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Modelling and Visualisation of Material Flow in Friction Stir Spot Welding

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Abstract: The material flow in friction stir spot welding of aluminium to both aluminium and steel has been investigated, using pinless tools in a lap joint geometry. The flow behaviour was revealed experimentally using dissimilar Al alloys of similar strength. The effect on the material flow of tool surface features, welding conditions (rotation speed, plunge depth, dwell time), and the surface state of the steel sheet (un-coated or galvanized) have been systematically studied. A novel kinematic flow model is presented, which successfully predicts the observed layering of the dissimilar Al alloys under a range of conditions. The model and the experimental observations provide a consistent interpretation of the stick-slip conditions at the tool-workpiece interface, addressing an elusive and long-standing issue in the modelling of heat generation in friction stir processing.

Keywords: Friction stir spot welding; dissimilar materials; aluminium alloys; galvanised steel; automotive alloys; process modelling.

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