The Impact of Sr Content on Fe - Intermetallic Phase's Morphology Changes in Alloy AlSi10MgMn

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The effect of modification (with AlSr10) on the microstructure of hypoeutectic AlSi10MgMn cast was systematically investigated. The samples were studied in as cast state without Sr (0 % Sr) and after modification (0.05 % Sr; 0.1 % Sr and 0.15 % Sr). Iron is added to Al-Si alloy to increase hot tear resistance and to reduce die sticking, but can change the solidification characteristics by forming pre- and post-eutectic β-Al5FeSi phase or other Fe-rich phases, which can be very detrimental to the mechanical properties of the final cast part. A combination of different analytical techniques (light microscopy upon black-white etching; scanning electron microscopy (SEM) upon deep etching and energy dispersive X-ray analysis (EDX); quantitative phase analyse upon Image analyzer NIS Elements 3.0) were therefore been used for the microstructure study. The results show that the addition of Sr into AlSi10MgMn cast alloy modified eutectic silicon as well as Fe-intermetallic phases and improves mechanical properties (ductility, strength).

Keywords: aluminium cast alloy, microstructure, Fe-rich phases and morphology

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References

[1] TILLOVÁ, E., CHALUPOVÁ, M. (2009). *Structural analysis* (Štruktúrna analýza), Edis Žilina (in Slovak).

[2] ZHANG, G., ZHANG, J., LI, B., CAI, W. (2011). Characterization of tensile fracture in heavily alloyed Al−Si piston alloy. In. *Progress in Natural Science: Materials International*, 21, pp. 380-385.

[3] TILLOVÁ, E., CHALUPOVÁ, M., HURTALOVÁ, L., ĎURINÍKOVÁ, E. (2011). Quality control of microstructure in recycled Al-Si cast alloys. In: *Manufacturing Technology*, Vol. 11, pp. 70-76.

[4] PEZDA, J. (2014). Influence of heat treatment parameters on the mechanical properties of hypoeutectic Al-Si-Mg alloy, In. *METABK*, Vol. 53, 2, pp. 221-224.

[5] PEZDA, J. (2015). Effect of the T6 heat treatment on change of mechanical properties of the AlSi12CuNiMg alloy modified with Strontium, In. *Archives of Metallurgy and Materials*, Vol. 60, 2, pp.627-632.

[6] SHABESTARI, S. G. (2004). The effect of iron and manganese on the formation of intermetallic compounds in aluminum–silicon alloys. In. *Materials Science and Engineering A*, Vol. 383, pp. 289–298.

[7] FARKAŠOVÁ, M., TILLOVÁ, E., CHALUPOVÁ, M. (2013). Fracture surface of recycled AlSi10Mg cast alloy. *Manufacturing technology*, Vol. 13, 1, p. 109-114.

[8] TAYLOR, J. A. (2004). The effect of iron in Al-Si casting alloys. In: *35th Australian Foundry Institute National Conference*, pp. 148-157, Adelaide, South Australia.

[9] SEIFEDDINE, S. (2007). The influence of Fe on the microstructure and mechanical properties of cast Al-Si alloys. In. *Literature review - Vilmer project*. Jönköping University, Sweden.

[10] KNUUTINEN, A., NOGITA, K., MCDONALD, S. D., DAHLE, A. K. (2001). Modification of Al-Si alloys with Ba, Ca, Y and Yb. In. *Journal of Light Metals*, 1, p. 229-240.

[11] MARKER, M., SKOLYSZEWSKA-KÜHBERGER, B., EFFENBERGER, H. S., SCHMETTERER, C., RICHTER, K.W. (2011). Phase equilibria and structural investigations in the system Al-Fe-Si. In. *Intermetallics*, Vol. 19, pp. 1919-1929.

[12] CASARI, D., FORTINI, A., MERLIN, M. (2013). Fracture behaviour of grain refined A356 cast aluminium alloy: tensile and Charpy impact specimens. *Convegno Nazionale IGF XXII*, Roma, Italia, pp. 314-321.

[13] STUNOVÁ, B. B. (2012). Strontium as a structure modifier for non-binary Al-Si alloy. In. *Acta Polytechnica*. Vol. 52, No. 4, p. 26-32.

[14] TILLOVÁ, E., CHALUPOVÁ, M., HURTALOVÁ, L. (2011). Evolution of phases in a recycled Al-Si cast alloy during solution treatment. Chapter 21: *The scaning Electron Microscopy*. Book edited by: Dr. Viacheslav Kazmiruk, pp. 411 - 438, INTECH.

[15] BOLIBRUCHOVÁ, D., RICHTÁRECH, L. (2013). Effect of adding iron to the AlSi7Mg0.3 (EN AC 42 100, A356) alloy. In: *Manufacturing Technology*, Vol. 13, No. 3, pp. 276-281.

[16] TRŠKO, L., GUAGLIANO, M., BOKŮVKA, O., NOVÝ, F. (2014). Fatigue life of AW 7075 Aluminium Alloy after Severe Shot Peening Treatment with Different Intensities. In. *Procedia Engineering*, Vol. 74. pp. 246-252.

[17] NICOLETTO, G., KONEČNÁ, R., FINTOVÁ, S. (2012). Characterization of microshrinkage casting defects of Al–Si alloys by X-ray computed tomography and metallography. In. *International Journal of Fatigue*, Vol. 41, pp. 39-46.

[18] KONEČNÁ, R., FINTOVÁ, S., NICOLETTO, G. (2011). Shrinkage pores and fatigue behavior of cast Al-Si alloys. In. *Key Engineering Materials*, Vol. 465. pp. 354 -357.

[19] *ASM Handbook*. (2002). Vol.15 - Casting. ASM International.

[20] VAŠKO, A. (2009). Analysis of the factors influencing microstructure and mechanical properties of austempered ductile iron. In: *Communications.* Vol. 4, pp. 43-47.

[21] Taylor, J. A. (2012). Iron-containing intermetallic phases in Al-Si based casting alloys, In. *Procedia Materials Science*, 1, pp. 19-33.

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