Bonding of Alumina using Cupreous Oxide as Insert Material†

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KEY WORDS: (Aluminium Oxides) (Cupreous Oxide) (Adhesive Bonding) (Shear Loading Strength)

Ceramic to metal joints are used in various areas of high temperature industries. Some current uses and others under development are hermetically seeled terminals, high-pressure seels, printed circuits of microelectronics for high temperature applications, and envelopes for transistors, quartz crystals resistors and capacitors. In order to know the adhesion of metal to ceramic, the wetting of liquid metals on ceramics has been greatly studied by the sessile drop method.[1,2,3] However, the mechanical strength of ceramic to ceramic joints bonded by molten metal or by other methods has been hardly examined.[4,5]

We wish to report a simple and convenient method for bonding of Alumina. The method was done using cupreous oxide as insert material in vaccume of 6.7×10^{-3} Pa. Moreover, the effect of bonding temperature on the shear strength of $Al_2O_3/Cu_2O/Al_2O_3$ joints was investigated.

Figure 1 is the apparatus for the bonding of Alumina

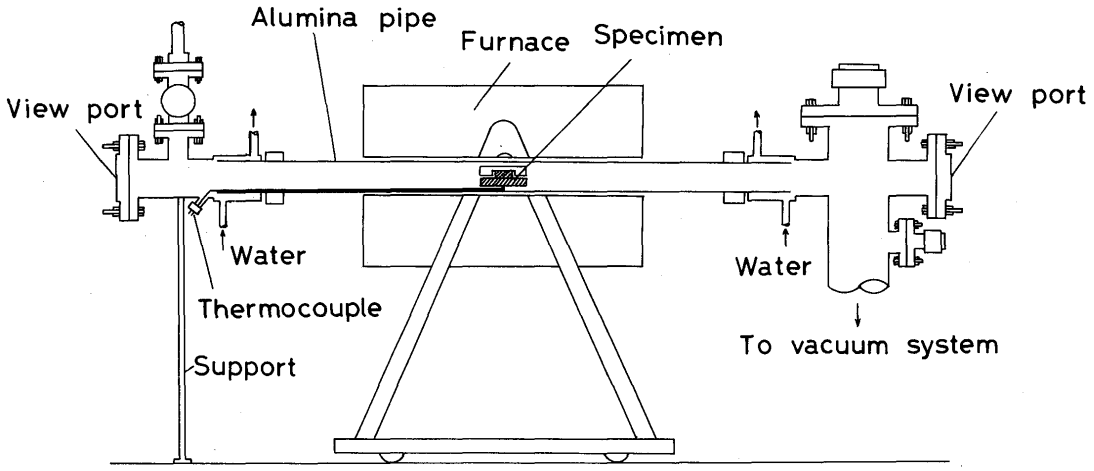

Fig. 1 Apparatus for bonding

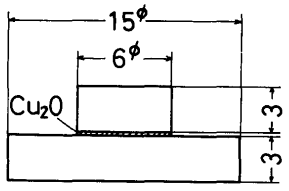

Fig. 2 Specimen size

and **Fig. 2** shows the specimen size used in the present work. High purity alumina (99.6%) cylinders were used throughout this experiment. These cylinders were provided two parallel faces, one polished with a 1500 grade emery paper and degreased by washing in acetone. Chemically pure grade cupreous oxide powder(13 mg) was supplied on the polished alumina surface with carbon

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tetrachloride and then the joint was set as shown in Fig. 2. This combination was bonded together at a required temperature by resistance furnace heating as shown in Fig. 1. After cooling, the shear strength of this joint was measured, using the jig as shown in **Fig. 3**. The obtained joint strength is dependent greatly on the bonding temperature as shown in **Fig. 4**. From this result, it is noted that alumina is bonded tightly with Cu_2O for 20 min. at 1250°C or for 40 min. at 1200°C and these joints fracture at alumina base plate, without at interfacial layer. In **Photo. 1**, the cross sectional view of $Al_2O_3/Cu_2O/Al_2O_3$ joint bonded for 40 min. at 1200°C is shown. **Figure 5** shows the EPM analysis result of the cross section of the specimen shown in Photo. 1. From these results, it is presumed that alumina reacts with cupreous oxide to give $CuAlO_2$[6] at the bonding interfacial layer and the bonding temperature dependence of joint strength may be due

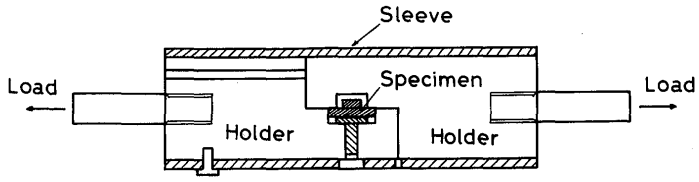

Fig. 3 Jig for shear strength test

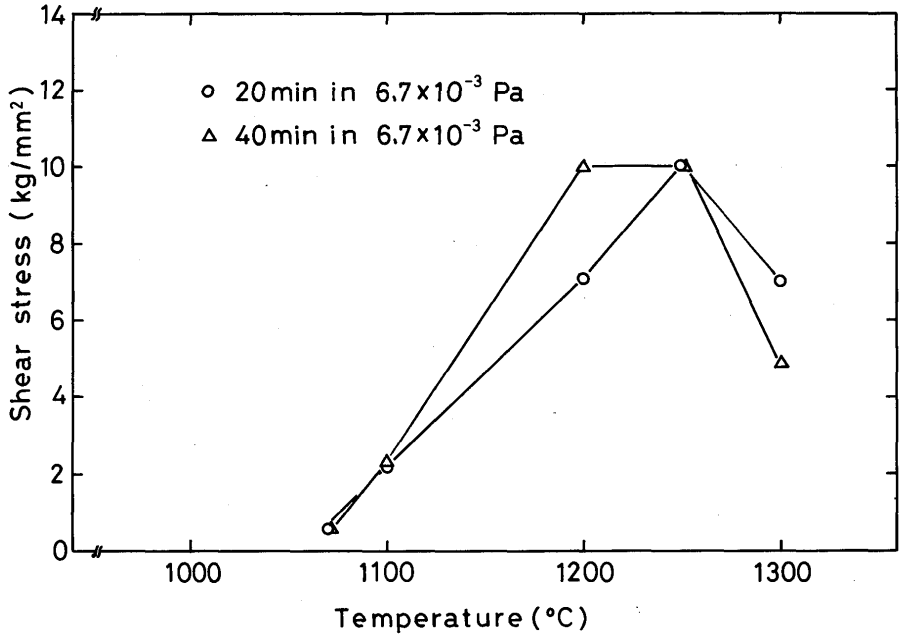

Fig. 4 Temperature dependence of shear strength of $Al_2O_3/Cu_2O/Al_2O_3$ joints

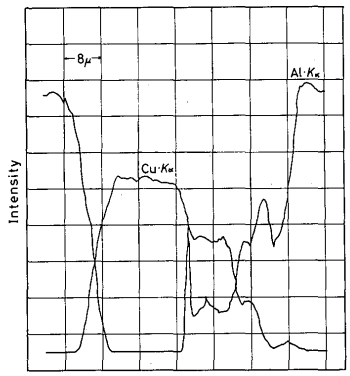

Fig. 5 Scanning profile of $Al_2O_3/Cu_2O/Al_2O_3$ joint part

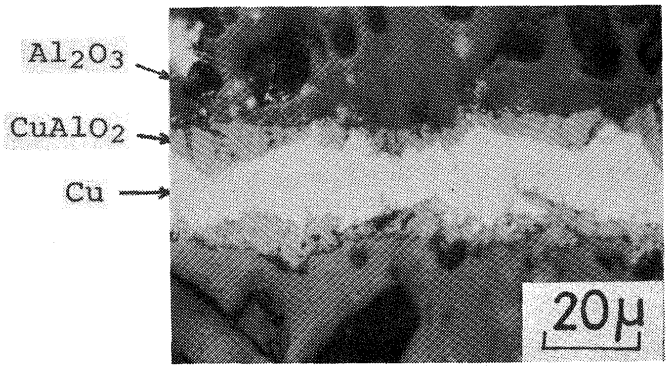

Photo. 1 Section through $Al_2O_3/Cu_2O/Al_2O_3$ joint bonded for 40 min. at 1200°C (x600)

to the formation amount of $CuAlO_2$, and also the dissociation of cupreous oxide in vaccum atomosphere.

The more details including the effect of atomosperic pressure, heating time and etc. will be published in next issues.

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