Seminar

Institute for Plasma Research

Title : Joining of ceramic materials by microwave-assisted brazing

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Date : 22nd June 2018 (Friday)

Time : 03.30 PM

Venue : Committee Room 3, (New Building), IPR

Abstract :

Joining is a method used to assemble separate parts or components together to fabricate a whole assembly. The joining challenges are growing faster than our knowledge of the method. Joining of ceramics and glasses to other materials (e.g. metals) is vitally important for many advanced, high performance applications[1]. Ceramics/glasses are often selected for their unique thermal, electrical, optical, magnetic, chemical, or mechanical properties, but they rarely have the required toughness to constitute the whole assembly. Active metal brazing is used mainly for joining ceramics that are not wetted by 'conventional' brazes.

In active metal brazing, a metal (usually titanium) is added to the braze alloy to promote reaction and wetting with a ceramic substrate. The addition of titanium to several braze alloy compositions results in increased reactivity and considerable improvement in wetting behaviour. The ceramic is wet by the formation of an intermetallic interfacial reaction product which can then form a joint with the braze alloy.

Microwave processing of ceramics has gained significant attentions over the last few decades due to its superiority over the conventional processing, such as volumetric heating, faster processing, and lesser energy consumption. Microwave processing occurs via the interaction of the material with the induced electromagnetic field. The microwave-material interaction generates heat inside the material and that causes a much faster processing compared to the conventional furnaces[2].

Alumina-alumina and alumina-zirconia joining was carried out using microwave-assisted brazing and conventional brazing methods under different processing parameters using TICUSIL (68.8Ag-26.7Cu-4.5Ti in wt.%) paste as the brazing filler alloy [3].The brazed joints were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray (EDX) analysis, Vickers microhardness evaluation, brazing strength measurement, helium leak test and scratch test. XRD confirmed the formation of Ti-based compounds at the substrate-filler alloy interfaces of the microwave and conventionally brazed joints. The elemental compositions along the joint cross-section were determined by EDX analysis. Vickers microhardness measurement indicated reliable joint performance for the microwaveassisted brazed joints during actual application in an electron tube. Brazing strength measurement and helium leak test proved the formation of good alumina-alumina and alumina-zirconia brazed joints by both microwave and conventional heating techniques. Scratch tests indicated superiority of the microwave brazing technique for improving interfacial joint strength of ceramic-ceramic joints and reducing chances of brittle fracture compared to the conventional brazing technique.

Keywords: Joining of materials, Microwave Processing, Ceramic materials, Brazing of ceramics

References

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[3] M. Shukla, S. Ghosh, N. Dandapat, A. K. Mandal, V. K. Balla, Microwave-Assisted Brazing of Alumina Ceramics for Electron Tube Applications, Bull. Mater. Sci., 39 (2016), 587-591