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论文

由形核过冷度研究Ga熔体原子团尺寸变化的滞后性

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摘要：

DSC测试表明, Ga的形核过冷度随其熔体高温保温时间的延长而增大, 随熔体降温后保温时间的延长而减小, 表现出明显的滞后性. 通过对熔体温度与熔体中原子团尺寸之间关系的热力学和动力学研究, 得到了金属熔体原子团中的原子数随温度变化的关系式, 获得了确定熔体温度变化后其形核温度变化滞后幅度的方法, 确定的Ga的形核温度变化滞后幅度与实验结果相吻合, 其误差只有3.9%-4.8%.

关键词： Ga 熔体 形核过冷度 原子团尺寸 滞后性

RESEARCH ON THE HYSTERESIS OF ATOM CLUSTER SIZE VARIATION IN Ga MELT FROM THE NUCLEATION UNDERCOOLING

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Abstract:

In order to achieve the relationship between the melt thermal history and the solidification structure so as to explore new methods to effectively control the solidification process and the solidification structure of metal,
the effect of the melt thermal history of Ga on the nucleation undercooling has been studied by using DSC,
and some formulae among the atom cluster size in melt, the nucleation undercooling of melt, the melt temperature and
the concerned physical and chemical parameters of metal have been proposed. The experimental results show that the nucleation undercooling increases with increasing the holding time at high temperature after a
heating process and decreases with increasing the holding time after cooling to low temperature, but the change
rates of the nucleation undercooling decrease with increasing the holding time. An equation between the atom
number in the largest cluster in the melt and the melt temperature has been obtained by studying the effect of the
liquid temperature on the cluster size thermodynamically and kinetically. Formulae between the homogenous
nucleation undercooling, the heterogeneous nucleation undercooling and the temperature of liquid metal have been
achieved. In terms of these formulae, the atom number in the largest cluster in the melt and the nucleation
undercooling of the melt can be predicted if the temperature at which liquid metal is heated and hold is known. A
method for predicting the hysteretic extent of nucleation temperature after changing the liquid temperature has
been developed. The predicted results of the hysteretic extent of the nucleation temperature are in agreement with
the experiential results. The predicted and experimental hysteretic extents of the nucleation temperature are -10.7
and -10.3 K for Ga heated from 303 K to 373 K, and 7.9 and 8.3 K for Ga cooled from 373 K to 313 K, respectively. The errors between the predicted hysteretic extent of the nucleation temperature and the experimental
result are only 3.9\% for Ga heated from 303 K to 373 K and 4.8\% for Ga cooled from 373 K to 313 K, respectively.

Keywords: Ga melt nucleation undercooling atom cluster size hysteresis

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