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研究论文

液态金属冷却工艺对NiAl--Cr(Mo)--Hf(Ho)定向合金组织的影响

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摘要：

用液态金属冷却技术(LMC)和传统的定向凝固技术(HRS)制备了名义成分为Ni--33Al--31Cr--2.9Mo--0.1Hf--0.05Ho(%, 原子分数)的定向合金, 研究了制备工艺对其组织的影响. 结果表明, 合金由初生NiAl枝晶、NiAl/Cr(Mo)共晶胞和少量Hf固溶体组成. 与HRS工艺相比, LMC工艺能提高固液前沿温度梯度和冷却速度. 较高的固液前沿温度梯度扩大了NiAl/Cr(Mo)共晶共生区成分范围, 减少初生NiAl枝晶的体积分数. 而较高的冷却速度抑制固溶元素扩散, 细化定向合金的组织, 增加合金中固溶元素总量. 另外, LMC工艺能避免HRS工艺中产生的生长缺陷, 包括斑点、NiAl一次枝晶的偏转和NiAl一次枝晶的不连续.

关键词： 金属材料 金属间化合物 NiAl合金 定向凝固工艺 液态金属冷却技术 显微组织

Effect of liquid metal cooling on microstructures of directionally solidified NiAl–Cr(Mo)–Hf(Ho) alloy

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Abstract:

The alloy with nominal composition Ni–33Al–31Cr–2.9Mo–0.1Hf–0.05Ho (%) has been directionally solidified by liquid metal cooling (LMC) and conventional high rate solidification (HRS) processes. Investigations reveal that the directionally solidified alloys are composed of primary dendritic NiAl, NiAl/Cr(Mo) eutectic cell and Hf solid solution. Compared with the conventional high rate solidification process, the liquid metal cooling process can provide higher thermal gradient and higher cooling rate. Higher thermal gradient widens the composition range of coupled zone and reduces the volume fraction of primary dendritic NiAl. Higher cooling rate restrains the diffusion and results in the refinement of the microstructure and the expansion of total contents of the solid solution elements (except Si) in NiAl and Cr(Mo) phases. In addition, casting defects including freckles, misoriented primary dendritic NiAl grains and discontinuities of primary dendritic NiAl grains decrease or even disappear completely in the directionally solidified alloys processed by liquid metal cooling process.

Keywords: metallic materials intermetallics NiAl alloy directional solidification liquid metal cooling technique microstructure

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