Influence of Reinforcement Particles Addition and Processing Intensity on the Mechanical Properties in an Al-7075 Composite Produced by Mechanical Milling

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Aluminum is the second most commonly used metal after iron. On account of its easy formability and light weight, it has a great diversity of industrial applications, but the use of these alloys is limited due to their relatively low yield stress. Increase aluminum strength for selected applications has motivated the study of aluminum matrix composites (AMC). Reinforcement particle additions improve mechanical and frictional properties of monolithic metallic materials as Young's modulus, strength, and wear resistance with a very small increase in density. Mechanical milling (MM) is a method of producing a fine and homogenous distribution of these stable hard particles within the matrix and avoids some problems related to melting and solidification process.

The aim of this paper is to study the influence of the graphite addition and milling intensity on the final mechanical properties of dispersion strengthened alloy.

AMC´s were prepared by a powder metallurgical route from elemental powders. The studied matrix was an Al7075 alloy reinforced with 0, 1 and 2 wt. % of metallized graphite (MG). As-mixed powders were milled in a high-energy Simoloyer mill for 0, 2.5, 5.0 and 10.0 h intervals under argon atmosphere. Green bulk products were prepared by pressing the powders at 460MPa under uniaxial load, sintered at

773K and hot extruded. Hardness tests were reported in Brinell scale using the ASTM E-140 convention table. Tension tests were carried out in the longitudinal (extrusion) direction with bone shaped samples in accord with ASTM B557M standard.

Since powders size tended to decrease by MM processing, it is clear that both, the matrix and reinforcement particles were fracturing and mixing. With further milling the fragmented particles are captured by the welding particles and confined into the welding lines obtaining the so called lamellar structure. This process induces a microstructural refinement where formation of a structure with composite particles uniformed distributed into the metallic matrix can be achieved, as can be observed in Fig. 1.

The mechanical results of the tensile test and hardness measure for the composites are reported in Figure 2. The samples were tested without heat treatment and compared with a 7075 commercial alloy in T651 and T735 temper. Hardness value in 2%MG sample milled 5 h, shows an increase of 20% compared with the blank (un-milled and un-doped Al7075). Milling time and MG addition have an effect on hardness after hot extraction. By the other had, in the strain plot one can be see that the milling process lead to a 40% increase of the ultimate tensile strength in 2%MG sample compared with the blank. In addition, the as-milled sample (without MG addition) is almost 20% harder than the as-mixed sample. It is evident that the tensile properties found in the as-milled composites were reduced by the MG addition. Sample milled 2.5 h with 2%MG addition presented the lowest value compared with the as-milled samples

The poor tensile properties for the as-mixed composites could possibly resulted from the low contact area between the matrix alloy and the reinforced particles, required for suitable plastic deformation, as well as the elongated shape of the composite powders. In addition, porosity is also an important factor in the decrement of mechanical properties. On the other hand, homogeneous and fine dispersion of the reinforcement is more likely to contribute to the improvement of the tensile strength, because of the homogeneous stress dispersion associated with a favorable microstructural arrangement.

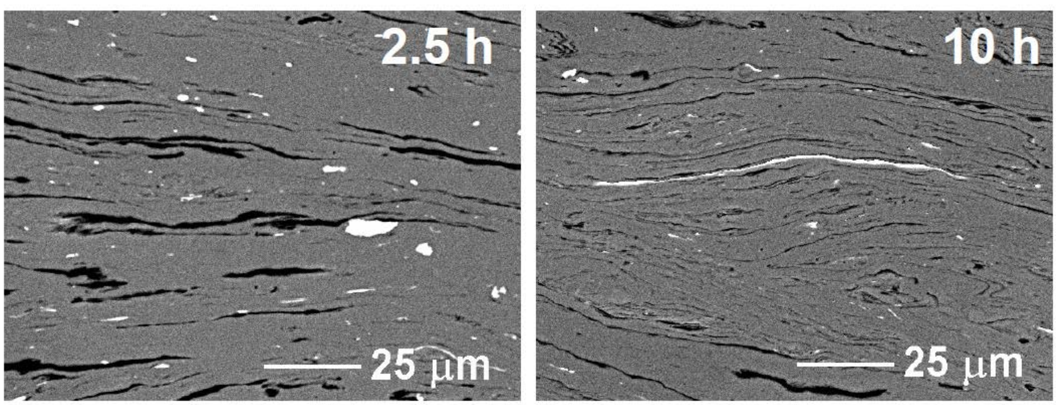

Fig.1. SEM Micrographs of Al_{7075}-0%MG alloy with different milling intensities. This images shown the Zn (bright dots) distribution along the matrix is more homogeneous and particles present a lower final size as the milling time increases

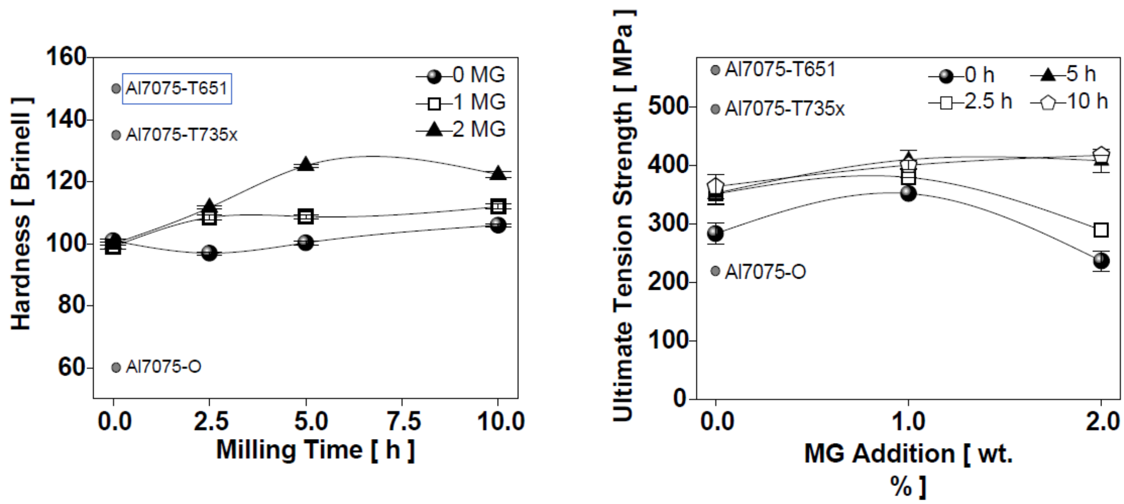

Fig. 2 Graphs of mechanical properties of Al-based composites as a functions of milling time and MG additions. a) Hardness Brinell vs. milling time, b) Ultimate tension strength vs. MG concentration

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