1430 Microsc. Microanal. 17 (Suppl 2), 2011
doi:10.1017/S1431927611008026

Characterization of Ag_CNP/Al_{2024} Composites Prepared by Mechanical Processing in a High Energy Ball Mill

C. Carreño-Gallardo[*, **], I. Estrada-Guel[*], M. A. Neri-Flores[*], M. Romero-Romo[**], C. López-Meléndez[*] and R. Martínez-Sánchez[*].

[*]Centro de Investigación en Materiales Avanzados (CIMAV), Miguel de Cervantes #. 120, C.P. 31109. Chihuahua, México.
[**]Universidad Autónoma Metropolitana, Departamento de Materiales, Av. San Pablo # 180, Col. Reynosa-Tamaulipas, CP 02200. D. F. México.

Aluminum-matrix composites have been synthesized by different methods including casting, spray atomization and codeposition, and powder metallurgy techniques, the last one can include: densification of mixtures of metal and ceramic powders or composite powders made by mechanical processing. The mechanical properties of these composites are significantly influenced by the concentration, distribution of the reinforcement particles and by the characteristics of the interface between the reinforcements and the matrix [1].

The aim of this work was to study the effect of carbon-coated silver nanoparticles (Ag_CNP) dispersed in an Al_{2024} and the effect of aging T6 treatment on the same alloy. Microstructural characterization is reported as a function of T6 treatment and the Ag_CNP concentration.

Aluminum alloy (Al_{2024}) reinforced with 0.0, 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0 wt. % Ag_CNP composite was produced by mechanical milling (MM). The milled products were cold compacted in a cylindrical die (6.5 mm in diameter), pressure less sintered at 773 K and consolidated by hot extrusion at 823K. Extruded samples were characterized after T6 heat treatment (768K 1 h, quenching, and aging at 463K 2h). After T6 temper, microstructural characterization was done in a high resolution transmission electron microscopy JEOL JEM-2200FS with a spherical aberration Cs corrector in the condenser lens. The mechanically milled, extruded and heat treatments composites show finer and homogenous distribution of reinforcement particles which give rise to better mechanical properties in consolidated products. Fig. 1a shows the Al-Cu precipitate morphology in the composite after aging, the tiny needle shaped precipitates are observed in the matrix co-existing with Ag_CNP. Fig. 1b shows the interaction of dislocation lines with reinforcement nanoparticles. Fig. 2 shows Ag_CNP found in grains as well as in grain boundaries, indicating no preference, EDS analysis found silver as main constituent of nanoparticles as well as magnesium, copper, manganese and aluminum from the precipitates and matrix. The Mn was found in a precipitate with a composition very close to $Al_{20}Cu_2Mn_3$, the precipitate was reported before by Robinson [2], and is identified as precipitate T. The Ag_CNP could pin grain boundaries to avoid the grain growth, causing grain boundary strengthening. The micrographs obtained by TEM show no agglomeration which can reduce the amount of effective nano-particulates available and the particle strengthening effect diminishes. It is expected that Ag_CNP will have an additional strengthening effect to the typical precipitation hardening occurring in Al_{2024} alloys.

References
[1] H. Lagace´, D.J. Lloyd, Can. Metall. Quart. 28 (1989) 145.
[2] Robinson: Philos. Mag., 1952, 43, 775–782. Al-Cu-Mn (Aluminium - Copper - Manganese).

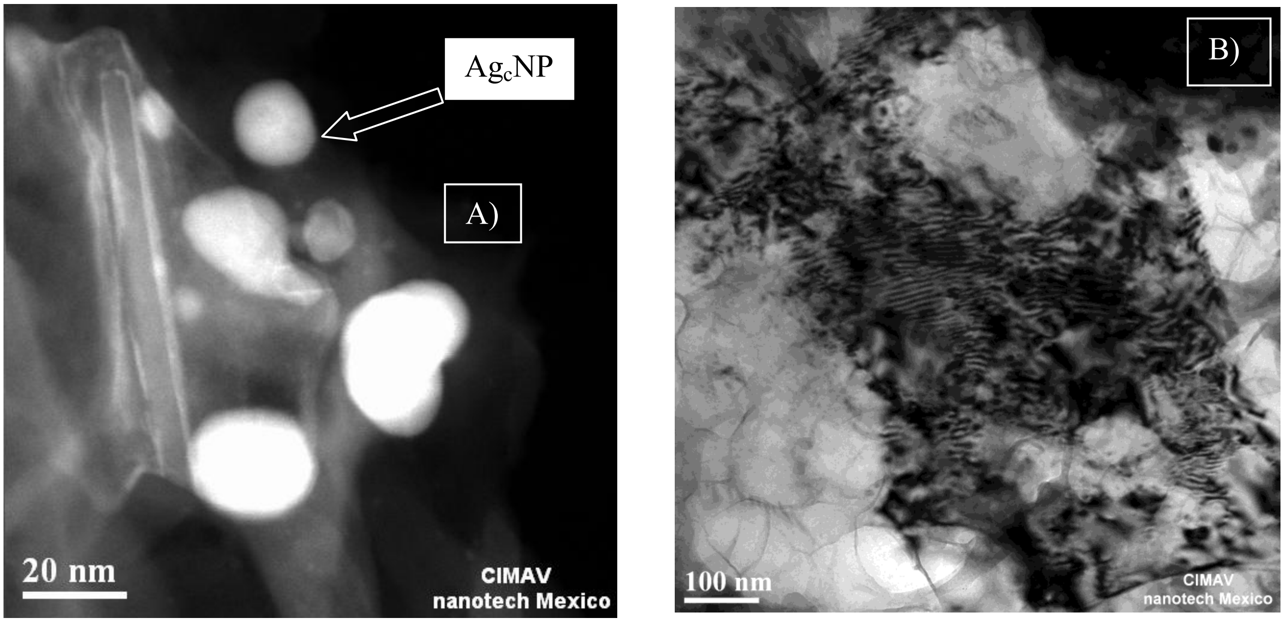

FIG. 1. Precipitates morphology co existing with Ag_CNP and dislocation interacting with Ag_CNP, aged at 463K

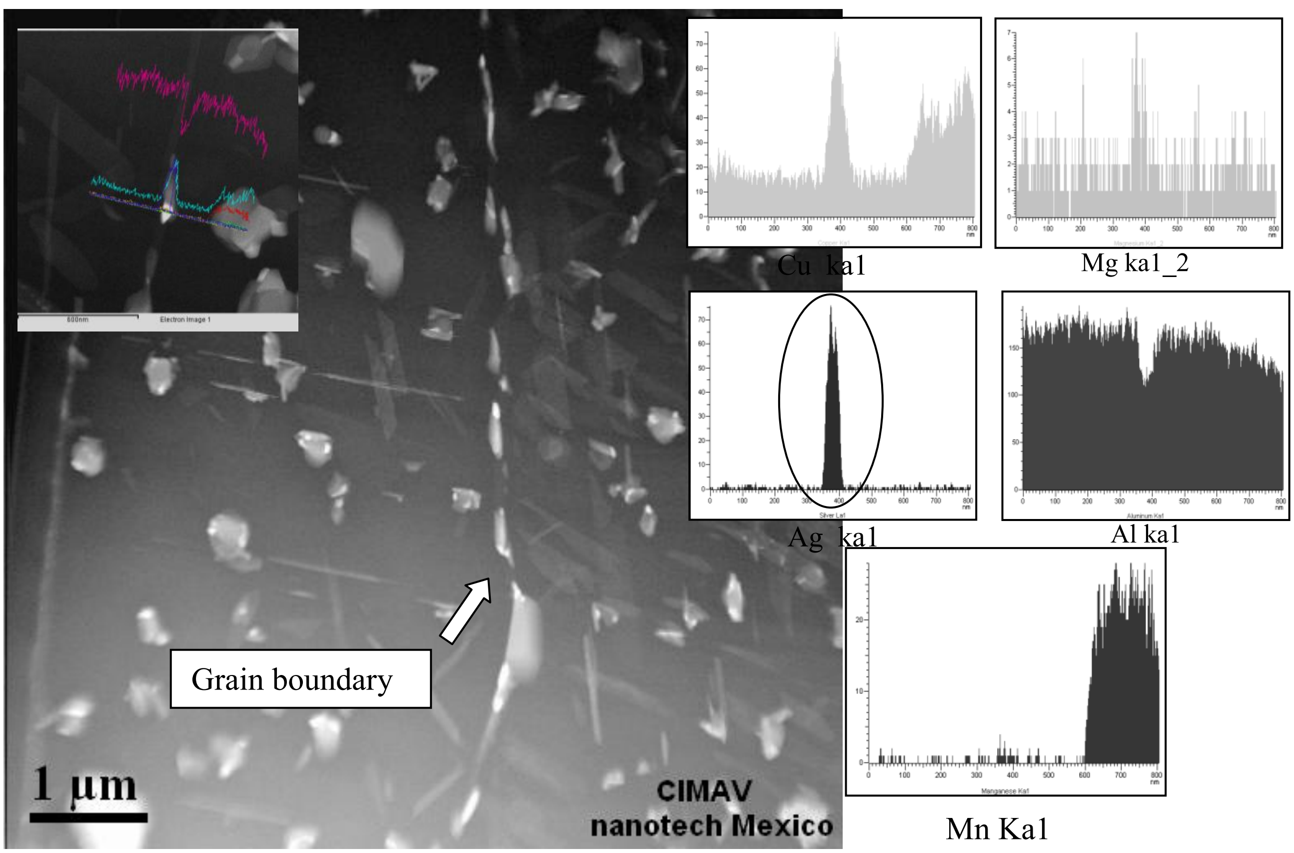

FIG. 2. Ag_CNP into grain boundaries of Al_{2024}-3.0%Ag_CNP composite aged at 463K.