doi:10.1017/S1431927616010795
Microsc. Microanal. 22 (Suppl 3), 2016

Microstructure and Mechanical Properties of Al_{2024} Alloy Modified with Mg and Zn Additions after Hot-Extrusion and Aging Processes

C.G. Garay-Reyes[1], M. A. Ruiz-Esparza-Rodríguez[1], E. Cuadros-Lugo[1], H. M. Medrano-Prieto[1], I. Estrada-Guel[1], M. C. Maldonado-Orozco[1] and R. Martínez-Sánchez[1]

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

The use of Al alloys in industry is increasing owing to their high strength/density ratios and other advantage properties; in addition, standard extrusion technology for high-strength Al alloys in T6 temper allows producing profiles of simple geometrical shapes. Because of its high yield strength and good fatigue resistance, the Al_{2024} is a commercial alloy used in the aerospace industry principally. The precipitation-hardening is the main strengthening mechanism due the precipitation of Al_2Cu (θ) phase. Additional alloying elements are being used seeking an increment on mechanical properties. Have been reported that Mg additions have a positive effect on the strength and hardness, However, has been reported a decrement in ductility and impact resistance [1]. On the other hand, by Zn additions, aluminum could be hardened by solid solution [2].

The aim of this work is evaluate the effect of Mg and Zn addition on the microstructure, precipitation kinetics and mechanical properties of Al_{2024} alloy after hot-extrusion and aging processes.

The Al_{2024} alloy fabrication with Mg and Zn additions (0.25, 0.50 and 0.75 wt. %) was made by conventional casting, the melt was degassed with argon gas (20 psi) for 5 min. 0.13 wt % of AlTiB was added as grain refiner. Modification with Mg was performed with addition of pure Mg (99.99 %). Modification with Zn was performed with the addition of a Zn-Al master alloy (Zn72.7-Al27-Cu0.2 Mg-0.1), commercially known as ZA27. The microstructural characterization was done using an optical microscope ZEISS model Scope A1, a SEM Hitachi model SU3500 and a TEM PHILIPS model CM-200. The mechanical properties were evaluated using tensile and hardness test in accordance with the ASTM standards.

The Fig. 1 shows representative images of Al_{2024} alloy and those modified with Mg and Zn (0.5 wt. %) after hot extrusion process (HEP) and solution heat treatment (SHT). In this figure it can be seen different microstructure in each characterized section (cross-equiaxed grains and longitudinal-elongated grains).

The Fig. 2 shows the effect hardening due Mg and Zn addition to the Al_{2024} alloy after HEP, it is evident the increase in the hardness by the addition of Mg and Zn. In addition, the age-hardening curves in the Al_{2024} alloy and those modified with Mg and Zn show a higher effect of age-hardening with Mg addition. The alloys modified with 0.50 wt. % (Mg-Zn) shown higher values of hardness.

The Fig. 3 shows TEM micrographics of Al_{2024} alloy and those modified with Mg and Zn (0.50 wt. %) after SHT and at the peak age-hardening (PAH). It is evident the difference between number density, size, spatial distribution and type of precipitates in the PAH of all samples.

It is concluded from results that, *i)* Mg and Zn additions directly affect the number density, size, spatial distribution and type of precipitates in Al_{2024} alloy after aging process; and *ii)* the hardening effect of Mg is more important than Zn, in both, age-hardening and hardening by solid solution.

References:

[1] A.Garg and J.M. Howe, Acta Met. Mat. **40** (1992), p. 2451.

[2] Ž. Skoko, S. Popović and G. Štefanić, Croatica Chemica Acta **82** (2009), p. 405.

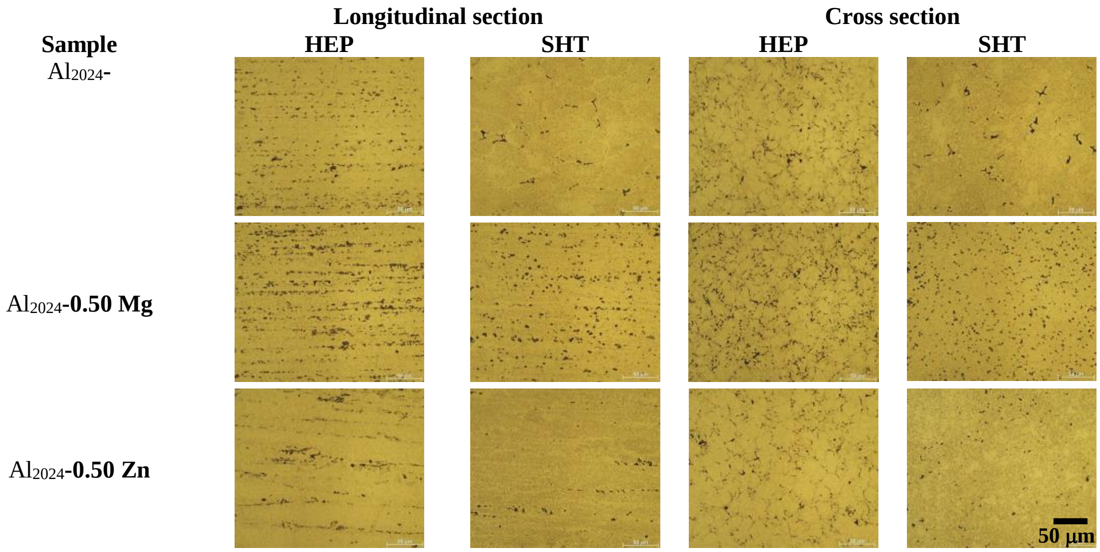

Figure 1. Optical micrographics of Al_{2024} alloy modified with Mg and Zn.

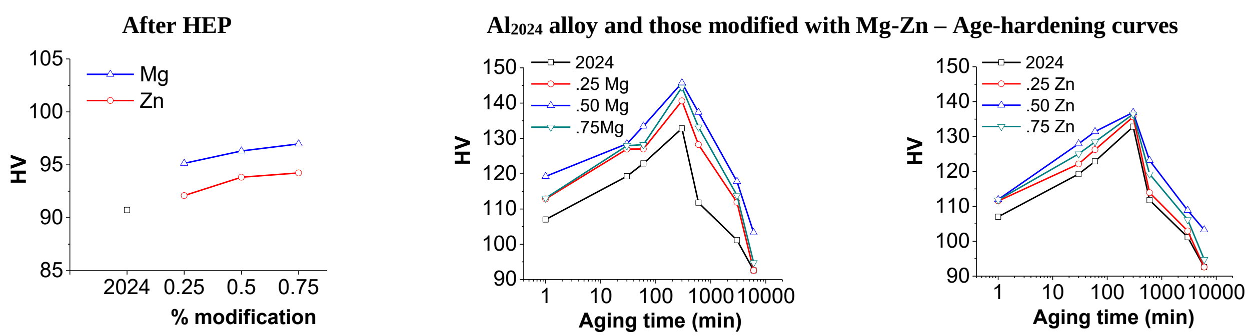

Figure 2. Age-hardening curves in Al_{2024} alloy and those modified with Mg and Zn.

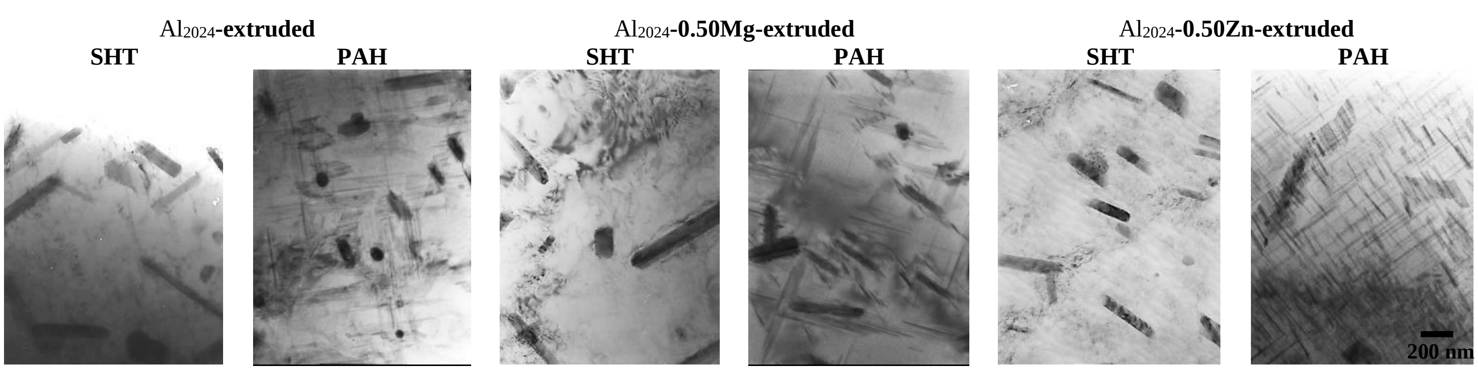

Figure 3. TEM micrographics of Al_{2024} alloy and those modified with Mg and Zn.