A coupled thermal-mechanical model based on Eulerian formulation for magnetic pulse welding

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ABSTRACT

A geometrically nonlinear model based on Eulerian formulation is proposed to predict thermal and mechanical interactions, which happen during magnetic pulse welding. Representative 2D model of the interface region is constructed to perform Eulerian simulations. Johnson-Cook model is used to define the constitutive behavior of materials under high strain rate deformation. Thermomechanical effects at the interfacial zone are predicated to investigate the complex kinetics and mechanisms of various interfacial features during the high-speed impact condition. The reliability and robustness of this computational model are evidenced by comparing the computed interfacial features and the experimental results. Interfacial features including jetting, regular and irregular waves, vortices and cavities found along the welded interface under various welding conditions, are successfully reproduced via numerical simulations. Due to the shear instability and local plastic strain, the intermittent upward and downward jetting are produced during collision. Moreover, the entrapment of the forward jetting is deflected in the upward direction leading to further interfacial instability and formation of vortices. Furthermore, the predicted temperature, ultra-high heating and cooling of the molten pockets explain that favorable condition was reached for the formation of fine porous structures as observed in the experimental results. Thus, the coupled thermomechanical simulation is highly suitable to predict the complex dynamic interfacial characteristics of high-speed impact welding.

***Keywords**: Magnetic pulse welding, Eulerian model, Coupled simulation, thermomechanical, interface characteristics*