Effect of Ni addition and hot deformation on the microstructure and hardness of 3xx.x type alloys.

H. M. Medrano-Prieto[1], C.G. Garay-Reyes[1], R.Perez-Bustamante[1], I. Estrada-Guel[1], M.C. Maldonado-Orozco[1], R. Martínez-Sánchez[1*].

[1] Centro de Investigación en Materiales Avanzados (CIMAV), Laboratorio Nacional de Nanotecnología, Miguel de Cervantes No. 120, C.P. 31109, Chihuahua, Chih., México.

*Corresponding author: roberto.martinez@cimav.edu.mx.

A356 aluminum alloy is included in 3xx.x type alloys based in Al-Si system. They have excellent flow characteristics during casting due to Si content, high thermal conductivity, corrosion resistant, excellent strength/weight ratio and optimal combination of strength and ductility. The most important alloying element in addition to Si is Mg. Excellent mechanical properties of A356 alloy are obtained after T6 heat treatment, because to precipitation of β-Mg_2Si phase and others metastable phases. The main applications are in the automotive, aerospace and military industries. The typical microstructure of A356 alloy is formed by Al-α dendrites, eutectic Si particles, based-Fe intermetallics and Mg_2Si equilibrium phases [1]. Several authors have reported that some transition metals like Ni, Fe, Zr and V, which main characteristics are their low solubility in Al, have a positive effect in reduction of coefficient of thermal expansion and mechanical properties of 2xx.x and 3xx.x type alloys [2-4]. Additionally, it has also been reported than the modification of microstructure by hot forming process in 3xx.x type alloy, enhances the mechanical properties [5-7]. Therefore, this study evaluates the changes on microstructure and hardness due Ni additions, hot deformation and heat treatments in A356 alloy.

A356 alloy and those modified with Ni (1 and 2 wt. %) were deformed at 350 °C (50 %), solution treated at 535 °C for different times, quenching in water at 60 °C and aged at 180 °C for different times. Variations in the microstructure and hardness were characterized and evaluated by OM, DRX, SEM, TEM and micro-hardness HV. The Ni addition and the hot deformation have important effects on microstructure of A356 alloy; mainly in morphology, size and distribution of Al-α dendrites and eutectic Si particles. The hardness values increase with Ni content, hot deformation and aging process ~9% HV. Ni additions retard the overaging step.

References.

[1] Q.G. Wang, Met. Mater. Trans. A. 34 (2003) 2887.
[2] S.K. Shaha, F. Czerwinski, W. Kasprzak, J. Friedman, D.L. Chen, J.Alloys Compd. 615 (2014) 1019.
[3] W.S. Miller, L. Zhuang, J. Bottema, A.J. Wittebrood, P.D. Smet, A. Haszler, A. Vieregge, Mater. Sci. Eng. 280 (2000) 37.
[4] V.S. Zolotorevsky, N.A. Belov, M.V. Glazoff, Casting Aluminum Alloys, 1st ed. Elsevier, Oxford, 2007 (327–335).
[5] D.G. Mallapura, K. Rajendra Udupaa, S.A. Korib, Mater. Sci. Eng. A. 528 (2011) 4747.
[6] Kyuhong Lee, Yong Nam Kwon, Sunghak Lee, J. Alloys. Compd, 461 (2008) 532.
[7] A. Dodangeh, M.Kazeminezhad n, H.Aashuri, Mater. Sci. Eng. A. 558 (2012) 371.