Effect Mg Addition on Microstructure and Hardness of Al 2024 Alloy after Thermo-Mechanical Treatments

C.G. Garay-Reyes[1], I. K. Gómez-Barraza[1, 2], M. A. Ruiz-Esparza-Rodríguez[1], H. M. Medrano-Prieto[1], I. Estrada-Guel[1], M. C. Maldonado-Orozco[1, 2] and R. Martínez-Sánchez[1,*]

[1]Centro de Investigación en Materiales Avanzados (CIMAV), Laboratorio Nacional de Nanotecnología, Miguel de Cervantes No. 120, 31109, Chihuahua, Chih., México.
[2]Universidad Autónoma de Chihuahua (UACH), Facultad de Ingeniería, Circuito No. 1, Nuevo Campus Universitario, CP 31125 Chihuahua, Chih., México.

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

Aluminium alloys possess favorable characteristics which make them useful in a wide variety of application. Particularly, Al 2024 alloys are extensively used as structural materials in commercial airplanes; this is because to their good balance of properties including high specific strength, formability and corrosion resistance [1, 2]. It has been reported an increment on strength and hardness by Mg addition (< 2 wt. %); however, this is accompanied by a decrement in ductility and impact resistance [3]. By another hand, the mechanical properties of this alloy can be influenced by artificial aging and by plastic deformation, however, only few of thermo-mechanical treatments have been practically applied to Al alloys [4], in which the applied deformation is relatively small. The reason is to avoid the introduction of the non-uniform distribution of dislocation cell structures, which may act as nucleation sites of heterogeneous precipitation [4]. Although, in others studies a significant increment on the strength is achieved by relatively high cold deformation after solution treatment [5]. Therefore, the aim of this work is to evaluate the effect of Mg addition on microstructure and hardening of the Al2024 alloy after thermo-mechanical treatments.

The samples were hot-rolling at 460°C (50%) just after casting and were cold-rolling (5-15%) just after solution treatment at 495 °C, later they were artificial aging at 195 °C. Variations in microstructure and hardness were characterized and evaluated by OM, DRX, SEM, TEM and hardness. Effects on the microstructure of Al2024 alloy; mainly in morphology, size and distribution of precipitates is observed. The increment in hardness values after the Mg addition and plastic deformation provides evidence of three basic mechanisms: i) Strain effect, ii) Precipitation hardening, and iii) precipitates coarsening. The effect on precipitation is the main contribution at the hardening peak. Plastic deformation has an important effect on precipitation kinetics.

References.

[1] G.H. Bray, D.J. Chakrabarti, D. Denzer, J. Lin, J. Newman, G. Venema, C. Yanar, Patent No. US 8673209 B2, (2014).
[2] X. Xu, Y. Zhao, B. Ma, M. Zhang, J. Alloys Compd. 610, (2014) 506.
[3] A. Garg and J.M. Howe, Acta Met. Mat. 40 (1992) 2451.
[4] A.L. Ning, Z.Y. Liu, S.M. Zeng, Trans. Nonferr. Met. Soc. China 16 (2006) 1121.
[5] A Naimi, H. Yousfi, M. Trari, Mech. Time-Depend Mater. 17 (2013) 285.