Non-oxide Ceramic 용 Ag-Cu-Hf 계 Brazing 활성금속의 개발
(Development of active filler metals in the system Ag-Cu-Hf)

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1. Introduction

Due to the increasing applications of non-oxide ceramic in technical structures, new active filler metals have to be developed for joining ceramics either to other ceramics or to metals. In commercially dominant active braze alloys titanium as the reactive agent is added to the base filler metal particular to the Ag-Cu eutectic. Apart from titanium and other reactive elements, Hafnium additives are also known for promoting the wetting of ceramics by conventional braze metals.

2. Experimental Procedure

The investigation deals with hafnium added Ag-Cu active filler alloys and the examination of their brazing properties for joining SiC and Si_3N_4 ceramics to themselves and to steel. Therefore active filler metals in the system Ag-Cu-(In)-Hf with Hafnium contents ranging from 2 wt % to 5 wt % and an eutectic Ag-Cu composition have been fabricated by arc melting. Differential thermoanalysis showed that the alloys have a similar melting behaviour as titanium containing Ag-Cu alloys. Wettability test conducted on SiC and Si_3N_4 proved that they exhibit good wetting properties at elevated temperatures (>1273 K). Metallographic observations showed that a typical reaction layer at the ceramic surface was formed which was enriched in Hafnium. This indicates that the desired reaction between Hafnium and Si_3N_4 or SiC has taken place. Correlating thermodynamic calculations of possible reactions between Hafnium and the ceramics suggests that the formation of Hafnium nitrides or carbides will occur. The silicide reaction are not very probable due to too low brazing temperatures.

3. Results.

Brazing test joints at different brazing conditions showed that Hafnium containing filler metals are suitable for joining SiC/Si_3N_4 ceramics to themselves as well as for joining them to steel. The quality of the joint strongly depends on the quality of the vacuum on account of the high reactivity of Hafnium even to traces of atmospheric gases. Regarding the mechanical properties of joints brazed with Hafnium containing filler metals four-point bending test specimen have been fabricated. The results gained in the tests indicated that a brazing temperature above 1273 K is inevitable for a strong joint with bending strengths above 149 MPa (21.6 ksi) in the case of Si_3N_4.. SiC ceramics perform weaker mechanical properties due to their thicker reaction zone.