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论文

铌硅化物基超高温合金整体定向凝固组织和固/液界面形态演化

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摘要:

采用有坩埚整体定向凝固技术研究了铌硅化物基超高温合金在不同过热温度下的定向凝固组织和固/液界面形态演化. 研究结果表明: 在抽拉速率均为15 μm/s的条件下, 当过热温度为1950 ℃时, 定向凝固组织由初生铌基固溶体(Nb_{ss}) 枝晶和耦合生长< 的花瓣状(Nb_{ss}+γ--(Nb, X)$_5Si_3$)共晶组成; 当过热温度为2000和2050 ℃时, 凝固组织为耦合良好的花瓣状共晶; 但随着过热温度进一步提高到2100和2150 ℃, 凝固组织演变为粗大树枝状Nb_{ss}和细小共晶. 随着过热温度的提高, 固/液界面形态出现树枝状界面→胞状界面→树枝状界面的形貌变化.

关键词: 铌硅化物 超高温合金 熔体过热温度 定向凝固组织 固/液界面形貌

MICROSTRUCTURE AND SOLID/LIQUID INTERFACE MORPHOLOGY EVOLUTION OF INTEGRALLY DIRECTIONALLY SOLIDIFIED Nb--SILICIDE--BASED ULTRAHIGH TEMPERATURE ALLOY

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Abstract:

Nb-silicide-based ultrahigh temperature alloys have attracted considerable attentions as potential high temperature structural materials because of their high melting point, suitable density, good elevated temperature creep strength and acceptable room temperature fracture toughness. However, the shortcoming in both high temperature strength and high temperature oxidation resistance retarded their practical applications. Directional solidification and alloying can be used in overcoming these deficiencies at certain degree. In this paper, the alloy with the composition of Nb-22Ti-16Si-6Cr-4Hf-3Al-3Mo-2B-0.06Y (atomic fraction, %) was designed and the master alloy ingot was prepared by firstly vacuum non-consumable arc melting and then vacuum consumable arc melting. The integrally directional solidification of this alloy was conducted with the use of special ceramic crucibles in a self-made resistance heating directional solidification furnace with ultrahigh temperatures and high thermal gradients. The microstructure and solid/liquid (S/L) interface morphology evolution of directionally solidified alloy were investigated under the condition of different melt superheat temperatures θ_s (1950, 2000, 2050, 2100 and 2150 ℃) but with a constant withdrawing rate of\linebreak 15 μm/s. The results revealed that when the melt superheat temperature θ_s=1950 ℃, the directionally solidified microstructure is composed of straight primary Nb_{ss} dendrites and couple grown lamellar (Nb_{ss}+γ-(Nb, X)$_5Si_3$) eutectic colonies (petal--like) along the longitudinal axes of the specimens. When θ_s=2000 and 2050 ℃ respectively, the directionally solidified microstructure is completely composed of straight petal-like eutectic colonies. As θ_s increased to 2100 and 2150 ℃ respectively, the directionally solidified microstructure evolves into straight coarse primary Nb_{ss} dendrites and fine lamellar eutectic colonies along the longitudinal axes of the specimens. The S/L interface morphology changes from coarse dendrite to cellular, then to coarse dendrite with the increase of melt superheat temperature.

Keywords: Nb-silicide ultrahigh temperature alloy melt superheat temperature directionally solidified microstructure solid/liquid interface morphology

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