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Abstract

THE ROLE OF LANTHANIUM ADDITION IN THE MICROSTRUCTURAL EVOLUTION OF AN EN AW-7175 ALLOY DURING SOLUTION ANNEALING

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Abstract

The outstanding properties of the high-strength 7xxx aluminium alloys are achieved through critical heat treatment. This research focussed on the significant effects of lanthanum addition on the microstructural changes of EN AW-7175 alloy during solution annealing, the first stage of heat treatment. The main objective was to elucidate these microstructural changes and in particular to determine how lanthanum influences the evolution of the different phases.

To investigate the microstructural evolution, the alloys were first produced. After casting, a heat treatment, i.e. solution annealing, was carried out with holding times of 1 to 24 hours. Differential scanning calorimetry (DSC) was then carried out to analyse the characteristic temperatures and enthalpies of the samples. And finally, metallographic analysis was performed, which included scanning electron microscopy (SEM) and transmission electron microscopy (TEM) to analyse the microstructure.

The results showed that lanthanum profoundly changes the microstructure by increasing the eutectic solidus temperature, affecting the melting behaviour of Mg_2Si and promoting the formation of LaAlSi (while suppressing Mg_2Si) and increasing the melting enthalpy of the aluminium matrix. Lanthanum also accelerated the eutectic melting kinetics and effectively controlled the grain growth with an optimum annealing time of 10 hours and a minimum lanthanum concentration of 0.15 wt% to stabilise the grain size. In addition, lanthanum was involved in the development of chromium-containing phases leading to the formation of a novel $Al_{20}Cr_2La$ phase. Processing parameters such as faster cooling rates led to grain refinement due to precipitation along the grain boundaries. Longer annealing times caused a decrease in the T-phase content due to the diffusion of Mg and Zn into the matrix (Zn diffuses faster) and favoured the formation of the intermetallic phase Al_7Cu_2Fe over $Al_{13}Fe_4$.

***Keywords**: EN AW-7175, lanthanum, solution annealing, microstructure*