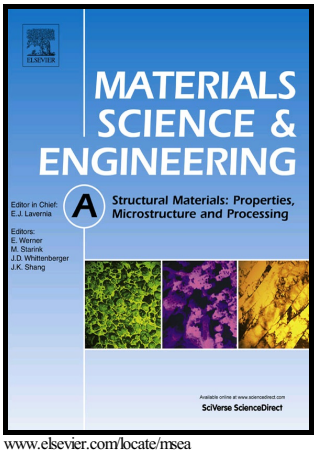
A physical-based constitutive model to describe the strain-hardening and dynamic recovery behaviors of 5754 aluminum alloy

Chang-Qing Huang, Deng Jie, Si-Xu Wang, Lei-lei Liu



www.elsevier.com/locate/msea

PII: S0921-5093(17)30556-7
DOI: http://dx.doi.org/10.1016/j.msea.2017.04.086
Reference: MSA34987

To appear in: *Materials Science & Engineering A*

Received date: 7 January 2017
Revised date: 20 April 2017
Accepted date: 21 April 2017

Cite this article as: Chang-Qing Huang, Deng Jie, Si-Xu Wang and Lei-lei Liu, A physical-based constitutive model to describe the strain-hardening and dynami recovery behaviors of 5754 aluminum alloy, *Materials Science & Engineering A* http://dx.doi.org/10.1016/j.msea.2017.04.086

A physical-based constitutive model to describe the strain-hardening and dynamic recovery behaviors of 5754 aluminum alloy

Chang-Qing Huang[a, b, c *], Deng Jie[a, c], Si-Xu Wang[a, b], Lei-lei Liu[a, b]

[a]*State Key Laboratory of High-performance Complicated Manufacturing, Central South University, Changsha 410083, China;*

[b]*Light Alloy Research Institute, Central South University, Changsha 410083, China;*

[c]*School of Mechanical and Electrical Engineering, Central South University, Changsha 410083, China*

[*]Corresponding author. huangcq64@csu.edu.cn.

Abstract:

Plane strain hot compression tests of 5754 aluminum alloy were conducted on a Gleeble-3500 thermo-mechanical simulator under various conditions. These tests simulated flat rolling to investigate how hardening and softening behaviors respond to controlled parameters, such as the deformation temperature and strain rate. This data allowed the parameters for the hot rolling process to be optimized. The restoration mechanism primarily proceeds via dynamic recovery, as shown by the deformed microstructure analysis and strain-stress curves. The dislocation density was used as internal state variable to develop a physical constitutive model, which characterized the evolution of the dislocation density caused by strain-hardening and dynamic recovery behaviors. The relationship between the flow stress and the dislocation density could be quantified with this model. The strain-hardening and softening behavior was analyzed in detail by Kocks-Mecking type plots. Furthermore, the relevant material coefficients were expressed as functions related to the temperature and the strain rate. The experimental flow stress was found to be in close agreement with the calculated, which confirms that the model developed herein can represent the flow behaviors of the 5754 aluminum alloy effectively.

Keywords : 5754 aluminum alloy; plane strain hot compression; dynamic recovery; microstructural evolution; constitutive model

1. Introduction