TEM Investigation of Precipitation in Al-Mn Alloys with Addition of Zr

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Aluminium and its alloys belong to the most widely used metallic materials for industrial applications. One of the possible casting methods is twin-roll casting which produces sheets with high solid solution supersaturation. Decomposition of this supersaturated material during heat treatment was studied in aluminium alloys from the AW-3003 series – one standard grade and the other modified by addition of zirconium. Characterization by differential thermal analysis and observations by electron microscopy revealed that precipitation of α–AlMnFeSi phase occurred in two steps around 360 and 450 °C in twin-roll cast sheets, firstly on subgrain boundaries and afterwards also within the grains. In cold-rolled sheets, precipitates formed directly within the grains. The zirconium addition shifts recrystallization to higher annealing temperatures in the cold-rolled Zr-containing alloy.

Keywords: Aluminium alloys, AW-3003, TEM, precipitation, α–AlMnFeSi

Acknowledgment

This work was financially supported by a project of The Czech Science Foundation GAČR P107-12-0921. M. P. would also like to acknowledge support of student grants SVV-2012-265303 and GAUK 92210 and a scholarship from the French embassy.

References:

[1] Y. BIROL: Analysis of macro segregation in twin-roll cast aluminium strips via solidification curves. *Journal of Alloys and Compounds* 486 (2009) 168-172.

[2] Y. J. LI, A. M. F. MUGGERUD, A. OLSEN, T. FURU: Precipitation of partially coherent α-Al(Mn,Fe)Si dispersoids and their strengthening effect in AA 3003 alloy. *Acta Materialia* 60 (2012) 1004-1014.

[3] D. T. L. ALEXANDER, A. L. GREER: Solid-state intermetallic phase transformation in 3XXX aluminium alloys. *Acta Materialia* 50 (2002) 2571-2583.

[4] M. KARLÍK, T. MÁNIK, H. LAUSCHMAN: Influence of Si and Fe on the distribution of intermetallic compounds in twin-roll cast Al-Mn-Zr alloys. Journal of Alloys and Compounds 515 (2012) 108-113.

[5] N. A. BELOV, D. G. ESKIN, A. A. ASKENOV: Multicomponent Phase Diagrams: Application for Commercial Aluminum Alloys, ELSEVIER (2005).

[6] M. CIESLAR, M. SLÁMOVÁ, M. HÁJEK, J. VESELÝ: Effect of Thermomechanical Pretreatment on Mechanical Properties of Modified Al-Mn-Fe-Si Based Alloys. *Materials Science Forum* Vols. 567-568 (2008) pp. 325-328.

[7] M. DEHMAS, P. WEISBECKER, G. GDIER, P. ARCHABAULT, E. AEBY-GAUTIER: Experimental study of phase transformation in 3003 aluminium alloys during heating by in situ high energy synchrotron radiation. Journal of Alloys and Compounds 400 (2005) 116-124.

[8] M. SLÁMOVÁ, A. KUBOŠOVÁ, J. POLITELLO, M. CIESLAR: Effect of annealing on microstructure and properties of twin-roll-cast Al-Mn alloys with different copper content. *International Journal of Materials Research* 100 (2009) 428-432.

[9] M. POKOVÁ, M. CIESLAR, M. SLÁMOVÁ: The influence of dispersoids on the recrystallization of aluminium alloys. *International Journal of Materials Research* 100 (2009) 391-394.

[10] H.-W. HUANG, B.-L. OU: Evolution of precipitation during different homogenization treatments in a 3003 aluminum alloy. Materials and Design 30 (2009) 2685-2692.

[11] M. CIESLAR, M. SLÁMOVÁ, J. UHLÍŘ, CH. COUPEAU, J. BONNEVILLE: Effect of composition and work hardening on solid solution decomposition in twin-roll cast Al-Mn sheets. *Kovové Materiály* 45 (2007) 91-98.

[12] K. S. VECCHIO, D. B. WILLIAMS: Convergent beam electron diffraction study of Al_3Zr in Al-Zr and Al-Li-Zr alloys. *Acta Metallurgica* 35 (1987) 2959-2970.

[13] E. NES, H. BILLDAL: Non-equilibrium solidification of hyperperitectic Al-Zr alloys. *Acta Metallurgica* 25 (1977) 1031-1037.

[14] K. E. KNIPLING, D. C. DUNAND, D. N. SEIDMAN: Precipitation evolution in Al-Zr and Al-Zr-Ti alloys during aging at 450-600 °C. *Acta Materialia* 56 (2008) 1182-1195.

[15] M. CIESLAR: EBSD studium rozdělení disperzních částic v nerovnovážně utuhnutých hliníkových slitinách. Metalografie : metody a postupy 1 (2010) 120-128, Adin, Prešov.

[16] M. POKOVÁ, M. CIESLAR, J. LACAZE: The Influence of Silicon Content on Recrystallization of twin-roll cast Aluminum Alloys for Heat Exchangers. *Acta Physica Polonica A* (2012) in press.

[17] J. E. HATCH: *Aluminum. Properties and Physical Metallurgy.* ASM, Ohio (1984).

[18] E. NES, S. SLEVOLDEN: Mechanical properties of new strip-cast AlMnZr alloys. *Aluminium* 55 (1979) 398-400.

[19] M. POKOVÁ, M. CIESLAR, J. LACAZE: The Influence of Pre-deformation on Minority Phases Precipitation in Modified AW-3003 Aluminium. *Metal 2012 Conference Proceedings* (2012) 73-78.

[20] H. WEILAND, S. CHEONG: The Role of Zirconium Additions in Recrystallization of Aluminium Alloys. *Materials Science Forum* 558-559 (2007) 383-387.

[21] Z. JIA, G. HU, B. FORBORD, J.K. SOLBERG: Enhancement of recrystallization resistance of Al-Zr-Mn by two-step precipitation annealing. *Materials Science and Engineering A* 483-484 (2008) 195-198.

Paper number: M201244

Manuscript of the paper received in 2012-07-19. The reviewer of this paper: *Dalibor Vojtech.*