

Czochralski 結晶成長法の原料融解過程における 炭素汚染と昇温履歴との相関に関する研究

Correlation study on heating profile and carbon contamination during the melting process of Czochralski silicon crystal growth

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Czochralski (CZ) crystal growth of single crystalline silicon (Si) is invariably accompanied by transport of species such as carbon (C), oxygen (O), and related products from chemical reactions in the high temperature range. C contamination in CZ-Si crystal is detrimental for the minority carrier lifetime, which is one of the critical parameters of electronic wafers. Chemical reactions relevant to C generation are triggered during the heating up and melting stages. Moreover, the generation rates of C compounds are dependent on the thermal history of the growth system. Thus, the heating profile of Si feedstock could affect the C contamination during the melting process of CZ-Si crystal growth.

Transient global simulations of heat and mass transport were conducted for melting process of CZ-Si crystal growth with different heating profiles. A virtual PID controller for temperature was introduced to realize the power control of the heater. Temperature evolutions of heater and Si feedstock are presented in Fig. 1, as well as power profile. Accumulation of C in Si feedstock was predicted for the entire melting process, which consists of heating up, melting and stabilization. Owing to the thermal capacity of setup, the fast heating resulted in high melting rate but long stabilization time, while the slow heating leads to the low melting rate but short stabilization time. The amount of C incorporated into the Si melt depends on the total time of melting and stabilization. Comparison of C accumulations with different thermal histories is shown in Fig. 2. The result indicates that an optimization window exists according to the correlation between heating profile and C contamination during the melting process of CZ-Si crystal growth.

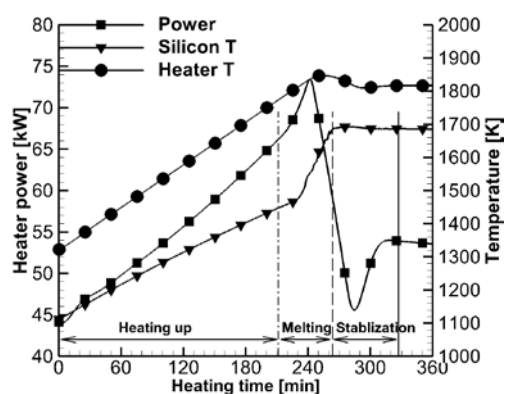


Fig. 1 Profiles of power and Temperatures

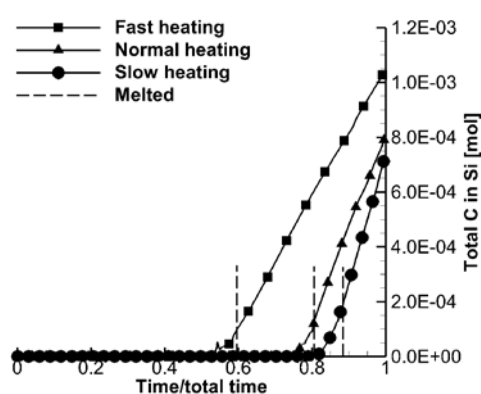


Fig. 2 Comparison of C accumulations

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