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Effect of Mg Addition and Solution Heat Treatment Time on Microstructure and Hardness of Al_{2024} Alloy

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Al alloys of 2xxx series (Al_{2024}) with high specific strength, good fracture toughness, and excellent fatigue properties have been found important applications in the aerospace industry. In commercial Al_{2024} alloys, Cu and Mg are the main alloying elements with small amount of Si and other minor elements such as Mn, Zn, Ti and Fe [1-2]. Nonetheless, has recently been reported an increment on strength and hardness by Mg addition (< 2 wt. %); however, this is accompanied by a decrease in ductility and impact resistance [3].the final mechanical properties are a direct function of experimental sequence, the target of this work is to evaluate the effect of Mg addition and solution heat treatment time and on microstructure and hardening during aging of the 2024 Al alloy (Al_{2024}).

The Al_{2024} alloy fabrication with 0.25 wt. % of Mg additions ($Al_{2024\text{-}0.25\ Mg}$) was made by conventional casting, the melt was degassed with argon gas (20 psi) for 5 min and AlTiB was added as grain refiner (0.13 % wt.). Modification with Mg was performed with addition of pure Mg (99.99 %). The solution heat treatment (SHT) was at 495°C for 3, 5 and 7 h. The cold-plastic-deformation treatment involved 5 % thickness reductions by cold-rolling and a final aging step (195°C) at several times. The microstructural characterization was done using a SEM Hitachi model SU3500 and a TEM PHILIPS model CM-200; XRD. The mechanical properties were evaluated using hardness test in accordance with the ASTM standards.

The microstructures of $Al_{2024\text{-}0.25\ Mg}$ alloy after SHT times of 3, 5 and 7 h are illustrated in Fig. 1. It is observed that in all SHT times, the segregation decreases when is compared with as-cast condition. However, Cu-rich phases remain undissolved. It is probable that a saturation of the aluminum matrix has been reached or longer SHT times are required. The Fig. 2 shows the effect of solution time on aging treatment, the HV values in samples with 5h of solution time are higher than 3 and 7h of solution time. The Fig. 3 shows the micrographs of Al_{2024} Alloy after SHT at 5h (a-b) and peak hardening (c-d). In the peak age-hardening is observed the presence of precipitates with the needle-type morphology. In addition, rod-like precipitates are identified.

The presence of Mg decreases considerably the Al_2Cu intermetallic phase and increases the presence of Al_2CuMg intermetallic phase. In addition, the plastic deformation allow a redistribution of solute elements (Mg-Fe), which facilitates the diffusion of these elements to the Al_2Cu intermetallic phase and the formation of Al_2CuMg and Al_7Cu_2Fe intermetallic phases

References.

[1] G.H. Bray *et al*, Patent No. US 8673209 B2, (2014).
[2] X. Xu *et al*, J. Alloys Compd. 610, (2014) 506.
[3] A.Garg and J.M. Howe, Acta Met. Mat. 40 (1992) 2451.

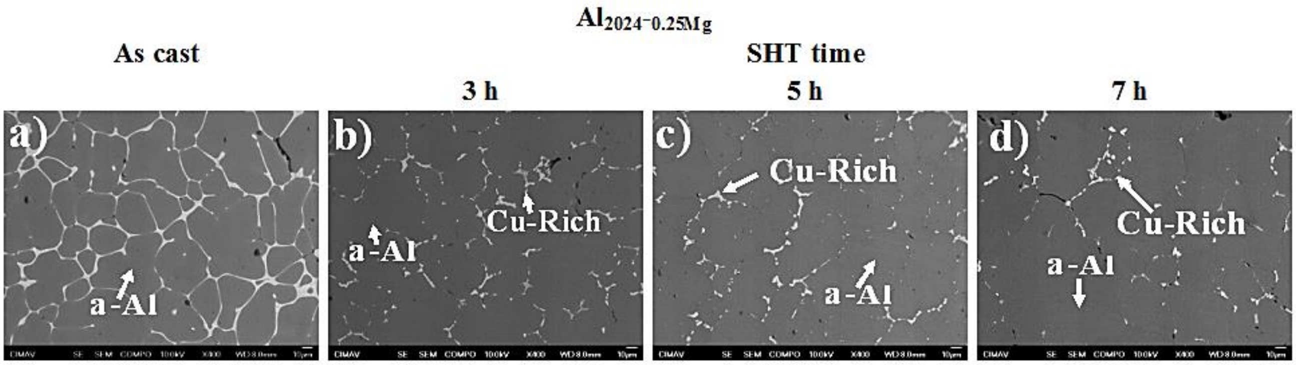

Figure. 1 SEM micrographs of $Al_{2024\text{-}0.25\ Mg}$ alloy in as cast condition (a) and after SHT for 3(b), 5(c) and 7h (d).

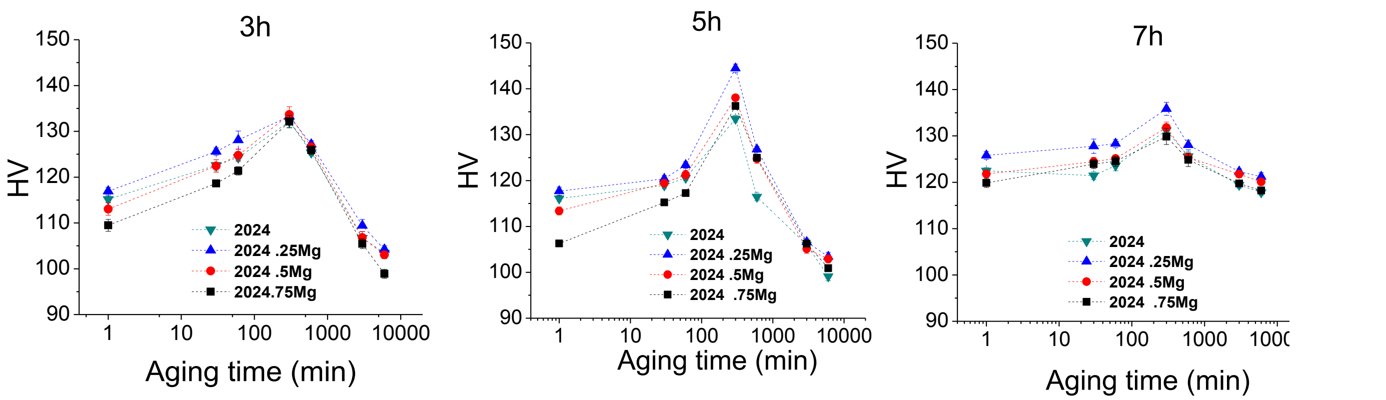

Figure. 2 Age-hardening curves in Al_{2024} alloy and those modified with Mg after SHT at 3 h, 5h and 7h and cold rolling (5 % and 15 %).

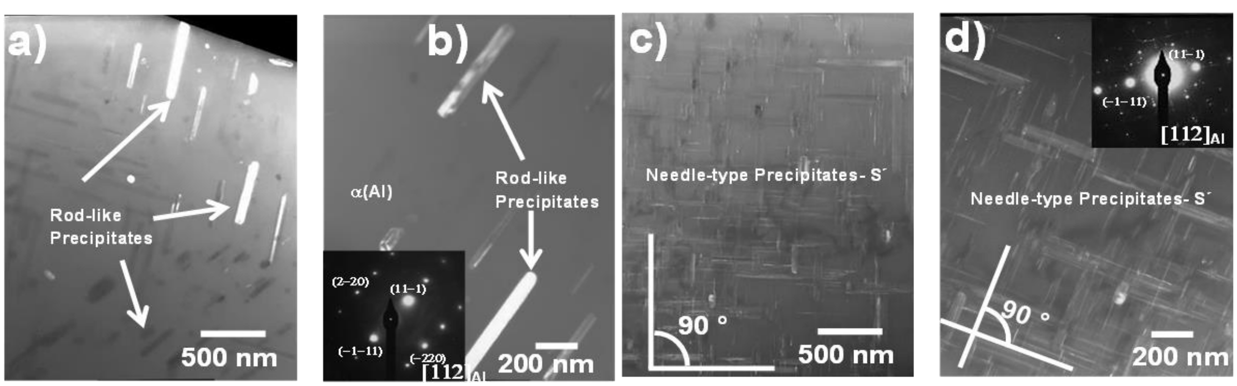

Figure. 3 DF-TEM micrographs and PDAS of Al_{2024} Alloy after SHT at 5h (a-b) and peak hardening (c-d).

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