NUMERICAL SOLUTION OF FRICTION STIR WELDING

Arnab Samaddar Chaudhuri

Abstract

Friction Stir Welding (FSW) is a fully coupled thermo-mechanical process and should in general be modeled as such. Basically, there are two major application areas of thermo-mechanical models in the investigation of the FSW process: i) Analysis of the thermo-mechanical conditions such as e.g. heat generation and local material deformation (often referred to as flow) during the welding process itself. ii) Prediction of the residual stresses that will be present in the joint structure post to welding. While the former in general will call for a fully-coupled thermo-mechanical procedure, however, typically on a local scale, the latter will very often be based on a semi-coupled, global procedure where the transient temperatures drive the stresses but no vice-versa.

To gain physical insight into the FSW process and the evaluation of the critical parameters, the development of models and simulation techniques is a necessity. In the present work, an attempt to understand the interaction between process parameters from a simulation study, performed using commercially available nonlinear finite element code COMSOL. A moving coordinate is introduced to reduce the difficulty of modeling the moving tool. Heat input from the tool shoulder and the tool pin are considered in the model. The finite element method was applied in solving the control equations. A non-uniform grid mesh is generated for the calculation.

The distributions of temperature, iso-surfaces, isotherms, were analyzed across various regions of the weld apart from material flow as a means of evaluating process efficiency and the quality of the weld. The distribution of process parameters is of importance in the prediction of the occurrence of welding defects, and to locate areas of concern for the metallurgist. The suitability of this modeling tool to simulate the FSW process has been discussed.