

§61. Evaluation of Thermal Shock Resistances of Joining Materials between C/C Composite and Oxygen-free Copper for a Divertor Plate of LHD

Oku, T., Imamura, Y., Kurumada, A., Kawamata, K.  
(Faculty of Engineering, Ibaraki University)  
Noda, N. and Motojima, O.

A technique of joining by using Ti powders except for silver solder was examined to join oxygen-free copper with a C/C composite as a candidate material for a divertor plate of LHD. The strength of joining portion was evaluated by the micro indentation method and the microstructures were observed by SEM.

Fig.1 shows a shape of the joining material of CX-2002U composite with oxygen-free copper by using Ti powder as a solder, which was screened out by 325 meshes and the purity was 99.98%. The specimens were joined at 850°C, 900°C, 950°C and 1000°C in an atmosphere of Ar gas. The holding time at the temperature of joining was 5 minutes. Temperatures of joining were from 850°C to 1000°C near the melting point of copper because C/C composite and copper materials could not be joined by using Ti powders below 850°C in the preliminary test.

Fig.2 shows SEM images at joining parts at (a) 850°C and (b) 1000°C. Fig.2(a) shows that CX-2002U is effectively joined with Cu by using Ti powders and is clearly divided into three layers, carbon, Ti and Cu. Fig.2(b) shows a mixing layer of Cu and Ti and invading of Ti into pores of CX-2002U near the boundaries. The specimen joined at 1000°C is considered to be better than that at 850°C.

Mechanical properties near joining parts were measured by a micro indentation method (DUH-201 made by Shimadzu works.). In the tests, the load and depth by a triangular cone diamond anvil were continuously recorded in the loading and unloading processes, respectively. The test load was 5gf. The parameters B and D were evaluated from the slopes of curves between the load/depth and depth in the loading and unloading processes. The parameters B and D which are corresponded to the strength and the Young's modulus of materials, respectively. Fig.3 shows the distribution of parameter B around joining parts. It is nearly constant near the boundary between Cu and Ti joined at 1000°C because it is believed that compounds of Cu and Ti were formed in a joining part. Specimens joined by using silver solder and molybdenum plate as a middle layer indicated high values of parameters B and D [1], though specimens joined with Ti powders showed nearly constant

values of the parameters. The future problem is to examine the strength of the joining portion and to clarify if the higher values of B and D is desirable or not.

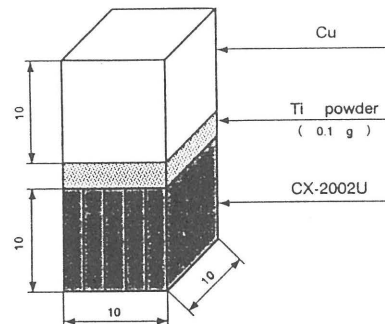


Fig.1 Shape of a joining specimen.

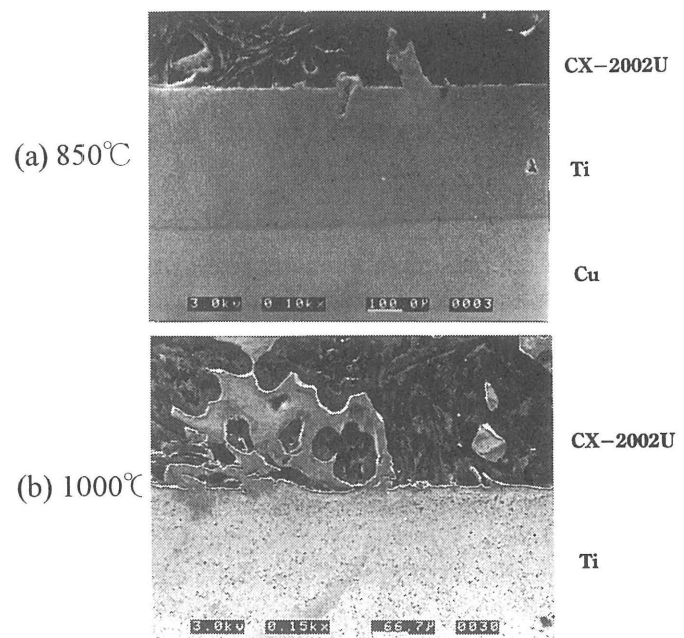


Fig.2 SEM images of joining materials.

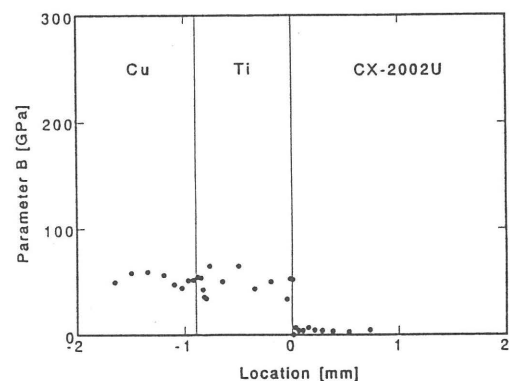


Fig.3 Distribution of parameter B around joining part.

References : 1) Oku,T., et al., Research on plasma facing materials for fusion reactor, No.3 (1995) 247.