# High shear melt conditioned direct chill casting: a Constellium case study

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Direct chill (DC) casting of aluminium alloys has been an essential process for feedstock production and further mechanical processing of wrought product forms.

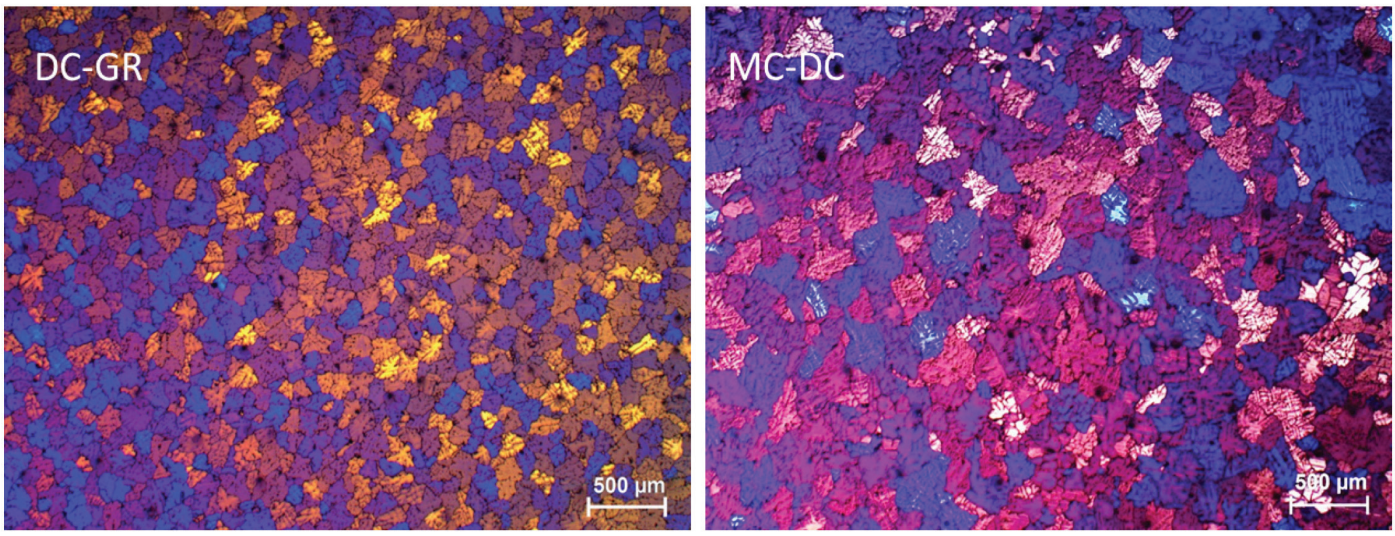


**FIGURE 1.** Grain structure of A6082 alloy under different DC casting conditions showing globular grain in DC-GR and fine equiaxed dendrites in MC-DC.

Achieving a fine, uniform and defect-free microstructure throughout the billet cross section has been a long standing industrial challenge. DC cast ingots of wrought Al alloys conventionally require the deliberate addition of a grain refiner (DC-GR) to provide a fine equiaxed as-cast microstructure. However, grain refiner additions cannot ensure the uniformity of microstructures and refinement of secondary phases. These problems can be addressed by combining the conventional DC casting with high shear melt conditioning directly in the casting sump. Melt conditioning direct chill casting (MC-DC) is an emerging technology which manipulates the solidification process to control and tailor the microstructure for high quality billet production. To study the potential benefits of melt conditioning, an alloy 6082, one of the major regular production alloys of Constellium was selected for industrial trials. The microstructure of a MC-DC billet was compared with the billet produced using commercial practice with Al-Ti-B grain refiner.

In conventional DC casting with grain refiner, low thermal gradient and high nucleation rate by inoculants favour globular growth resulting coarse dendritic arm spacing. The non-uniform cooling rate across the section of the billet in conventional DC casting results in the variation of grain size. In contrast, the solidification process in MC-DC at a lower speed is characterised by high thermal gradient / high undercooling compared to DC-GR due to enhanced rate of heat extraction by the intensive forced convection. This results in uniform distribution and finer eutectics in MC-DC due to fine dendritic arm spacing, as shown in Figure 1. The grain refinement observed in MC-DC billet is attributed to the effective dispersion and uniform distribution of naturally occurring oxides in the Al melt.

Future research will be focused on investigating the effect of homogenisation on microstructure of MC-DC billets; in particular a detailed characterisation of the secondary phases before and after homogenisation.