Numerical simulation of crystal rotation effect on the solid-liquid interface in the floating-zone (FZ) silicon

FZ シリコン結晶の固液界面形状に対する結晶回転の数値シミュレーション

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Single crystal silicon with high purity can be produced by FZ method. Without contamination by the crucible, the oxygen concentration in the FZ silicon is low. The striations in the as-grown crystal are caused by the asymmetric electromagnetic (EM) field due to the EM supplier [1]. A. Mühlbauer conducted 2D calculation and compared with experimental results. The discrepancy between calculation and experiment qualitatively shows influence of the asymmetric electromagnetic field on the radial resistivity distribution [2]. To investigate the asymmetric electromagnetic field on the interface, a three dimensional global model has been developed based on the open-source library OpenFOAM. In the numerical simulation, the effect of EM force on the melt flow is considered. The 3D melt flows at free surface under different rotation speeds have been obtained (Figure 1). The interface deflections caused by EM supplier under different rotation speeds are calculated. The calculation results (Figure 2) show that high rotation speed could decrease the deflection of interface caused by the EM supplier.

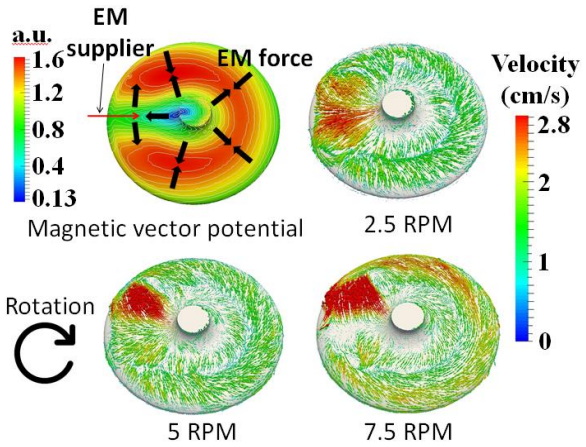

Fig. 1. Magnetic vector potential distribution and melt flow velocity distribution at free surface under different rotation speeds.

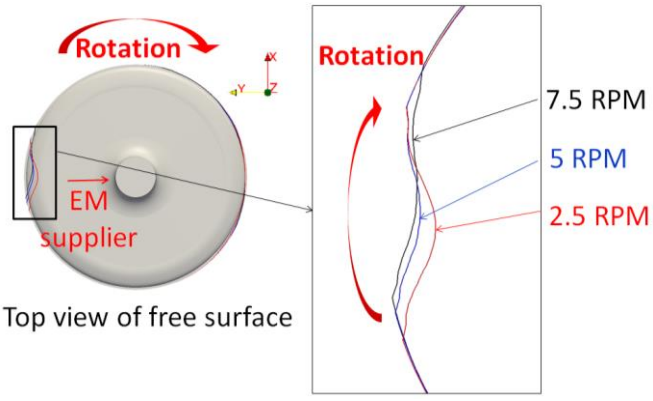

Fig. 2. Comparison of deflection of solid-liquid interface shape under different rotation speeds.

Reference

[1] A. Mühlbauer, A. Muiznieks, J. Virbulis, A. Lüdge, and H. Riemann, J. Cryst. Growth 151, 66-79 (1995)
[2] A. Mühlbauer, A. Muiznieks, G. Raming, H. Riemann, and A. Lüdge, J. Cryst. Growth 198, 107-113 (1999).

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