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定向凝固Al-4.5%Cu合金枝晶组织与抽拉速率的关系

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摘 要: 用自制下拉式定向凝固设备, 在一定的温度梯度下, 在20-220 $\mu\text{m/s}$ 的抽拉速率范围制备定向凝固Al-4.5%Cu合金, 并对其微观组织、特别是一次枝晶间距随抽拉速率的变化规律进行研究。结果表明: 定向凝固微观组织随抽拉速率的增大呈细化趋势, 其一次枝晶间距减小; 当抽拉速率小于100 $\mu\text{m/s}$ 时, 枝晶间距随抽拉速率而减小的幅度较大; 当抽拉速率大于100 $\mu\text{m/s}$ 时, 枝晶间距减小幅度较为平缓。在综合分析抽拉速率、界面生长速率、温度梯度等影响因素的基础上, 推导出界面局域平衡条件下预测定向凝固次枝晶间距的理论模型, 该模型能够较为准确地反映定向凝固一次枝晶间距随抽拉速率在100-220 $\mu\text{m/s}$ 范围的变化规律, 为定向凝固工艺获得特定组织而预先选配合适的工艺参数提供理论参考。

关键字: Al-4.5%Cu合金; 定向凝固; 一次枝晶间距; 抽拉速率; 传热

Relationship between primary dendrite arm spacing of Al-4.5%Cu alloy and withdrawal rate during unidirectional solidification

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Abstract: The relationship between primary arm spacing of Al-4.5%Cu alloy and withdrawal rate during unidirectional solidification was investigated when the withdrawal rate is in the range of 20-220 $\mu\text{m/s}$. The result shows that the primary arm spacing decreases along with increasing withdraw rate. The primary arm spacing decreases sharply with withdrawal rate below 100 $\mu\text{m/s}$, and decreases more gently with a withdrawal rate beyond 100 $\mu\text{m/s}$. Through the comprehensive consideration of the difference between withdrawal rate and interface growing rate, temperature gradient and etc, the function between primary arm spacing and withdrawal rate is founded, which could predict the variation of primary arm spacing exactly when the withdrawal rate is in the range of 100-220 $\mu\text{m/s}$. It is hoped that the function can be helpful to obtain a good match of experimental parameters during unidirectional solidification.

Key words: Al-4.5%Cu alloy; unidirectional solidification; primary dendrite arm spacing; withdrawal rate; heat transfer

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