Effect of Metallized Graphite Addition and Milling Intensity on Final Powder Morphology in an Aluminum 7075 Composite

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Aluminum and its alloys have a wide diversity of industrial applications because of their light weight, and high corrosion resistant. In general, they are used more often than any other metal, except steel. But their potential applications are limited by their low yield strength. Recently, the interest to increase aluminum strength for applications in demanding industries has motivated the study of aluminum matrix composites (AMC) strengthened by hard particles dispersion. Generally, a decrease of the reinforcement particle size induces an increase on the mechanical strength of the composite. By Mechanical milling (MM) technique, it is possible to produce a fine and homogeneous distribution of hardening particles with a very fine particle distribution. The amount that the dispersoids strengthen the final composite it depends mainly on particle type, size, morphology, volume fraction and its distribution into metallic matrix.

The aim of this work is to produce an AMC, and evaluate the effects of additive concentration and milling intensity on resulting powder characteristics. The selected system was a 7075 aluminum alloy (Al_{7075}) doped with metallized graphite particles

(MG), at three concentrations (0, 1 and 2%wt). The MG was produced from graphite powder and metallized with copper by mechanical milling in a high energy SPEX mill during 8 hours. Composite powders were produced milled the as-mixed powders in quantities shown in Table 1, in a high energy CM01 Simoloyer mill for three milling intervals (2.5, 5 and 10 h) under argon atmosphere. A ball-to-powder ratio of 20 was set in all runs. Methanol was used as milling process control agent.

Figure 1 shown SEM images that present the effect of milling intensity on the morphology of the unreinforced Al_{7075} powder. The original particles (a) exhibit a semi-spherical shape with a moderately broad size distribution. After milling (b), the particles were plastically deformed; the size was increased extremely and forms larges agglomerates. Micrograph (c) shown the initial fragmentation of the flakes, particles present sharp edges and cracks near of the borders. With further milling time (d) flattened particles are broken to smaller pieces by activation of fracture process (hardened to a critical value). Figure 2 present a general morphology of Al_{7075}-1%MG (A) and 2%MG (B) milled powders. The sequence of milling steps is rather similar to the elemental powders mixture (a-d). The reduction in the particle size indicates that a strong conminution of the material has occurred and provokes a shift of the size distribution to lower values.

High density values found in as-mixed samples (Fig. 3) are characteristic of spherical morphology, where powders pack densely. On the other hand, flattened particles in early stage of milling yield a lower density values due to bridges formation in addition these particles fit randomly and thus do not provide good powder packing. It is evident a progressive density increment as the milling and MG concentration increases, as a result of a change in the particle morphology from flake-like to irregular.

In consistent with the results of morphological study, the variation of the density versus milling time indicates severe plastic deformation of the aluminum powder during milling to form flake-like particles with low density in early stages of processing; reinforcement particles accelerate the milling process of aluminum matrix and consequently the rate of density changes increases considerably, reached a stable state condition with higher milling intensity (10 h)

Table 1. Elemental composition of Al_{7075} alloy prepared powders and characteristics of starting materials [% wt/wt].

	Zn	Mg	Cu	Cr	Al	MG
Al_{7075}	5.6	2.5	1.6	0.23	Bal.	0 - 2
Purity	99.799.8		99	99	99.5	99

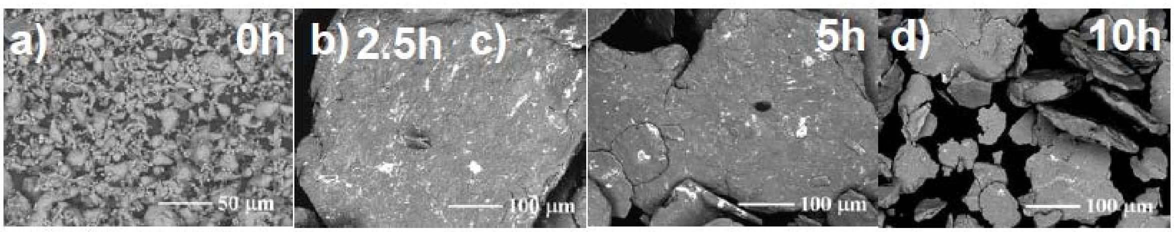

Fig.1 SEM micrographs (BE) showing milling intensity effect on the morphology of the unreinforced Al_{7075} particles.

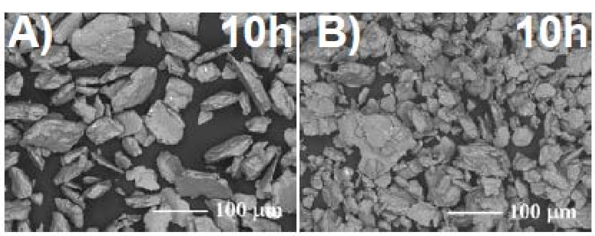

Fig. 2 SEM images of Al_{7075}-1%MG (A) and 2%MG (B) milled powders.

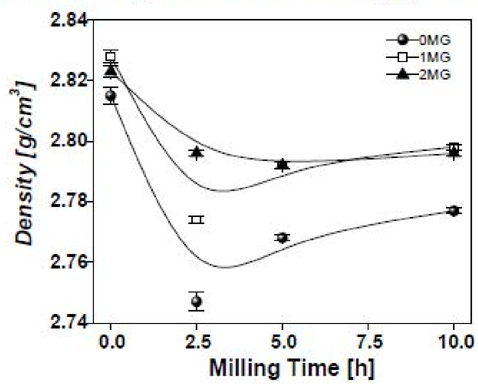

Fig. 3 Graph of powders density as a function of milling time.