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Effect of B_4C Particles Addition on the Microstructure and Mechanical Performance of Some Aluminum-Based Composites

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The addition of ceramic particles in light alloys provides an interesting route to economically produce particulate metal matrix composites (MMCs) with improved mechanical properties at room and elevated temperatures modifying their physical properties, being attractive for electronic and structural applications. Boron carbide (B_4C) has many attractive properties, such as: low specific gravity, high hardness, high elastic modulus and good chemical stability [1–3]. All these characteristics become B_4C an excellent candidate as reinforcement phase for MMCs used on structural applications. Boron carbide-aluminum composites with low density and high toughness have wide applications, as light and hard disc substrates, brakes with high wear resistance, disc drives actuators and armor plates with high ballistic efficiency [4]. Mechanical milling (MM) can provide the combined advantage of significant grain refinement and homogeneous distribution of the reinforcement particles. It has already been demonstrated as a feasible method to synthesize nanostructured Al-based powder mixed with ceramic particles.

The purpose of the present work is to produce the B_4C particle reinforced MMCs by MM, examine the bending problem after the incorporation of B_4C particles in 2024 aluminum alloy and investigate the effect of B_4C particles concentration and size on the microstructure, density and hardness of prepared samples.

Commercial AA2024 alloy powder with Cu (~4), Mg (~0.83), Fe (~0.21), Mn (~0.67), Si (~0.12) and Cr (~0.03) as the primary alloying elements (in wt.%) and B_4C powder (density: 2.50 g/cm^3, hardness: 4949 kg/mm^2) were used as the starting material. The powder of the two materials was mixed together at a ratio of 5:1 (B_4C:AA2024) in weight, 10 drops of methanol were used as a process control agent in all milling experimental tests. Argon was used as an inert atmosphere during milling to avoid metal oxidation.

The microhardness of the consolidated composites and the pure AA2024 alloy is presented in figure 1. After consolidation, the microhardness of matrix increased to about 120 ± 3 for MMCs-4%, 216 ± 4 for MMCs-1% these values are almost twice of the pure AA2024 sample. These results indicate that both, MM processing and B_4C addition can significantly improve the microhardness of the alloy.

Two SEM images of reinforced composites microstructure with different sizes: 4 and 10 μm are shown in figure 2. The properties of the MMCs depend not only of matrix, particle size and weight/volume fraction but also of reinforcement particle distribution and interface bonding between the reinforcement particle and the matrix. Based on the above evidence, we can conclude that the key factor for the fabrication of MMCs with improved properties is the uniform dispersion of the reinforcements.

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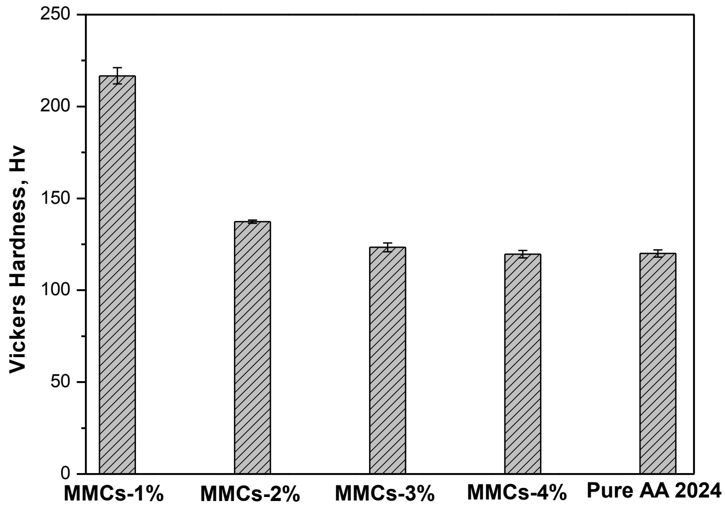

Figure 1. Microhardness of the consolidated MMCs and pure AA2024 alloy. The microhardness value of MMCs-1% is almost twice in comparison with pure alloy.

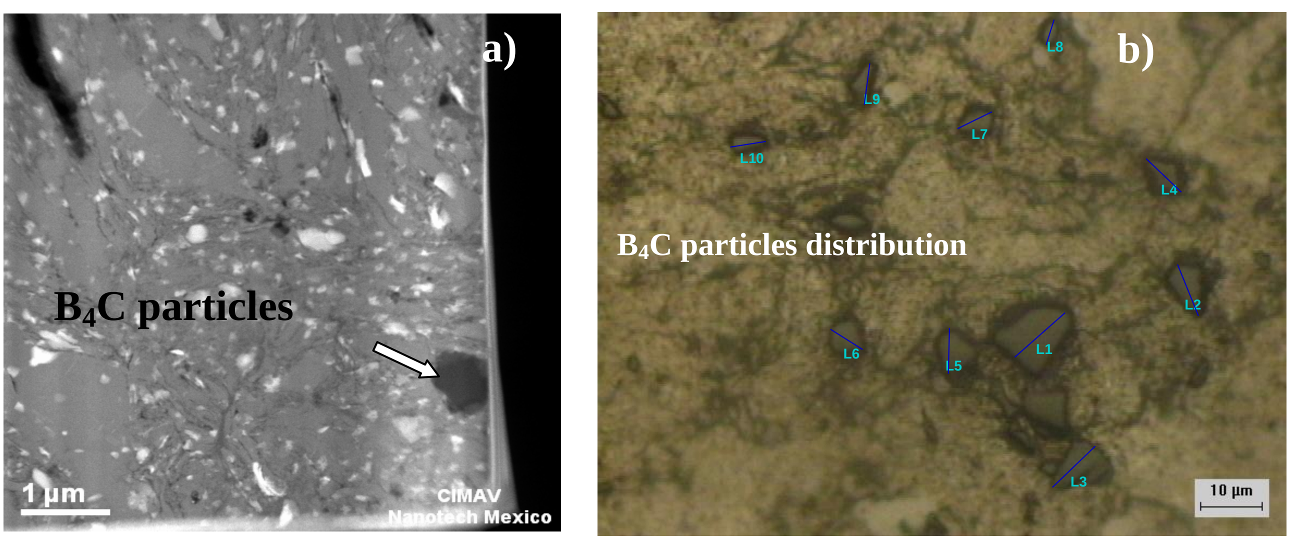

Figure 2. Image (SEM) showing a B_4C particle (a) and reinforcement distribution in an AA2024–B_4C composite (b).

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