FZ シリコン結晶成長に対するハルバッハ配列磁石の適用

Application of Halbach array magnet on the Floating Zone Silicon

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Floating zone (FZ) silicon is widely used in the high-voltage power device because of its high purity. Previous study demonstrated that increasing the growth rate or diameter could increase the deflection of the solid-liquid interface [1]. More deflection of solid-liquid interface could introduce high thermal stress and lead to crack of single crystal. Therefore, we propose to use Halbach array magnet in the vicinity of three-phase line to improve the deflection of solid-liquid interface. To investigate the effect of Halbach array magnet on the deflection of solid-liquid interface, numerical simulations are conducted in three dimensions considering high-frequency electromagnetic (HF-EM) field, static magnetic field, fluid flow and heat transfer. The simulation model is constructed and performed using OpenFOAM [2]. Fig. 1 shows schematic diagram of the FZ process with Halbach array magnet (red color). The Halbach array magnet induces a relatively strong inward magnetic field and relatively weak outward magnetic field. In the vicinity of the solid-liquid interface, the melt flow toward the center is damped under the effect of the Lorentz force. Fig. 2 shows the comparison of deflection of solid-liquid interface between the calculation results with and without Halbach array magnet. The calculation results demonstrate that the application of Halbach array magnet could improve the deflection of solid-liquid interface.

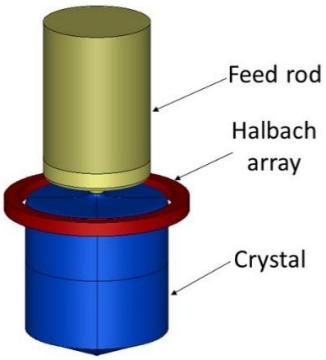

Fig. 1. Schematic diagram of FZ process with Halbach array magnet

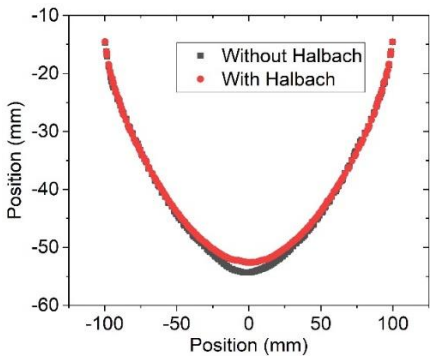

Fig. 2. Comparison of the deflection of the solid-liquid interface between the calculation results with Halbach array magnet and without Halbach array magnet.

Reference

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