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Numerical Simulation On Joining Of Ceramics With Aluminum Dissimilar Joints By Friction Welding

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ABSTRACT

Dissimilar metal joining offers the potential to utilize the advantages of different materials often providing unique solutions to engineering requirements. The main reasons for dissimilar joining are due to the combination of good mechanical properties of one material and either low specific weight or good corrosion resistance or good electrical properties of second material. Consequently, joining processes for dissimilar materials have received considerable attention in the recent years. Much of this activity has focused on the transportation industries such as aerospace, aviation, shipbuilding, railway transportation. This is especially in the automotive industry due to the potential weight reduction of both vehicle components and structures. Friction welding is a joining technique used to joint various materials in manufacturing process. The method has widespread use since 1950, it is a solid state joining process that generates heat through mechanical friction between a moving work piece and a stationary component.

This paper presents a numerical simulation on thermal analysis of friction welded ceramic/aluminum joint by Finite Element Analysis (COMSOL) software. The selected materials are AA1100 aluminum alloy and Alumina as a ceramic. The considered geometry for simulation is rods of 12 mm diameter and 60 mm length. In order to validate the numerical model, a similar experimental work was developed by a direct friction welding machine. Just the effect of rotational speed on temperatures variation was investigated, which means that the other welding parameters were kept constants, and only the results of temperature measurements at aluminum interface were done.

Using the numerical heat generation, the predicted temperatures matched closely to the experimental data. Moreover, the experimental results show a maximum interfacial temperature of ~ 350 °C below the melting point of aluminum (650°C).

The ceramic-aluminum bond is strongly present in industrial tools, due to the need to combine the properties of metals, such as ductility, thermal and electrical conductivity, with ceramic properties like high hardness, corrosion and wear resistance. In recent years, some joining techniques have been developed to achieve a good bonding between these materials such as brazing, diffusion bonding, ultrasonic joining and friction welding.

Keywords: *Thermal, Dissimilar Welding, Ceramic, Aluminum, Friction, Modeling.*
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