Al2024-CNTs composites produced by milling process

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The use of carbon nanotubes (CNTs) for the development of composites produced from a metal matrix has attracted the attention of the scientific community in recent years. In this aspect, aluminum alloys, have been of particular interest due to their strength/weight ratio. Mechanical milling process provides an excellent route toward a homogeneous dispersion of CNTs into aluminum alloys, leading to a subsequent enhancement in their mechanical properties.

In this work, CNTs synthesized by chemical vapor deposition (CVD) were dispersed into a 2024 aluminum alloy (Al2024) synthesized from elemental powders. CNTs were added in concentrations of 0.0-5.0 wt.% and dispersed into the aluminum matrix by means of mechanical milling. The selected milling times were from 5 to 30 h. The powders obtained from the milling process were cold consolidated by uniaxial pressure followed by pressure-less sintering under argon atmosphere at 500ºC for 2 h. The microstructural characterization of the composites was carried out by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM). The mechanical characterization was done through the microhardness test.

Three phases were observed after sintering treatment. The first one is an aluminum solid solution, the second one involves the interaction between Al and Cu forming Al2Cu phase detected by XRD and corroborated by SEM, and the last one, was produced by the interaction between Al and the CNTs to crystallize the Al4C3. The signal intensity of the aluminum carbide observed in the XRD spectra is a function of the CNTs concentration. Aluminum based composites are under TEM characterization. The CNTs presence in the composites after 30 h of milling was corroborated by SEM and TEM.

Results from microhardness measurements show that the composite with 20 h of milling and 5.0 wt.% of CNTs has 291 units of hardness (µHV), which represents an increase of 238 % over the unreinforced alloy prepared by the same route (86 µHV). It is important to note that after milling process, the composites studied in this work, present several strengthening mechanisms, solid solution, grain refinement, and CNTs as well as aluminum carbides strengthening dispersion. All of them contributing to the improvement of the mechanical behavior of the composites here studied. It is expected that an additional T6 temper increase the mechanical resistance reached in these composites.

Keywords: aluminum composite, nanometric, mechanical properties, microstructural.

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