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Microstructural and Mechanical Behavior in the Al_{2024} Alloy Modified With Addition of CeO_2

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The 2xxx series aluminium alloys are important advanced functional materials due to their high yield strength, good fracture toughness and excellent fatigue properties [1]. Due to the extremely important role that the 2xxx series aluminum alloys play in the aviation industry, much attention has been devoted to understanding their structures and properties [1-2]. Particularly, comprehensive investigations have been made to elucidate the morphological dependence of the precipitates on material composition, thermal treatment history, and impurity elements to optimize the materials performance for designed applications [1-2].

By another hand, in the last decades, the use of metallic matrix composites of two or more different metals, intermatallic compounds or second phases has been researched widely. They are produced by controlling the properties of the constituent phases, their relative amount, dispersed phase geometry including particle size, shape and orientation in the matrix to achieve optimum combination of microstructural and mechanical properties [3, 4]. Reinforcing particle such as SiC, Al_2O_3, and MgO, have emerged as a potential alternative for conventional aluminum-base composites because of their high mechanical properties. Additionally, because the effects on microstructure, mechanical properties, electrical conductivity and corrosion resistance the use of rare earth, especially La, Ce, Nd, Y and Sc have called attention, recently. Thus, the present work evaluates the effect of CeO_2 nanoparticles on the microstructure, precipitation sequence and hardening mechanisms of the Al_{2024} alloy.

A compound of Al-16.66% by weight of CeO_2 ($CMAlCeO_2$) was prepared by mechanical milling (Fig.1). Subsequently, the $CMAlCeO_2$ was added in proportions of 0.1, 0.5,3 and 5 wt. % of CeO_2 to the Al_{2024} alloy by conventional casting. Finally, the material obtained was extruded and aged. The characterization of $CMAlCeO_2$ suggests a reaction of the chemical reduction of CeO_2 and the formation of a layer of Al_2O_3 that covers the elemental Ce during the process (Fig.2). On the other hand, the hardness tests indicate that the lower content of $CMAlCeO_2$ (0.1, 0.5% weight of CeO_2) obtained hardness superior to the commercial alloy Al_{2024}. In addition, the preparation of the $CMAlCeO_2$ composite material by powder metallurgy is an alternate route for homogeneously dispersing CeO_2 nanoparticles in an aluminum matrix. However, long sintering times are not recommended since this favors the formation of elongated Ce rich phases.

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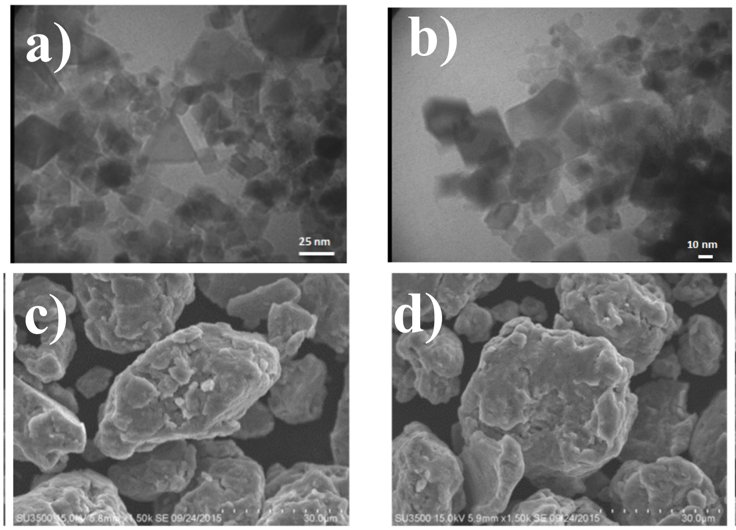

Figure. 1 Micrographs obtained by SEM of CeO_2 nanoparticles (a-b) and $MCAlCeO_2$ powders (c-d)

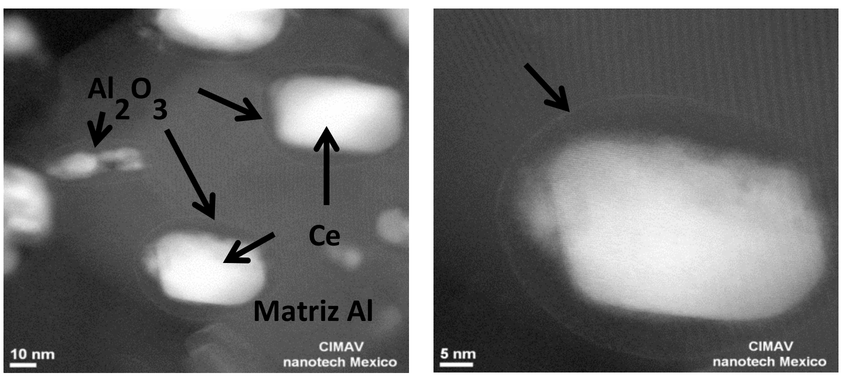

Figure. 2 Micrographs obtained by TEM of $MCAlCeO_2$

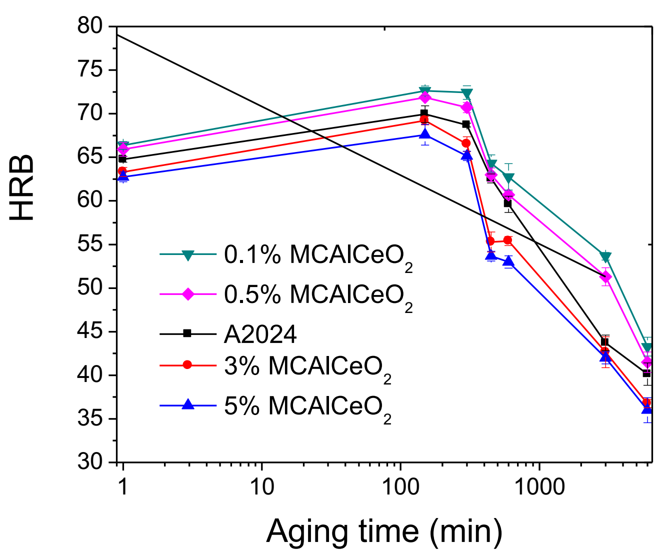

Figure. 3 Hardness curve (Rockwell B) for the Al_{2024} alloy reinforced with 0.1, 0.5, 3 and 5% of CeO_2 by the addition of $MCAlCeO_2$.