Investigation of the hot deformation characteristics during friction stir welding of high-purity aluminum*

Dr. Bala Radhakrishnan[1]; Dr. Gorti Sarma[1]; Dr. Oleg Barabash[2]; Dr. Zhili Feng[2]; Dr. Stan David[2]
[1]Computer Science and Mathematics Division, Oak Ridge National Laboratory, Building 5600, Mail Stop 6008, Oak Ridge, Tennessee 37831-6008 USA
[2]Metals and Ceramics Division, Oak Ridge National Laboratory, Building 4508, Mail Stop 6095, Oak Ridge, Tennessee 37831-6095 USA

The quasi steady-state three-dimensional thermal and flow fields in the vicinity of the tool during friction stir welding of high-purity aluminum are modeled using the commercial flow software, FLUENT. The viscosity of aluminum is calculated from available stress-strain data at various temperatures and strain rates and used in the flow computations. From the steady state temperature and strain-rate fields the operating Zener-Hollomon parameters are calculated at various distances from the tool, and used to predict the size and shape of the swirl zone. The model results are compared with experimentally measured profiles for the swirl zone. The deformation substructure in terms of the grain size, grain size distribution, texture and grain boundary misorientation distribution are measured using orientation imaging microscopy. The model predictions combined with experimental measurements of substructure are used to elucidate whether dynamic recovery or dynamic recrystallization was the operating mechanism during hot deformation in the swirl zone.

*Research sponsored by the Division of Materials Sciences and Engineering, U.S. Department of Energy, under contract DE-AC05-00OR22725 with UT-Battelle, LLC. The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-00OR22725. Accordingly, the U.S. Government retains a non-exclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes.