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Study of Microstructure and Hardness in A356 Aluminum Alloy Reinforced with Al_2O_3 and WC After Hot Extrusion.

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The A356 alloy system has as a principal alloying element the silicon, where the high levels of such element (4.0–13%) generate excellent casting characteristics [1]. In order to expand its application range, a method commonly used is reinforcing with hard particles to improve the mechanical properties [2]. A wide variety of reinforcements have been used as Al2O3, among others; however, only a few studies have focused on the use of heavy refractory reinforcements [3]. Stir casting is a method of manufacturing composite materials in a liquid state, in which a dispersed phase (reinforcing) is mixed with a molten matrix metal by mechanical stirring. The liquid composite material is then molded by conventional molding methods and can also be processed by conventional metal forming technologies [4].

A356 commercial alloy was selected as a starting material and used for the metallic matrix. Al2O3 and WC with particle sizes of 0.3 μm and 0.8 μm were used as reinforcing particles. The A356 alloy was placed into the graphite crucible in the resistance furnace and then heated to 740 °C. After the A356 alloy was completely melted, the reinforcing particles were poured into the liquid metal and stir to manufacture the alloys with 3 wt.% of reinforcing (A356-3Al2O3 and A356-3WC). After that, each alloy was degassed for 5 min using argon gas (20 psi) and a graphite propeller at 180 rpm. Then samples were hot extruded into 10 mm-diameter bars by indirect extrusion with an extrusion ratio of 16. The microstructural characterization was carried out by scanning electron microscopy HITACHI SU3500, and the evaluation of Rockwell B hardness was carried out in a Wilson C503-R tester.

Figure 1 shows the differences in the microstructure of an A356 alloy extruded and with reinforcement particles. A minimum porosity and a homogeneous distribution of the reinforcing particles were observed. Besides, analysis of Rockwell B hardness values showed that the hot extrusion process reduces hardness, but also, it was found A356-3WC composite got higher hardness measurements that the other compound extruded (Figure 2), so it was concluded that the WC is an excellent candidate to reinforce alloy A356.

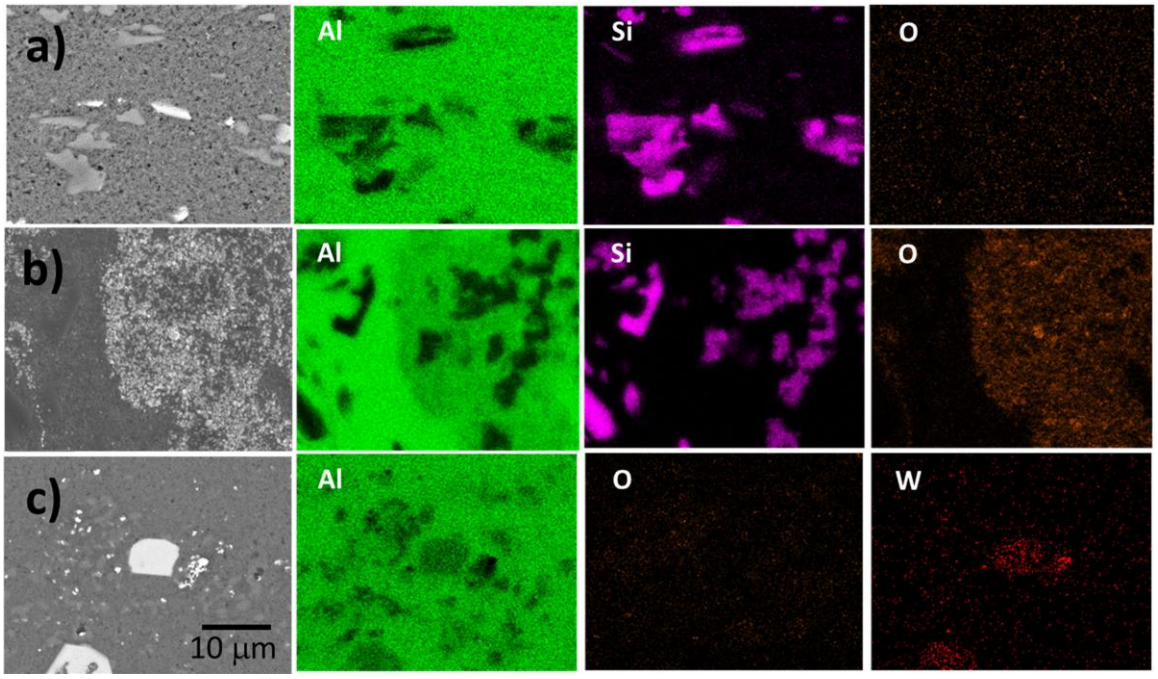

Figure 1. MEB Micrographs, and the corresponding EDS analysis (map of elements distribution) for A356 (a), A356-3Al2O3 (b), A356-3WC (c) samples.

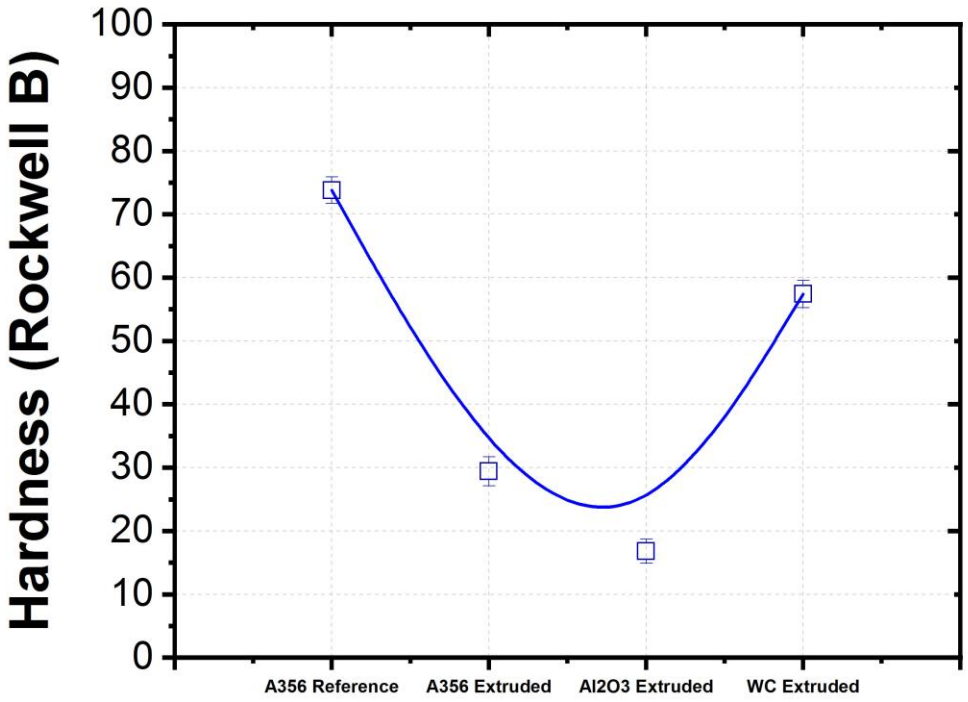

Figure 2. Rockwell B hardness values obtained in the A356 alloy and those alloys modified with 3 wt. % of Al2O3 and WC.

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