INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:

Plasma assisted hybrid friction stir welding of similar and dissimilar materials

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SHORT ABSTRACT

This thesis work is primarily motivated to develop plasma assisted hybrid FSW (P-FSW) process for joining of similar and dissimilar materials and the validation of the experimental results with the development of physics based numerical model. At first major efforts are put forward to experimentally investigate the heat transfer process in P-FSW process for joining both similar and dissimilar materials. The thermal history influences the mechanical properties and microstructural changes that decide the final weld joint quality. In addition, different tool profiles also influence the mechanical and microstructural characterization of friction stir welded aluminum alloy due to variation in material flow pattern during welding. A comparative study between FSW and P-FSW put forward the fundamental advantages of hybrid welding process. However, tool-offset is one of the most significant parameters during joining of dissimilar materials by FSW process. An investigation was carried out on the effect of tool offset towards thermal history, welding force, weld joint morphology, material flow pattern, and mechanical properties of the weld joint. It was found that offsetting towards aluminium side along with a plasma-assisted heat source is an effective way to address one of the most important difficulties in aluminium-copper solid-state welding process. The offset influences the amount of intermetallic at the joint interface and in-effect impacts on final strength and material flow behaviour. There exists optimum continuous layer of intermetallic that produces the maximum weld joint strength. The specimen welded with optimum tool offset shows the highest strength using 55 A plasma current in hybrid FSW process. Quantitative calculation by a sophisticated mathematical model of hybrid friction stir welding for dissimilar materials is a daunting task due to complex issues like mixed property in the weld zone, flow mixing action and solid state phase transformation. A 3D finite element based phenomenological model is developed to study various aspects of P-FSW between aluminum and copper. A dedicated heat generation model at various contact conditions between tool and workpiece, and a Gaussian distributed heat flux from plasma arc is used for the simulation. In weld zone, the impression of time-varying functionally graded material (FGM) is used for material behavior. The numerical model results are validated with experimental measurement of P-FSW in terms of time–temperature history and computed isotherm of nugget zone.