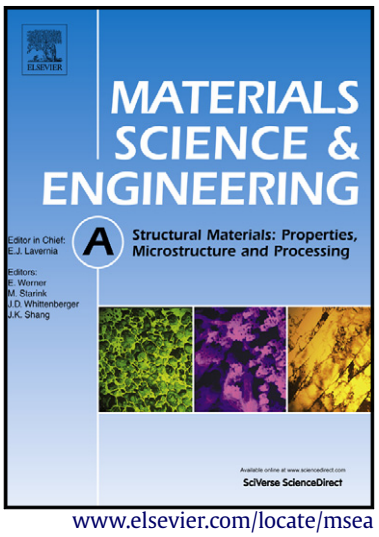

Compressive flow behavior of Al-Si based alloy: role of heat treatment

Sudha Joseph, S. Kumar, R. Prasath Babu

www.elsevier.com/locate/msea

PII: S0921-5093(15)00062-3
DOI: http://dx.doi.org/10.1016/j.msea.2015.01.046
Reference: MSA31984

To appear in: *Materials Science & Engineering A*

Received date: 4 October 2014
Revised date: 12 January 2015
Accepted date: 19 January 2015

Cite this article as: Sudha Joseph, S. Kumar, R. Prasath Babu, Compressive flow behavior of Al-Si based alloy: role of heat treatment, *Materials Science & Engineering A*, http://dx.doi.org/10.1016/j.msea.2015.01.046

Compressive flow behavior of Al-Si based alloy: role of heat treatment

Sudha Joseph*, S. Kumar, R. Prasath Babu

Department of Materials Engineering, Indian Institute of Science, Bangalore 560 012, India

sudhajos.iisc@gmail.com

Abstract

The flow characteristics of a near eutectic Al-Si based cast alloy have been examined in compression at strain rates varying from $3x10^{-4}$ to 10^{2} s^{-1} and at three different temperatures, i.e., room temperature (RT), 100°C and 200°C. The dependence of the flow behavior on heat treatment is studied by testing the alloy in non-heat treated (NHT) and heat treated (HT) conditions. The heat treatment has strong influence on strain rate sensitivity (SRS), strength and work hardening behavior of the alloy. It is observed that the strength of the alloy increases with increase in strain rate and it increases more rapidly above the strain rate of 10^{-1} s^{-1} in HT condition at all the temperatures, and at 100°C and 200°C in NHT condition. The thermally dependent process taking place in the HT matrix is responsible for the observed greater SRS in HT condition. The alloy in HT condition exhibits a larger work hardening rate than in NHT condition during initial stages of straining. However, the hardening rate decreases more sharply at higher strains in HT condition due to precipitate shearing and higher rate of Si particle fracture. Thermal hardening is observed at 200°C in NHT condition due to precipitate formation, which results in increased SRS at higher temperatures. Thermal softening is observed in HT condition at 200°C due to precipitate coarsening, which leads to a decrease in SRS at higher temperatures. Stress simulations by finite element method support the experimentally observed particle and matrix fracture behavior. A negative SRS and serrated flow are observed in the lower strain rate regime ($3x10^{-4}$ to 10^{-2} s^{-1}) at RT and 100°C, in both NHT and HT conditions. The observations show that both dynamic strain aging (DSA) and precipitate shearing play a role in serrated flow.

Keywords: Al-Si alloys; Heat treatment; Strain rate sensitivity; Finite element modeling; Deformation mechanisms.

1. Introduction

Hypoeutectic and near eutectic Al-Si alloys are widely used in automotive industry due to their excellent foundry characteristics and good mechanical properties. These alloys typically contain 6-12 wt. % Si and given that the maximum solubility of Si in Al is 0.05 wt. % at room temperature (RT), excess Si will exist in the form of large particles providing strength