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Al7075 Composites Reinforced with Al_2O_3 and CNT Particles

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Nowadays, composite materials have made possible the design of more efficient machines and equipment, due to the improvement in their physical, mechanical and chemical properties. This kind of materials have different structures and characteristics unlike simple materials, since the combination of different structures results in a material with properties that are very useful in engineering applications due to its high resistance and lightness [1]. Composites are solid-state materials that have multiple phases in the nanoscale range and are incorporated with nanometer-sized particles within the matrix of an alloy or metal.

Particularly, aluminum-based composite materials, as light materials, show attractive characteristics in engineering applications. However, the wide variety of reinforcement materials available today is a key factor in the synthesis of composites with an isotropic behavior. The particle size and homogeneous dispersion of reinforcement particles provide composites a good combination of mechanical strength, hardness, and wear resistance. Among reinforcing particles, alumina (Al_2O_3) particles and carbon nanotubes (CNTs) have proven their efficiency in the hardening of ferrous and non-ferrous alloys [2,3].

The present research involved the synthesis of aluminum composites reinforced with alumina nanoparticles and CNTs. For this purpose, a combination based on powder metallurgy routes and mechanical alloying was considered. The process of mechanical alloying (MA) was carried out in a high energy mill Spex 8000 mixer/mill. The mass of the powders was 8.5 g and a ball-to powder weight ratio was 5:1. All millings runs were performed with methanol as process control agent with argon was as inert milling atmosphere. The milling time was set 5 h. The alumina and nanotubes concentration was set to 5.0 wt.%. The microstructural behavior was screened by scanning electron microscopy and X-ray diffraction patterns.

Fig. 1 shows SEM results of the particle size evolution of the powders as function of CNT (Fig. 1a) and Al_2O_3 particle (Fig. 1e) concentration. A notorious particle size reduction is observed in composites modified with CNTs (Figs., 1 b-d) whilst the alumina nanoparticles does not significantly affect the size and morphology of the as-milled powder as function of the content (Figs. 1 f-h). The analysis of the cross-section of the Al7075 alloy and its composites is shown in Fig. 2 (a-c). A homogeneous dispersion of the particles and nanotubes is evident as result of a homogeneous distribution carried out during milling process [3,4]. This effect can be corroborated in Fig. 2d, that display XRD results corresponding to the as-milled powders. The characteristic peak attained to the aluminum signal can be observed, with no other visible peaks attained to alumina nanoparticles nor nanotubes. The current research work of the present group is the microstructural and mechanical characterization of these group of composites under different heat treatments.

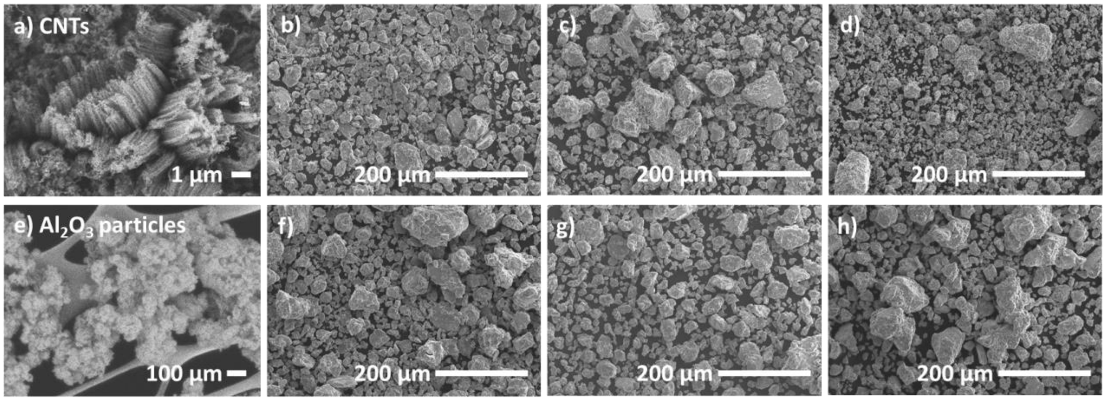

Figure 1. Secondary electron SEM micrographs of (a) CNTs. Al7075 composites reinforced with (b) 0.5, (c) 2.5 and (d) 5.0 wt. of CNTs. (e) Alumina nanoparticles. Al7075 composites reinforced with (f) 0.5, (g) 2.5 and (h) 5.0 wt. of alumina nanoparticles

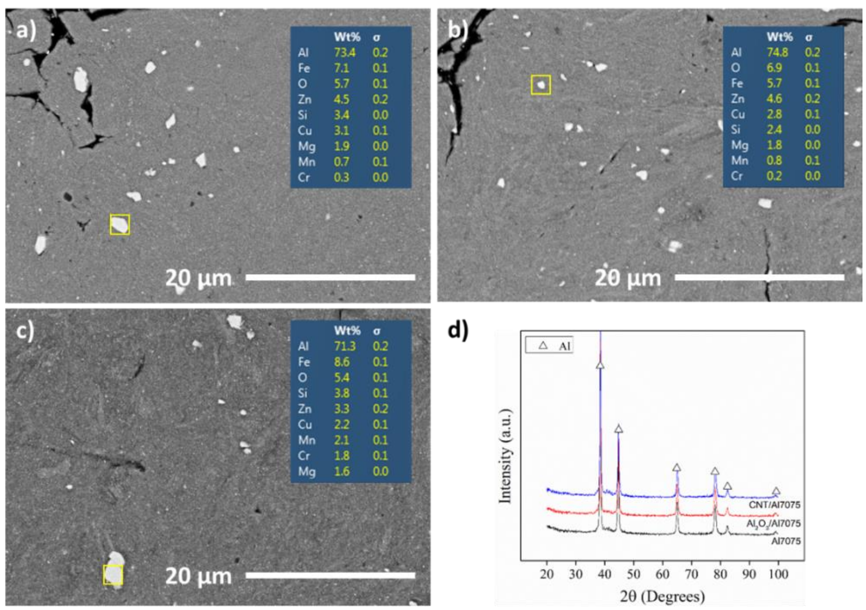

Figure 2. Backscattered electron SEM micrographs of the cross-section of the (a) Al7075 alloy (b) Al_2O_3/Al7075 composite, (c) CNT/Al7075 composite, and (d) XRD results of the Al7075 and its composites.

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