEM.

Figure 1 shows the microstructural change of interphase in W-SiC dual before and after thermal durability test. Before the test, the columnar phases extended from the interface into W were observed. The thickness of the columnar phases is about 30 microns. The columnar phases consist of bright-contrasted and relatively ―dark-contrasted phases. According to the previous studies, bright-contrast phase is tungsten silicide (W-Si) and dark-contrast phase is tungsten carbide (W-C). After the test, the contrast differences in the interface has been disappeared. In addition, reaction phase became the layer with fine grain.

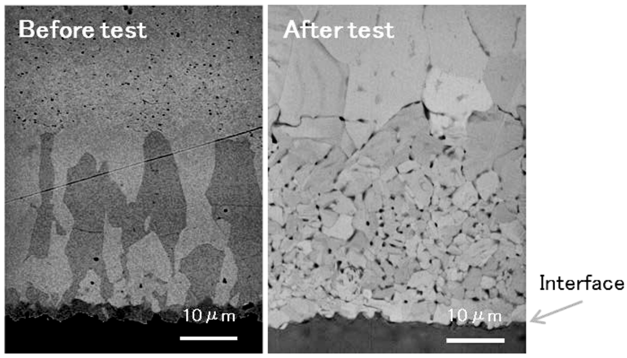

Fig. 1.Microstructural change of interphase in W-SiC plate before/after the thermal durability test.

Figure 2 shows the EPMA images of W-SiC dual plate after thermal durability test. W-Si phase in the reaction phase has been lost, but W-C phase was only confirmed at the interphase. Although, the microstructure of interphase is changed, but the debonding between W and SiC plates are not observed.

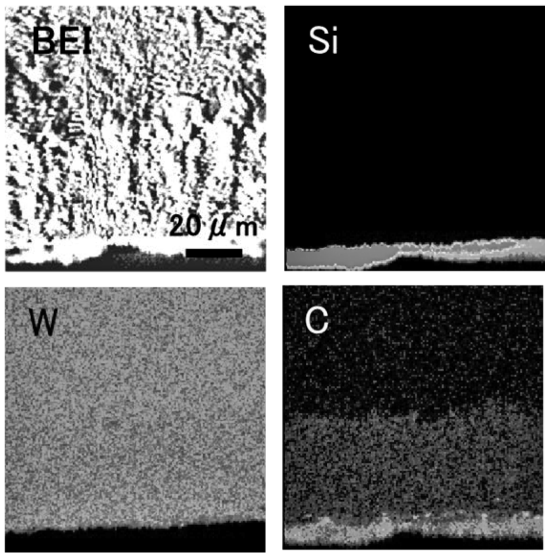

Fig. 2. EPMA images of W-SiC interphase after the thermal durability test

The thermal durability tests of W-SiC dual plates were conducted and their microstructural changes have been investigated in this study. The measurements of mechanical property are on-going.

For the plasma exposure test of W-coated ceramic materials using LHD in NIFS, their more detail thermal characteristics will be also obtained by the additional experiments using the electron beam irradiation device (ACT-2) and a plasma gun apparatus (SPICA).