

Thermomechanical modelling of dissimilar Friction Melt Bonding of AA6061 to Dual-phase steel: Prediction of solidification cracking and residual stresses

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Friction Melt Bonding (FMB) is a novel technique that has been successfully applied to weld aluminium to steel in lap-joint configuration. To carry out the weld, a rotating cylindrical tool showing no pin is pressed against the surface of the steel sheet which is placed over the aluminium one. Heat will be generated from the friction and plastic dissipation induced by the tool in the steel plate. This heat does not melt the steel, but locally melts the aluminium in contact underneath owing to the large difference in melting temperatures. The molten aluminium reacts with the solid steel and forms a thin Fe/Al intermetallic layer, responsible for the bonding.

In the case of AA6061, of wide use in transport industry, the solidification of the alloy can result in the formation of solidification cracks leading to low joining strengths. In this paper, the RDG criterion developed by Rappaz et al. is used to predict the initiation of the cracks. The prediction requires knowing the thermomechanical loads in the form of thermal gradient and strain rates. Both are estimated from a thermomechanical finite element modelling. The comparison with the experiments shows that it is possible to avoid the formation of hot tears by controlling the process parameters such as the thermal environment.

In addition to solidification cracking, residual stresses arising from the high thermal gradients might have a significant impact in the lap-shear strength of the welds. To measure the impact of residual stresses, as-welded and annealed samples are mechanically tested and results are compared to the simulations.