Towards a short homogenisation process for DC cast billets of wrought Al alloys by MC-DC casting

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In industrial practice, Al-Ti-B (C) master alloys are commonly used as grain refiners during DC casting of wrought aluminium alloys. However, addition of grain refiners results in more globular grains with a coarse necklace like morphology of second phase particles [1].

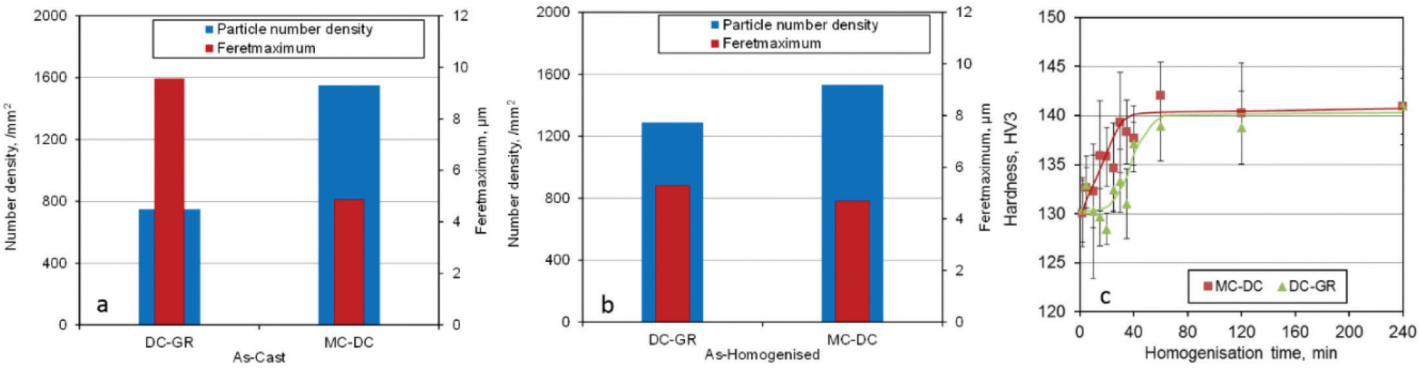

FIGURE 1. Size (feret maximum) and number density of intermetallic particles in an A6xxx alloy of 152 ø mm billets, prepared under different DC casting conditions. (a) As-cast, and (b) after homogenisation, (c) holding time of homogenisation treatment against hardness with the same ageing procedure.

A homogenisation treatment is an indispensable step for the DC cast billet prior to extrusion/rolling to reduce the micro-segregations of Mg and Si and transform the majority of the coarse β-AlFeSi to the finer α-AlFe(Mn)Si phases [2]. This transformation is however a slow and energy-consuming process to facilitate the downstream thermomechanical processing. The time to break up, transform and redistribute these Fe-rich intermetallics is the controlling factor to dictate homogenisation capacity far beyond that necessary to redistribute Mg and Si. By using MC-DC casting technology, fine equiaxed dendritic grains can be formed and thus, second phase particles can be refined and uniformly distributed. As a consequence, a short homogenisation treatment of MC-DC cast billet can be expected.

Compared with a DC cast billet of A6082 alloy with Al-Ti-B grain refiner addition (DC-GR), the MC-DC cast billet shows similar grain size but with fine equiaxed dendritic structure. This results in much finer second phase particles with a higher number density in the as-cast microstructure (Figure 1a). After the same homogenisation treatment, the size of second phases in DC-GR samples decreased significantly and the number density increased accordingly. However, the size and number density of MC-DC cast samples show almost no change (Figure 1b). This suggests a short homogenisation treatment might be necessary in the MC-DC cast sample to dissolve the Mg_2Si phase only. To achieve the peak ageing hardness in the MC-DC cast billet, less than 40 min of homogenisation was enough compared with the DC-GR samples in which more than 60 min were needed (Figure 1c).

Fine and uniformly distributed second phase particles facilitate a short homogenisation treatment, which is of significant economic importance, in particular for large-sized DC cast ingots/billets. Further investigations on hot formability after a short homogenisation treatment are necessary in MC-DC cast billets to guide the practice in industry. Further thermomechanical processing and microstructural assessment of MC-DC cast billets will demonstrate the full advantages of this emerging technology.

REFERENCES:

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