PhDThesis Defense

Title: Studies on Friction Stir Welding of Aluminium AA2024 alloy to pure Copperjoint.

Name: Anbukkarasi Rajendran.

SR. No: 09843.

Degree Programme: PhD.

Guide: Prof. Satish V.Kailas.

Abstract

Aluminium-copper joints are widely used inelectrical applications due to their unique properties. However, joining of these metals by conventional welding techniques is restricted due to the formation of brittle (bulk size) intermetallic phases.As the other solid-state welding techniques are restricted to a particular joint geometry and they are time-consuming, Friction Stir Welding (FSW) technique is used in the present work to joinAA2024 and pure Cu, which resulted in distribution of Cu particles in the stir zone. The nature and distribution of these particles, along with the nature and thickness of the intermetallic layer at the interface, would dictate the strength of the joint. However, theydepend on the various process parameters. Therefore, the objective of the current work was to optimize the various FSW parameters to obtain better properties by controlling the size of particles in the SZ. For the given purpose, the experiments are done with AA2024 on advancing side and Cu on retreating side and vice versa. Then the other parameters such as tool rotation speed and tool traverse speed are also optimized. These experiments are performed for varying interface positions by using a tapered plain tool and tapered threaded tool.

The optimum weldwas achieved by a plaintool whenthe tool was offset towards the advancing side i.e.AA2024side of the weld. The weld contains a thin continuous intermetallic layer at the interface,due to whichmaximum joint strength was achieved. Fromthree-point bend test; it was found that the root of this weld was the weakest region. The weakest region of the optimum weld (single side weld) was eliminated by double side weld, where the weldwas repeated from the backside of the previous weld. As the intrinsic microstructure of the AA2024-pure Cu weld can change due to heating when the weld is used as a current carrying system, the effects of heating on the optimum weld were also studied. In case of the threadedtoolalso the optimum weld was obtained, whentool was offset towards the advancing side i.eAA2024side of the weld. This weld contained high volume fraction of fine Cu particles in AA2024 matrix. This lead to increase in ductility of joint as compared to plain tool weld. Further, Zn and Ni interlayers were used to modify the composition of the particles formed in eth weld nugget. This further increased the ductilityof the joint due to the formation of binary/ternary intermetallics.

From this work, it is concluded that the expected desirable morphology of metallic and intermetallic particles can be achieved by optimum tool geometry and tool offsetposition. Due to thisoptimizationa considerable improvement in the mechanical properties of the AA2024-pure Cu welds was oberved.

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