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Hot extrusion of an aerospace-grade aluminum alloy modified with rare earths

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Reinforcing aerospace-grade aluminum alloys with rare earths, offers high potential for increasing their specific strength and young´s modulus [1]. Specifically, Ce/La rare earths, provides interesting mechanical characteristics in the synthesis of advanced materials though for automotive and aerospace components. The use of rare earth elements through melting routes, represent an advantage for the synthesis of these alloys with a favorable mechanical performance considering trace amount additions [1. 2].

In this work, rare earth additions from the Al6Ce3La master alloy were added to the aerospace grade Al7075 aluminum alloy in order to compare their mechanical performance at 0.2 and 2.0 wt. % of content. The Al7075 alloy was prepared by cast metallurgy at 750 ˚C. Specimens were hot extruded at 550˚C into a rod of 10 mm of diameter using indirect hot extrusion and an extrusion ratio of 16. As reference, an unmodified Al7075 alloy was prepared by the same route. The microstructure analysis was carried out by scanning electron microscopy, whilst the mechanical performance of the alloys was evaluated by Vickers hardness tests.

Fig. 1a shows a schematic of the hot extrusion process employed in the production of modified alloys. Secondary electron SEM micrographs of the rare earth master alloy (Al6Ce3La, Fig. 1b) and their effect on the microstructure of the Al7075 modified with 0.2 and 2.0 wt.% of content, are shown in the Figs. 1(c-f). Micrographs present the alignment of phases in the direction of the extrusion process. The microsctructure of the Al7075 alloy modified with 2.0 w.t% of Al6Ce3La, presents Ce-rich phases distributed along the matrix.

The addition and increment of the of the Al6Ce3La content into the Al7075 alloy, from 0.2 to 2.0 wt.%, display visible changes in the microstructure of the modified alloy, related with a reduction in the size of the bright phases. As response, the mechanical performance of the modified alloys (Fig. 2), evaluated through Vickers microhardness tests, is affected by increasing their hardness values. However, even though an increment from 8.0 %, of the alloy modified with 0.2 wt.% of rare earths in comparison with the unmodified alloy is observed, the increment of the modified alloy with 2.0 wt. % is of only 14 % in comparison with the reference alloy.

In this regard, it has been reported that small concentration of rare earths, such Er and Y [3,4], enhance the mechanical properties of metals, producing microstructure refinement and metamorphosis of inclusions. That behavior, correspond with the observed in the present research for smaller amount of rare earth addition in the modification of the Al7075 alloy. A deeper study related with transmission electron microscopy is an ongoing research topic by the research group.

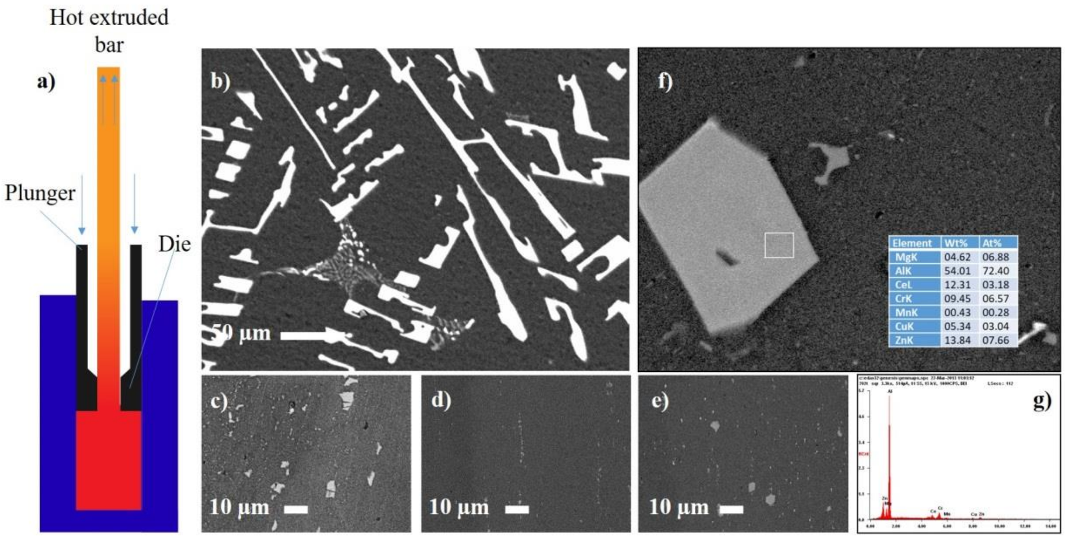

Figure 1. (a) Schematic process of the indirect hot extrusion process. (b) As-received master alloy. (c-d) reference alloy and those modified with 0.2 and 2.0 of master alloy respectively. (f,g) Ce-rich phases analysis

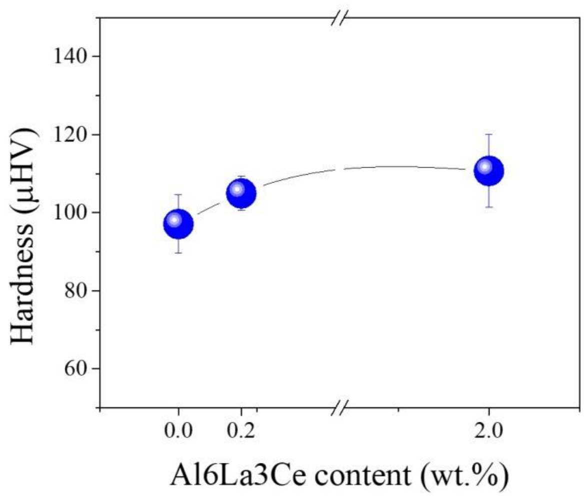

Figure 2. Hardness performance after hot extrusion of the Al7075 alloy modified with rare earths

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