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PROCEEDINGS

Developing a New Computational Fluid Dynamics Model for Friction Stir Welding of Al/Mg Alloys by Explicitly Including Intermetallic Compound Phase

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ABSTRACT

The dissimilar friction stir welding (FSW) of aluminum (Al) and magnesium (Mg) alloys occurs at relatively low temperatures, but how the plastic flow happens under these conditions remains unclear. In this study, a computational fluid dynamics (CFD) model was developed to investigate the thermo-mechanical-flow coupled material behavior during the dissimilar friction stir welding of AA6061-T6 Al alloy and AZ31B Mg alloy. The present work established a generation model and a constitutive model for intermetallic compound (IMC) in welding process. An iso-stress mixing model was utilized to determine the viscosity of the Al-Mg-IMC mixture by volume friction and viscosity of each phase. To distinguish the material behavior during dissimilar FSW of Al/Mg alloys, the welding of dissimilar alloys and identical workpieces were both studied by simulation and experiment. The simulation results were validated by precise prediction on welding temperatures and joint structures. The welding temperature for identical Al workpieces was found to be higher than that for identical Mg workpieces, both of which exceeded the temperature observed in dissimilar FSW of Al/Mg alloys. Both experimental and simulation results consistently showed that the stir zone (SZ) in identical alloy joints is larger than that in dissimilar alloys joints. On one hand, the presence of the IMCs reduces the heat generation, which decreases the welding temperature and hardens the alloys, limiting the region and velocity of material flow in dissimilar FSW. On the other hand, the IMCs with softening effect facilitates enough flowability for Al/Mg mixture to form sound joints. Additionally, the spatial flow behavior of the material was analyzed to elucidate the joint formation mechanism.

KEYWORDS

Friction stir welding; Al/Mg dissimilar welding; numerical simulation; intermetallic compounds

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