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论文

抽拉速率跃迁对定向凝固单晶高温合金DD3一次枝晶间距和微观偏析的影响

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摘要:

采用液态金属冷却高温度梯度定向凝固设备, 研究了抽拉速率跃迁对单晶高温合金DD3一次枝晶间距和微观偏析的影响. 结果表明, 单晶高温合金枝晶一次间距表现出明显的历史相关性.当抽拉速率(或生长速率)分别从600和300 μm/s跃迁到100 μm/s和直接以100 μm/s速率生长时, 一次间距分别为56.5, 86和111.5 μm. 而生长速率分别从50和100 μm/s跃迁到300 μm/s和直接以300 μm/s速率生长获得的一次间距分别为109, 93和70 μm. 一次间距值与Hunt-Lu模型预测的基本吻合, 但实验结果证明其上限与下限的比值$\lambda_1^{max}/\lambda_1^{min}>2$, 与Ma-Sahm的预测结果一致. 成分分析表明, 相同稳态条件下枝晶的一次间距变小, 偏析也有所降低.

关键词: 单晶高温合金 生长速率 跃迁 一次间距 微观偏析

INFLUENCE OF WITHDRAWING RATE TRANSITION ON THE PRIMARY DENDRITE ARM SPACING AND MICROSEGREGATION OF DIRECTIONALLY SOLIDIFIED SINGLE CRYSTAL SUPERALLOY DD3

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Abstract:

The microstructure of single crystal Ni–based superalloys is virtually determined by both processing parameters of growth rate v and thermal gradient G ahead of the solidification front. Previous researches have established the relationship between dendrite spacings and G or v under supposing those parameters to be constant from beginning to end of solidification, resulting in the disaccord between the predicted and experimental results for actual blade productions. Furthermore, previous experimental and theoretical works seldom involve the influence of processing parameter change on dendrite growth for multi–component industrial alloys. Therefore, investigation of directional solidified microstructure varying with processing parameter is the focus of present study. The influence of the withdrawing rae ransition during directional solidification on the primary dendrite arm spacing PDAS) and microsegregtion for single crystal superalloy DD3 has been studied by liquid metal cooled (LMC) directional solidification method. A wide range of withdrawing rate variations from 50 to 600 μm/s is allowable under G high to 250 K/cm. The results indicate that the average PDAS is remarkably dependent on the history of growth rate variation. The smaller PDASs of 56.5 and 86 μm can be obtained under withdrawing rate transition from higher values of 600 and 300 μm/s into 100 μm/s, while they are kept being 111.5 μm if withdrawing rate is 100 μm/s all the time. In contrast, PDASs increase to 109 and 93 μm under withdrawing rate transition from lower values of 50 and 100 μm/s into 300 μm/s, while tey are kept being a small value of 70 μm if growth rate is 300 μm/s at beginning. These experimental results agree approximately with those from Hunt–Lu model, but the maximum to miimum ratio of PDASs at a given solidification paameter, i.e., $\lambda_1^{max}/\lambda_1^{min}$, is roved to be more than 2It is also shown that the denrite microsegreation will be lessened with the decrease of PDASs at the same current soldfication parameters.

Keywords: single crystal superalloy growth rate transition primary dendrite arm spacing microsegregation

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