MODELLING SEMI-SOLID BEHAVIOR AND BRITTLE TEMPERATURE RANGE

Khalil Traidi1,2, Véronique Favier2, Philippe Lestriez3, Karl Debray3, L. Langlois4

1 Institut de Recherche Technologique Matériaux, Métallurgie Procédés
   Metz, France
e-mail1: traidi.khalil@gmail.com

2 Laboratoire PIMM/ Ensam CNRS Cnam Hesam Université
   Paris, France
   veronique.favier@ensam.eu

3 GRESPI/ Université Reims Champagne Ardennes
   Reims, France
   philippe.lestriez@univ-reims.fr/karl.debray@univ-reims.fr

4 LCFC/ Ensam Hesam Université
   Metz, France
   Laurent.langlois@ensam.eu

ABSTRACT

Semi-solid forming processes can lead to hot cracking. Hot cracking appears for solid fraction higher than 0.8-0.9 in the mushy zone loaded in tension. Indeed, the mushy material exhibits a “Brittle Temperature Range” (BTR) near to the solidus. It is commonly characterized by tensile tests from the solid to the mushy state. The BTR of the C38LTT steel was previously characterized (Traidi, et al., 2016). In this paper, a new poroelastic viscoplastic micromechanical modeling is proposed to represent the semi-solid behavior and predict the ductile-brittle transition of the C38LTT near the solidus. It is based on a viscoplastic modeling previously presented in (Favier, et al., 2009). The originality of the new model comes from three main enhancements: the transition between the solid state and the semi-solid state was included, the elastic properties was represented via a micromechanical approach in contrast to (Favier, et al., 2011) and the evolution of the internal variable describing the degree of agglomeration of the solid phase was enhanced. The model was implemented in the commercial software FORGE®. Tensile tests representing the experimental thermal conditions obtained using a GLEEBLE® machine were simulated. The comparison of the predicted and experimental results shows that, for the first time to our knowledge, the three steps of the load-displacement response and ductile-brittle transition were successfully described.