8th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS)

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 2: SOLIDIFICATION AND CASTING, SALON B

Co-Chairs: Qingyou Han, Purdue University; Lin Liu, Northwestern Polytechnical University; Dongke Sun, Shanghai Jiao Tong University; Shuanglin Chen, CompuTherm

SATURDAY, OCTOBER 15, 2016

Numerical simulation of material flow during FSW to predict defect generation based on non-uniform tool–material contact condition

Yu-can Zhu; Gao-qiang Chen; Shuai Zhang; Qi-long Cheng; Gong Zhang; Qing-yu Shi,
State Key Laboratory of Tribology

ABSTRACT

Friction stir welding (FSW) has gained wide application in many industries. Predicting defect generation during FSW is of interest to both industries and academics. Numerical simulation based on CFD method is one of the most common approaches to analyze the FSW process. But it is difficult to directly predict defect generation with CFD simulation. A non-uniform tool–material interaction model is proposed in this research based on analysis of tool–material contact and friction condition. The friction condition is judged by comparison between frictional force and materials flow stress, while the frictional force could be calculated based on the non-uniform distributed pressure on the tool. The non-uniform pressure on the tool is also calculated during simulation. Different contact and friction conditions, including slipping friction, partial slipping partial sticking friction, and sticking friction, could be integrated into this model. Furthermore, switching of different friction conditions could also be achieved in this model.

Based on the above model, the simulation results show that there is an area behind the tool where the pressure on the tool is quite low. Thus, the frictional force is so small that it could not drive the material to generate sufficient flow when FSW parameters are not suitable and defects generate in the nearby position. The results also show that the dimension and location of defects vary with FSW parameters. The simulation results correspond well with validation experiments. Further quantitative analysis would be carried out to more accurately predict the relationship between defect generation and FSW parameters.

KEYWORDS: CFD simulation, FSW defect, tool–material interaction, non-uniform pressure