CZシリコン結晶引き上げ過程における酸素偏析のモデル化

Dynamic global modeling of the oxygen segregation during the pulling process of Czochralski silicon crystal growth

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Transient global modeling of the Czochralski silicon (CZ-Si) crystal growth process has long been proposed for understanding the dynamic behaviors of the heat and mass transport in the crystallization set-up. Furthermore, segregations of impurities and dopants could also be predicted dynamically by the transient global simulation. However, most of the transient global simulations for CZ-Si crystal growth neglected the melt flow and mass transport due to the complexity of the convection modeling.

In the present study, the transient global model for the crystal pulling process was developed for CZ-Si growth with the cusp-shaped magnetic field (CMF). Heat transfer by solid conduction, melt convection, and diffuse grey radiation is taken into account for the crystal, melt and other components in the furnace. The applied CMF suppressed the turbulent melt flow and stabilized the heat and mass transport. Generation, transport, and segregation of oxygen were considered for the crystal growing process. The oxygen (O) distributions at the growth interface were predicted for the different solidified fractions, as shown in Fig. 1. The segregation curve of oxygen was plotted as the function of crystal length as shown in Fig. 2. The O concentration along the axis decreased with the increase of the length of the crystal. The radial and axial homogeneity of O was also investigated for the growing crystal. The developed dynamic global model is also applicable for the segregation prediction of other dopants and impurities in CZ-Si growing process.

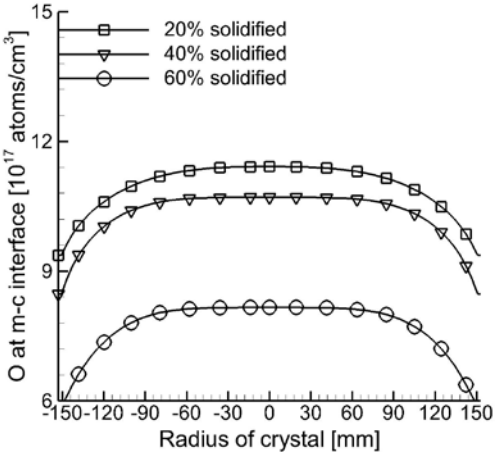

Fig. 1 O at growth interface during pulling

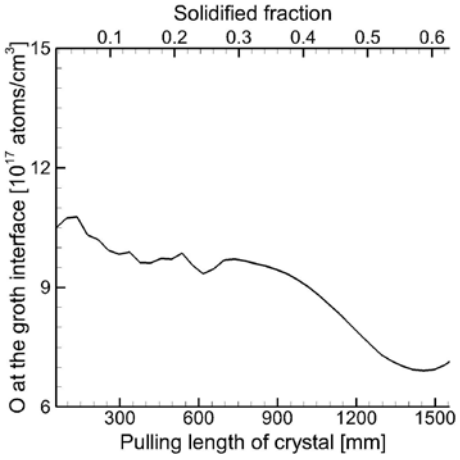

Fig. 2 Segregation curve of O during pulling

Acknowledgements

This work was partly supported by the New Energy and Industrial Technology Development Organization under the Ministry of Economy, Trade and Industry (METI).

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