doi:10.1017/S1431927619013874
Microsc. Microanal. 25 (Suppl 2), 2019

Wear Behavior in Al-Cu-Mg Alloy Reinforced with WC Particles Fabricated by Mechanical Alloying

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Aluminum alloys are attractive alternatives to ferrous materials for tribological applications due to their low density and high thermal conductivity. However, their uses have been limited by their inferior strength, rigidity and wear resistance [1]. In this regard, aluminum alloys are strengthened with different reinforcing particles (carbides, oxides, nitrides, etc.). Outstanding properties of these materials such as refractoriness, high hardness, wear resistance make them appropriate for use as reinforcement in matrix of composites [2]. Aluminum matrix composites reinforced with carbides have found extensive use in transportation engineering application due to their high specific strength and high specific modulus [3]. However, despite numerous reports on the wear behavior of Al alloys, there has never been Al-Cu-Mg system reinforced with WC particles investigated. The main objective of this research was investigated wear behavior by means of pin on disc test of Al-Cu-Mg system reinforced with WC particles adding in different amount 1, 2 and 3 %wt.

The composite powders were fabricated by mixing simultaneously elemental powder in the appropriate percentage to obtain chemical composition of Al-4Cu-1.5Mg alloy with 1, 2 and 3 wt.% of WC. The process of mechanical alloying (MA) was carried out in an E-max mill. The milling device and milling media used in the experiments were made from hardened steel. The mass of the powders was 50 g and a ball-to powder weight ratio was 4:1. All millings runs were performed with N-heptane as process control agent and argon was used as inert milling atmosphere. The milling time was set 3 h, powders were compacted and then sintered for 3 h at 500 ^{o}C under argon atmosphere and hot extruded into 10 mm-diameter bars by indirect extrusion with an extrusion ratio of 16. Specimens underwent the sliding wear tests against SiC abrasive papers of 220, 320 and 400 of grit. Load of 1.0 N was transferred directly to the specimens with the use of the pin. Tests were carried out at room temperature using water with a disc rotating at fixed speed of 2m/s against the samples. The total sliding distance was of 300 m and measurements in the weight of the specimens were taken every 100 m. The abrasive paper was conserved during the whole sliding distance and water was used as lubricant in order to prevent deterioration of abrasive SiC papers. The samples were ultrasonically cleaned in methanol, and weighted in order to calculate the volume loss of the specimens in each interval of the test. The microstructure study after metallographic preparation was performed by SEM. The magnitude of the measured wear is in function of the volume loss in regular intervals of 100 m in a total length of 300 m.

Figure 1 shows SEM micrographs of the worn surfaces for a) Al-Cu-Mg and c) Al-Cu-Mg - 3%wt. of WC. Also shows mapping for same samples where it is appreciated reinforced particles (WC). In figure 2 a linear behavior between volume loss and sliding distances is observed. Although a great difference is not appreciating between base alloy and composites this is due to the distance are short, therefore, with distances longer the difference could be more appreciable due to linear behavior.

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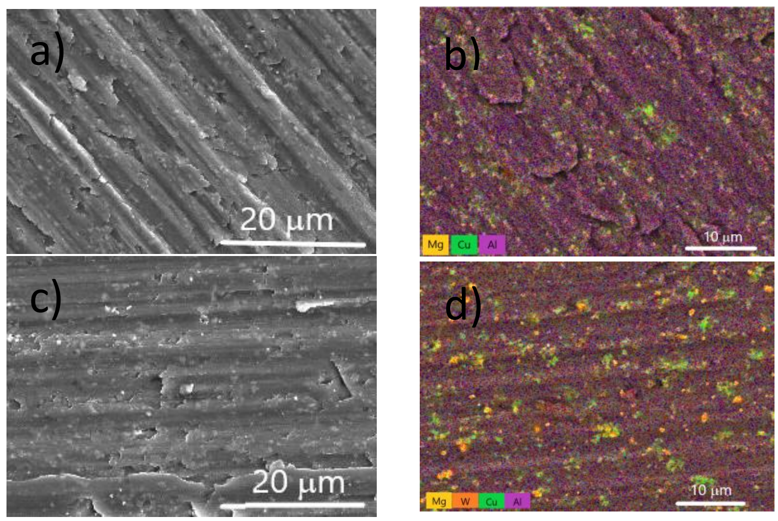

Figure 1. SEM micrographs and elements mapping of samples Al-Cu-Mg (a-b) and Al-Cu-Mg - 3% wt. of WC (c-d) after pin on disc test with load of 1.0 N, sliding distance of 300 m and #400 SiC abrasive papers.

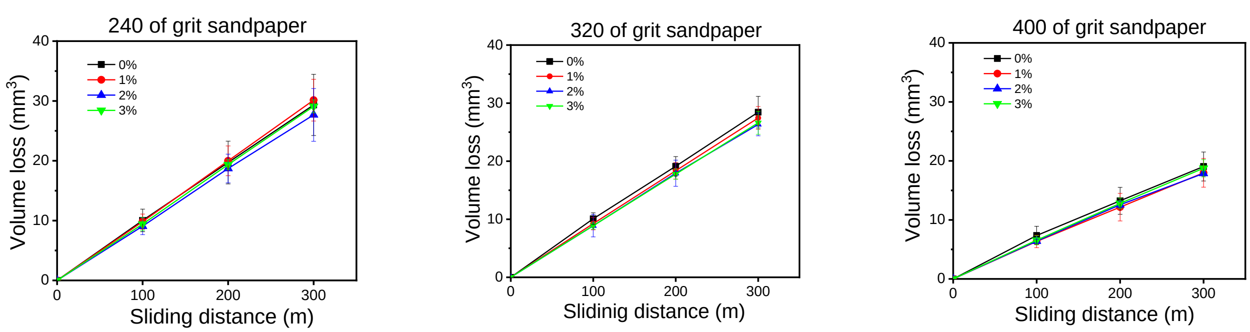

Figure 2. Wear behavior of the samples Al-Cu-Mg and Al-Cu-Mg/WC (1- 3% wt.) after pin on disc test with load of 1.0 N, sliding distance up to 300 m and different abrasive grit SiC papers.

https://doi.org/10.1017/S1431927619013874 Published online by Cambridge University Press