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

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 6: LIGHT ALLOYS, MARITIME HALL

Co-Chairs: Jong Ning Aoh, National Chung Cheng University; Zuyan Liu, Harbin Institute of Technology

SUNDAY, OCTOBER 16, 2016

Numerical and experimental characterization of material flow in forged aluminum wheel

Jong-Ning Aoh; Ming-Chiu Li; Chong-Jin Li, National Chung Cheng University

ABSTRACT

It is essential to analyze the plastic flow behavior during forging a disk billet for the manufacturing of aluminum wheels. The flow patterns, the possible flow separation, and dead zone in the workpiece can be predicted in advance so that the mold geometries and the flow pattern of the billet can be further optimized for a defect-free and near net-shape forging process.

In this study, up-set forging experiment was conducted on Gleeble tester to acquire flow curves of Al6061 as material data base for numerical simulation using SIMUFACT. The flow behavior, strain distribution, temperature profile, forging streamline, flow velocity, stagnation, and separation phenomenon during forging of aluminum wheels were analyzed and compared with those obtained from the transverse cross-section of a real forged wheel. Detailed metallographic investigation was conducted on the wheel cross-section to reveal the material flow pattern, possible defects, and the grain size distribution. The feasibility of the numerical simulation in predicting the aluminum wheel forging process was verified. A grain size distribution map of the forged wheel based on both numerical prediction and micrograph was proposed. The flow separation during forging was identified, and it is coincident with the real folding defect observed on the cross-section of the wheel. Further modification of the mold was conducted to improve the billet flow during forging process. An improved material flow enabled uniform strain distribution and dense streamline distribution. As a result, stagnation and separation of material flow can be effectively reduced so that the forging defects can be reduced or eliminated.