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Evolution of microstructure in an Al-Si system modified with the transition element addition and its effect on mechanicals properties.

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The effect of transition element addition and solution treatment time on the microstructure and hardness of the Al-Si alloy were studied by Vickers microhardness, Rockwell B Hardness, X Ray Diffraction (XRD), Optical Microscopy (OM) and Scanning Electron Microscopy (SEM). The A319 alloy and the A319 alloys modified with Ni were solution treatment at 495 °C for 5 and 7h, quenching in water at 60 °C and aged at 170 °C for 0.5, 3, 5, 10 and 96 h. The Ni addition between 1 and 2 wt. % to the A319 alloy have a direct effect on the microstructure, the morphology, size and distribution of precipitates during aging heat treatment, as well as, favors the formation of the Al-Fe-Ni, Al-Ni-Cu- and Al_3Ni_2 intermetallic phases, additionally, the Ni presence reduce the Cu content in the matrix for the Al_2Cu formation due formation of Al-Ni-Cu phases.

The A319 alloy is commonly used in the automotive industry as a material for engine blocks and cylinder heads. In order to improve the mechanical properties of such components they are frequently T6 heat treatment. In aluminum alloys, some transition metals like Ni and Fe, and some rare earths like Ce, which the main characteristic is their low solubility in Al (maximum of 0.01% to 0.03%), are employed mainly to reduce the coefficient of thermal expansion [1]. Additionally, the Ni is commonly used in aluminum alloys to improve the mechanical properties at elevated temperatures. For example, additions of 1 to 2% Ni to 2xxx and 3xxx series alloys enhance hardness and tensile properties at elevated temperatures [2-3]. Hayajneh et al. [4] studied the effect of Ni additions in the mechanical response in Al-Cu alloys; they reported that the presence of the Al_3Ni, $Al_3(CuNi)_2$ and Al_7Cu_4Ni intermetallic compounds have a direct relationship with mechanical properties. Higher amounts of dispersed intermetallic compounds higher hardness. Others investigations have reported the presence of Al_9FeNi Intermetallic compound [5].

The figure 1, show the microstructure of as-cast conditions in A319 alloy modified with Ni additions, where is observed a change in morphology of dendrites and interdendritic phase (fig. 1a), as well as the presence of platelets-like phases (fig. 1b). When Ni is added to the Al-Si system the eutectic transformation is characterized by a simultaneous formation of eutectic Si and Al_3Ni phase.

In figure 2, it is observed during the solution treatment as the eutectic Si platelets spheroidize and their aspect ratio decreases, which result in a loss of interconnectivity of the eutectic phases, which has been widely reported [6-7]. Additionally, the Al-Ni-Cu phases with Chinese script type and plate morphologies can be observed.

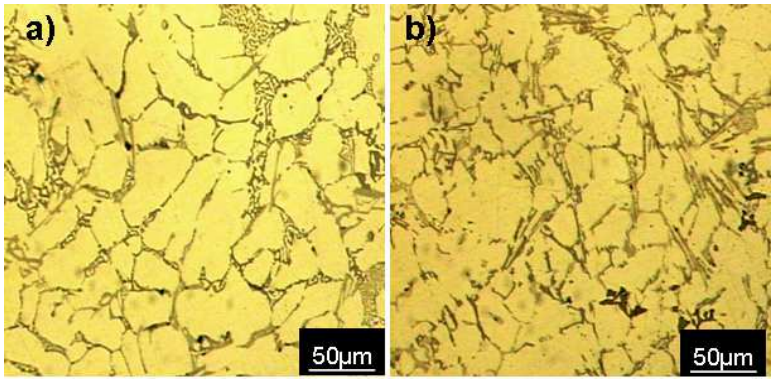

Fig. 1 OM micrographs of A319 alloy modified with Ni additions in the as-cast condition: a) 1 wt. % Ni and b) 2 wt. % Ni.

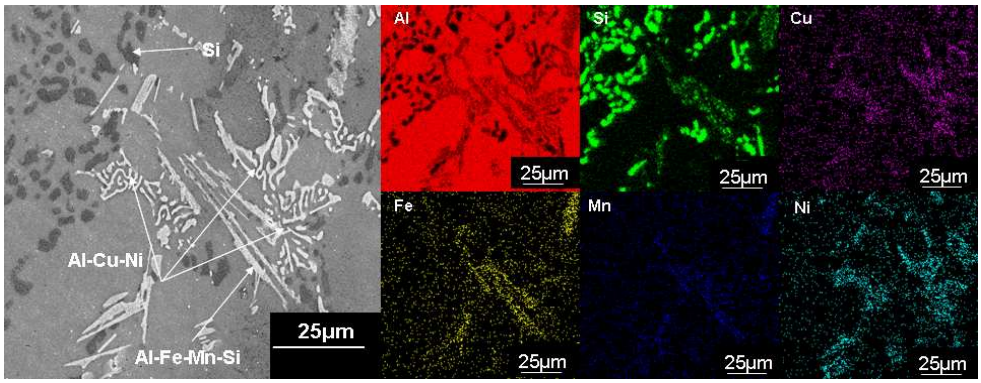

Fig. 2 SEM micrograph and elemental mapping of the A319 alloy with 1 wt. % Ni after solution treatment for 5 h.

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