Reduction of Excessive Flash in Friction Stir Processing of AA1100: An Experimental Observation Study

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Abstract

Friction stir processing (FSP) has proven to be a powerful emerging surface engineering technology for modifying metal surfaces and their bulk properties to desired forms. As a variant of friction stir welding (FSW), FSP borrows its principles of functionality from FSW. FSP technology is highly dependent on careful selection of process parameters. Its key parameters include tool rotational speed, traverse speed, tool tilt angles, axial force, tool and process design as well as base metal properties. Formation of excessive flash is a common FSP parametric challenge which needs to be studied. In this work, build-up of mass flash was experimentally observed and controlled by varying process tool tilt angle and the rotational during FSP of AA1100. The process was conducted using H13 tool steel cylindrical tool with a shoulder diameter of 21 mm with a 7 mm cylindrical threaded pin, at constant traverse speed of 20 mm/min at tilt angles varying from 0° to 3°, rotational speeds of 500 to 1500 rpm for unreinforced process and 2100–2800 rpm for reinforced process, at constant plunge depth of 0.2 mm, and traverse force of 11.2 kN. Results obtained from the physically examined FSP'ed samples show that excessive flash was generated for tilt angles from 0° to 2° as a result of limited under-shoulder space for flow of the plasticized material and the front tip of the tool digging into the base metal ejecting material from the processed zone. Massive flash reduction was observed at 2.5°. A further improvement of flash reduction was witnessed at 3° tilt angle but with reduced shoulder-to-base metal areal contact due to too much raised tool front.