Accepted Manuscript

Characterising precipitate evolution in multi-component cast aluminium alloys using small-angle X-ray scattering

P. Panagos, Y. Wang, D.G. McCartney, M. Li, B. Ghaffari, J.W. Zindel, J. Miao, S. Makineni, J.E. Allison, O. Shebanova, J.D. Robson, Peter D. Lee

PII: S0925-8388(17)30347-X

DOI: 10.1016/j.jallcom.2017.01.293

Reference: JALCOM 40660

To appear in: *Journal of Alloys and Compounds*

Received Date: 28 October 2016

Revised Date: 17 January 2017

Accepted Date: 25 January 2017

Please cite this article as: P. Panagos, Y. Wang, D.G. McCartney, M. Li, B. Ghaffari, J.W. Zindel, J. Miao, S. Makineni, J.E. Allison, O. Shebanova, J.D. Robson, P.D. Lee, Characterising precipitate evolution in multi-component cast aluminium alloys using small-angle X-ray scattering, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.01.293.

Characterising Precipitate Evolution in Multi-component Cast Aluminium Alloys using Small-Angle X-ray Scattering

P. Panagos[1,2], Y Wang[1,2], D.G. McCartney[2,3], M. Li[4], B. Ghaffari[4], J.W. Zindel[4], J. Miao[5], S. Makineni[5],J.E. Allison[5], O. Shebanova[6] , J.D. Robson[1] and Peter D. Lee[1,2,*]

[1]School of Materials, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK

[2]Research Complex at Harwell, RAL, Didcot, OX11 0FA, UK

[3]Advanced Materials Group, Faculty of Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK

[4]Materials Research Department, Ford Motor Company, Research and Innovation Center, MD3182, P.O Box 2053, Dearborn MI48121, USA

[5]Department of Materials Science and Engineering, University of Michigan, 2300 Hayward St., Ann Arbor, MI 48109, USA

[6]Diamond Light Source Ltd, Diamond House, Harwell Science and Innovation Campus, Didcot, Oxfordshire, OX11 0DE, UK

[*]Corresponding Author (e-mail address:peter.lee@manchester.ac.uk)

Abstract

Aluminium alloys can be strengthened significantly by nano-scale precipitates that restrict dislocation movement. In this study, the evolution of inhomogenously distributed trialuminide precipitates in two multi-component alloys was characterised by synchrotron small-angle X-ray scattering (SAXS). The appropriate selection of reference sample and data treatment required to successfully characterise a low volume fraction of precipitates in multi-component alloys via SAXS was investigated. The resulting SAXS study allowed the analysis of statistically significant numbers of precipitates (billions) as compared to electron microscopy (hundreds). Two cast aluminium alloys with different volume fractions of $Al_3Zr_xV_{1-x}$ precipitates were studied. Data analysis was conducted using direct evaluation methods on SAXS spectra and the results compared with those from transmission electron microscopy (TEM). Precipitates were found to attain a spherical structure with homogeneous chemical composition. Precipitate evolution was quantified, including size, size distribution, volume fraction and number density. The results provide evidence that these multi-component alloys have a short nucleation stage, with coarsening dominating precipitate size. The coarsening rate constant was calculated and compared to similar precipitate behaviour.