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The Effect of Electromagnetic Stirring during Solidification of Nickel Based Alloys

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Abstract : Nickel-based alloys are materials well suited for service in extreme environments subjected to pressure and heat. Some industrial applications for Nickel-based alloys are aerospace and jet engines, oil and gas extraction, pollution control and waste processing, automotive and marine industry. It is generally recognized that grain refinement is an effective methodology to improve the quality of casted parts. Conventional grain refinement techniques involve the addition of inoculation substances, the control of solidification conditions, or thermomechanical treatment with recrystallization. However, such methods often lead to non-uniform grain size distribution and the formation of hard phases, which are detrimental to both wear performance and biocompatibility. Stirring of the melt by electromagnetic fields has been widely used in continuous castings with success for grain refinement, solute redistribution, and surface quality improvement. Despite the advantages, much attention has not been paid yet to the use of this approach on functional castings such as investment casting. Furthermore, the effect of electromagnetic stirring (EMS) fields on Nickel-based alloys is not known. In line with the gaps/needs of the state-of-art, the present research work targets to promote new advances in controlling grain size and morphology of investment cast Nickel based alloys. For such a purpose, a set of experimental tests was conducted. A high-frequency induction furnace with vacuum and controlled atmosphere was used to cast the Inconel 718 alloy in ceramic shells. A coil surrounded the casting chamber in order to induce electromagnetic stirring during solidification. Aiming to assess the effect of the electromagnetic stirring on Ni alloys, the samples were subjected to microstructural analysis and mechanical tests. The results show that electromagnetic stirring can be an effective methodology to modify the grain size and mechanical properties of investment-cast parts.

Keywords : investment casting, grain refinement, electromagnetic stirring, nickel alloys
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