Study of Hot Tearing through Ingot Bending Tests: Thermomechanical and Solute Transport Analyses

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Hot tearing is one of the critical defects in cast products. It takes place close to the end of solidification, typically for solid fraction between 0.9 and 1.0, when the material experiences deformation based on tensile stress. In this study, a hot tearing experiment, so-called "bending test", is carried out in which a cast ingot is deformed by an external tool before the ingot is fully solidified. To analyze the experiment, two types of thermomechanical simulation are performed. The first one is a classical thermomechanical approach in which the mushy zone (composed of liquid and solid phases) is considered as a homogenized material so that a unique velocity field is solved for [1, 2]. Through stress-strain analyses, macroscopic hot tearing criteria found in literature are then evaluated [3]. The second type is an effective "two phase" modelling approach in which the liquid and solid velocity fields are computed separately in the mushy zone [4]. It allows simulating solute transport phenomena leading to macrosegregation induced by deformation shrinkage and advection. The effect of micro- and macro-segregation on hot tearing sensitivity is then discussed.

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