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Characteristics of Active Metal Brazed Joint of Al_2O_3/Cu Applicable to Electric Vehicle

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Extended Abstract

Ceramic-metal joints are widely used in the field of electric vehicles, nuclear reactors, aerospace and electrical engineering. In the electric vehicles, ceramic-metal joints can be applicable to a large current terminal parts, electrical relays, DBC (Direct Bonded Copper) substrate, circuit boards for power devices, heat dissipation substrates for power modules, an ECU (Engine Control Unit) and so on [1]. Several techniques for ceramic-metal joining have been developed like brazing, diffusion bonding, soldering, eutectic bonding, adhesive bonding, and so on [2-5].

Among these techniques an active brazing process is simple as well as economical compared to other processes because of direct bonding of ceramic to metal. The active metal brazing facilitates the bonding of ceramics and metals without melting the base materials, which makes easier to bond ceramics and metals, and it is characteristics of brazing and solid state bonding processes. The active brazing filler metal gives the chemical bonds between ceramic and metal directly, and enhances the wetting of brazing filler metal on a ceramic surface. In brazing of ceramic and metal, there are several problems to be overcome; for example, wettability of brazing filler metal on ceramic surface, and the difference of coefficients of thermal expansion (CTE) between ceramic and metal which can cause a residual stress in the brazed joint [2, 3]. The residual stress gives a direct effect on the strength of brazed joint and it even results in fracture. The objective of this study is to evaluate the wetting ability, microstructural evolution of Ag-Cu-Ti brazing filler metal and bonding strength between alumina and copper joint which can be applicable to an electric vehicle

In this study, Al_2O_3 and Cu were active brazed using Ag-Cu-Ti filler metal. We have studied the wetting of brazing filler metals, microstructure, hardness, and shear strength of the bonded joint for assuring their joint reliability. The brazing experiment was performed at a temperature of 980 ^{o}C for 30 min in a vacuum furnace (5×10^{-5} torr) atmosphere. The wettability test of the Ag-Cu-Ti was conducted on polycrystalline Al_2O_3 and commercial pure Cu substrates. It was found that in optimum condition the spreading ratio of brazing filler on the Cu and Al_2O_3 substrates was around 95% and 89%, respectively. The spreading ratio was defined as (D-H/D)x100%, where H is the height of the filler after spreading test, and D is the diameter of the filler when it is assumed to be a sphere. The Al_2O_3 and Cu substrates bonded well without noticeable defects along the bonding interface. The microstructure of the brazed joint showed the presence of an Ag-rich matrix and a Cu-rich phase. The Cu-Ti intermetallic compounds like Cu_3Ti were observed along the brazed joint interface. Hardness of the filler metal was in the range of around 115 ~ 130 Hv. The shear strength of the brazed joint between Al_2O_3 and Cu was measured by a high precision universal testing machine. These results suggest a high bonding strength of Al_2O_3/Cu joint where the fracture occurred partly in the base material of Al_2O_3 and partly in the filler metal. This indicates the brazed joint of Al_2O_3 and Cu is sound and reliable.

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