FZ シリコン結晶における抵抗率分布の 3D 数値シミュレーション

3D Numerical simulation of resistivity distribution in the FZ silicon process

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Production of high power semiconductor devices requires silicon wafer with high resistivity uniformity across the whole wafer. The resistivity depends on the dopant concentration in the silicon. In floating zone (FZ) silicon process, the melt flow pattern during the crystal growth has a large effect on the dopant concentration and radial resistivity variation (RRV). Computational Fluid Dynamics (CFD) simulation is a useful tool to predict the RRV profile. Previous studies have compared and validated the simulation results with experimental results of 100 mm FZ silicon process [1, 2]. The dopant is accumulated at the separation point of two vortices along solid-liquid interface. This phenomenon causes low resistivity at separation points and "V" shape of RRV profile. Fig. 1 shows the 3D model of silicon melt. The dopant concentration distribution is calculated (Fig. 2). The dopant is accumulated at the separation point. When the diameter of FZ silicon increases to 200 mm, the flow pattern is changed because of the change of phase boundary, temperature and electromagnetic force. The free surface of melt and solid-liquid interface are assumed to be axis-symmetric. The simulation conditions are asymmetric and derived from our previous study [3]. By using this 3D local model, the dopant concentration distribution in 200 mm FZ silicon can also be obtained.

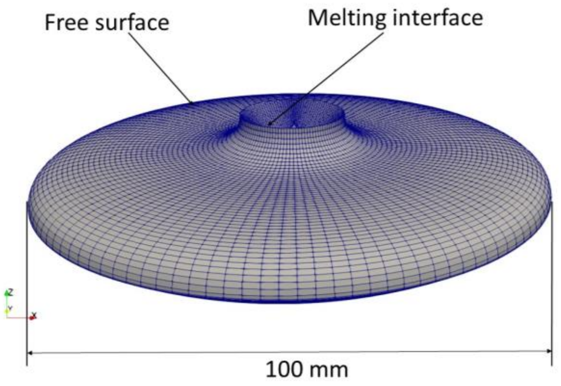

Fig. 1. 3D model of silicon melt in FZ process.

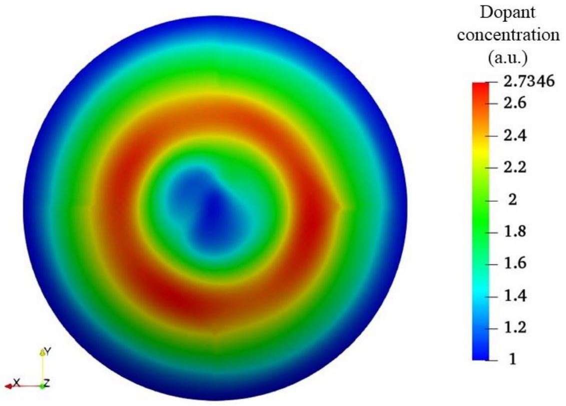

Fig. 2. Dopant concentration distribution at solid-liquid interface in 100 mm FZ silicon.

Reference

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