398
doi:10.1017/S1431927617002677

Microsc. Microanal. 23 (Suppl 1), 2017

Microstructure and Hardness of $Al_{2024-0.25\ Mg}$ Alloy after Plastic Deformation

C.G. Garay-Reyes[1], I. K Gómez-Barraza[2], M. A. Ruiz-Esparza-Rodríguez[1], I. Estrada-Guel[1], J. P Flores-De los Ríos[2], M. C. Maldonado-Orozco[2] and R. Martínez-Sánchez[1]

[1]Centro de Investigación en Materiales Avanzados (CIMAV), Laboratorio Nacional de Nanotecnología, Miguel de Cervantes No. 120, 31136, Chihuahua, Chih., México.
[2]Universidad Autónoma de Chihuahua (UACH), Facultad de Ingeniería, Circuito No. 1, Nuevo Campus Universitario, CP 31125 Chihuahua, Chih., México.

Al alloys possess many favorable characteristics which make them useful in a wide variety of application. Particularly, the Al_{2024} alloys are extensively used as structural materials in commercial airplanes owing to their good balance of properties including high specific strength, formability and corrosion resistance [1, 2]. These properties are mainly important in the aerospace industry. These alloys are currently used in high volume manufacturing in the aerospace e.g. aircraft wing and fuselage structures are made of T3 and T4 Al_{2024} alloy sheet [1-2]. By another hand, the mechanical properties of this alloy can be influenced by artificial aging and by plastic deformation, such as equal channel angular pressing, high pressure torsion and cold rolling. However, only few of thermo-mechanical treatments have been practically applied to Al alloys, like heat treatment T8 of Al_{2024} and T9 of Al_{2A12} 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, it should be mentioned that a significant increase of the strength was achieved by relatively large cold deformation after solution treatment in others studies [5]. The aim of this work is evaluate the effect of plastic deformation on microstructure and hardening of the 2024 Al alloy (Al_{2024}) modified with 0.25 wt. % of Mg additions ($Al_{2024-0.25\ Mg}$).

The $Al_{2024-0.25\ Mg}$ alloy fabrication was made by conventional casting, the melt was degassed with argon gas (20 psi) for 5 min period and AlTiB was added as grain refiner (0.13 % wt.). Modification with Mg was performed with addition of pure Mg (99.99 %). The hot-plastic-deformation treatment consisted of 50% of thickness reduction by hot-rolling at 490°C, followed by a solution heat treatment (SHT) at 495°C and different times. The cold-plastic-deformation treatment involved 5 and 15 % 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 precipitates with rod-like shapes are analyzed by EDS-Maps-TEM and SADP-TEM (Fig.1). The results shown that the precipitates are rich in the elements Al, Cu and Mn allowing infer that they correspond to the T-phase ($Al_{20}Cu_2Mn_3$) with orthorhombic structure. Has been reported that the presence of this phase during the solution heat treatment have a positive role in promoting dislocation accumulation and grain refinement during plastic deformation, which increase the kinetic of the precipitation during aging. The Fig. 2 show the micrographs of the $Al_{2024-0.25\ Mg}$ alloy with 5 (1) and 15 (2) % plastic deformation under solution condition and peak age-hardening at 300 min. In the peak age-hardening is observed the presence of precipitates with the needle-type morphology. The peak age-hardening in $Al_{2024-0.25\ Mg}$ alloy show the presence of S´ precipitates (Al_2CuMg) with needle-type morphology. In addition, the apparent number density and size of S´ precipitates in sample with 15% plastic deformation are higher with respect to sample with 5% plastic deformation from its nucleation sites increases between the interactions of point defects such as dislocations and Mg atoms.

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.
[4] Ning AL, Liu ZY, and Zeng SM. Trans Nonferr Met Soc China 16 (2006) 1121.
[5] Naimi A, Yousfi H, and Trari M. Mech Time-Depend Mater 17 (2013) 285.

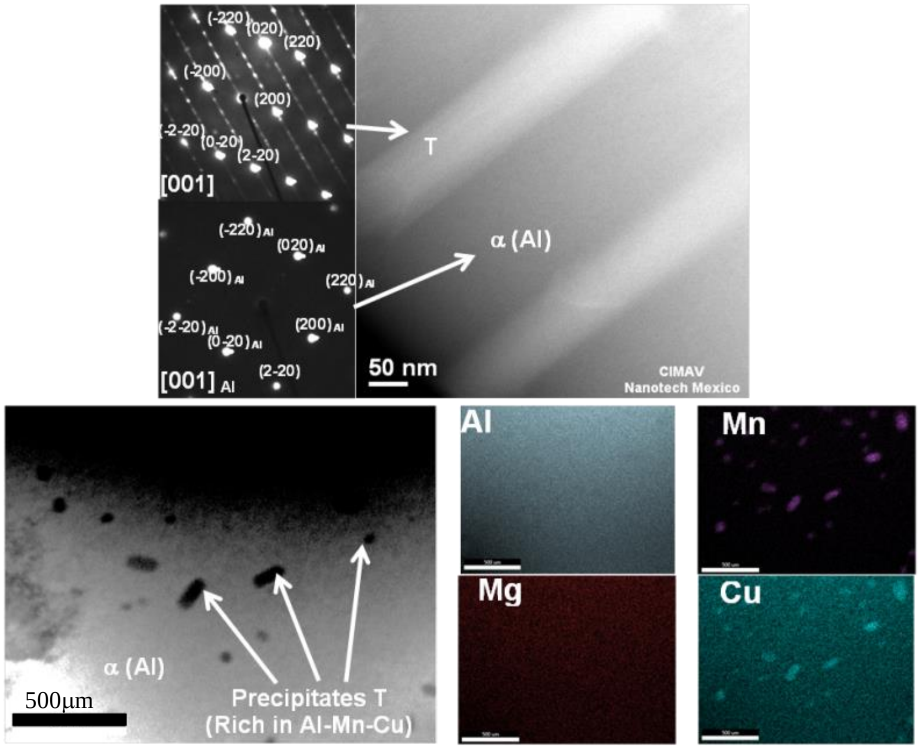

Figure. 1 SADP-TEM and EDS-Maps-TEM of the T phase in $Al_{2024\text{-}0.25\ Mg}$ alloy after SHT at 7h.

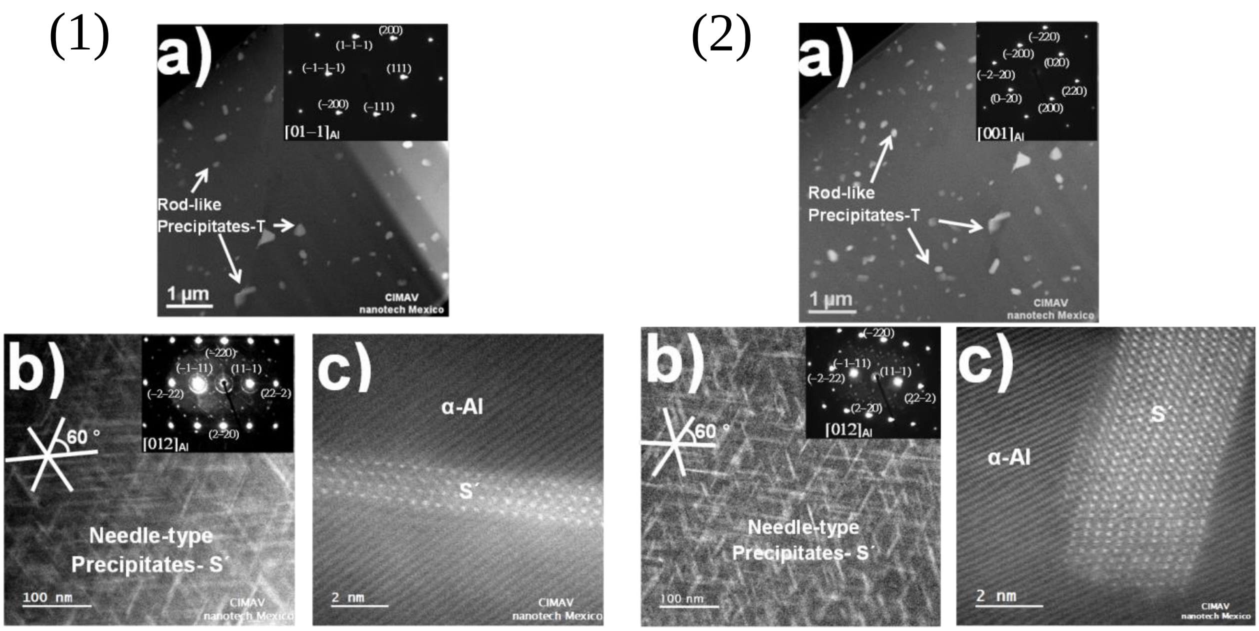

Figure. 2 STEM micrographs and PDAS of $Al_{2024\text{-}0.25Mg}$ Alloy with 5 (1) and 15 (2) % plastic deformation after SHT at 7h (a) and peak hardening (b-c).

https://doi.org/10.1017/S1431927617002677 Published online by Cambridge University Press