

Multiphysics and Multiscale Simulations of Direct-Chill Casting

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This paper presents the simulation system for the direct-chill casting of round aluminium billets, developed through the sequence of the applied and fundamental ARRS projects with the MARTIN project at last. According to the scales, the system is divided into related macroscopic, mesoscopic and microscopic solidification models and includes the possible influence of electromagnetic fields. Macroscopic models are divided into fluid mechanics models, used to calculate the temperature, velocity, concentration and phase fields, and solid mechanics models, which are used to calculate the stresses and deformation fields. Mesoscopic models are intended for grain size calculation, while microscopic models are devoted to microsegregation and detailed grain shape calculations. The simulation system can predict defects such as macrosegregation and hot tearing. Verification and validation of models and examples of simulations are presented. Ultimately, we give further directions for the system upgrades for slabs and refinement of the existing models.