Faceted growth of primary phase in Al-Cu alloys during directional solidification in high magnetic field

Chuanjun Li[1], Zhongming Ren[1], Yu Shen[1], Qiuliang Wang[2], Yinming Dai[2], Hui Wang[2]

[1] School of Materials Science and Engineering, Shanghai University, Shanghai 200072, China

[2] Institute of Electrical Engineering Chinese Academy of Sciences, Beijing 100190, China

The high magnetic field is widely used to modify the crystal morphology. In this work, the effect of the magnetic field on growing behavior of faceted crystals in the Al-40wt%Cu alloy was investigated using directional solidification technique. It was found that the faceted growth of primary Al_2Cu phase was degraded and the primary spacing was reduced upon applying the magnetic field. Additionally, the length of the mushy zone first decreased and then increased with increase of the magnetic field intensity. The quantitative analysis reveals that the shear stress induced by the fluid motion is insufficient to break the atom bonds at the solid-liquid interface. However, both of the thermoelectric magnetic convection (TEMC) and the thermoelectric magnetic force (TEMF) cause dendrites to fracture and reduce the primary spacing. The two effects also weaken the faceting growth. Moreover, the instability of the solid-liquid interface is generated by the TEMF, which further leads to degrade the faceted growth. The length of mushy zone was changed by the TEMC and reached the minimum in the magnetic field of 0.5T, which is in good agreement with the predicted value (0.83T).