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Continuous Directional Solidification of Aluminium Alloys Under Combined Electromagnetic Interaction

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Direct chill directional solidification is a method how to cast metal alloys with great control of solidification parameters like solidification velocity and temperature gradient at the solidification interface. This paper describes results and methods of our experiments with electromagnetic interaction (EM) in direct chill casting of silicon rich aluminium alloys like A356 and A360. Studies about EM influence on metal solidification shows that various combinations of magnetic fields have significant influence on grain structure in directionally solidified ingot. We directionally solidified aluminium rods with diameter of 10 to 20 mm under various EM interactions. In this study there are applied static electromagnetic field of 0.4T and current flow through solidification interface. Static field is created by an array of permanent magnets in ring formation where highest field value is in the center and pointed axially. The direct current is introduced with immersed electrode into molten aluminium through solidification interface to seed rod. Interaction between current and magnetic field creates tiny molten metal flows directly in mushy zone which than influences heat transfer and affects grain structure and properties of alloy. By studying microstructure we observed that EM interference can influence grain size and shape, and properties of alloy, like strength, ductility, isotropy. Columnar structure of dendrites disappears when magnetic field and current are introduced. We combined static magnetic field with induced short but strong current pulses in mushy zone with 100 to 500A. This creates pressure waves which also enhances the small scale flows in mushy zone

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