
Rotary friction welding of precipitate hardened maraging steel for aerospace and defence applications: Characterisation and finite element modelling

Amborish Banerjee*¹ and Laurie Da Silva*¹

¹Advanced Forming Research Centre (AFRC), University of Strathclyde, 85 Inchinnan Drive, Inchinnan, Renfrewshire, PA4 9LJ, UK – United Kingdom

Abstract

In the recent decade, industrial firms have shifted their focus towards long-term sustainable development that includes both circular economy and net-zero manufacturing. Rotary friction welding (RFW) is a technology that allows for solid state near-net-shape manufacturing. In this study, RFW of MLX®19 precipitation hardened maraging steel was carried out under different weld conditions viz. forge force, friction force and weld speed, and their effect on the mechanical properties of the weldments was studied. The mechanical and microstructural evolution of the weld assemblies were characterised, and the optimised process parameters were determined. The microstructure and texture features revealed the fact that the maximum temperature attained in the weld zone (WZ) was above A_{c3} , while in the thermo-mechanical affected zone (TMAZ) was in-between A_{c1} and A_{c3} . Examination of the crystallographic texture suggested that the WZ was subjected to pure shear deformation whereas the TMAZ experienced both shear and compressive deformation during the welding process. A 2.5D finite element (FE) model was also developed to predict the temperature distribution and stress-strain evolution during the welding process. The model exhibited the highest temperature and lowest stress at the weld interface. The predicted results from the FE model were compared with an actual instrumented weld (thermocouples embedded) and excellent agreement (error $\sim 4.7\%$,) was observed.

Keywords: Rotary friction welding, maraging steel, finite element model, temperature distribution

*Speaker