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Czochralski 結晶成長法の原料融解過程における炭素汚染に対するアルゴンガスの影響

Effects of Argon Flow on Carbon Contamination during Melting Process of Czochralski Silicon Crystal Growth

九大応力研

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Carbon (C) contamination in monocrystalline silicon (Si) leads to detrimental effects on the electrical properties of the wafer and device. Acting as the nucleation sites, C in the crystal promotes the oxygen (O) precipitates, which is decisive for the minority carrier lifetime. Due to the use of graphite- and O-containing components, C and O are introduced inevitably throughout the Czochralski (CZ) Si crystal growth process. Impurity levels in crystal depend on the chemical interactions and transport phenomena in the furnace. C contamination is strongly correlated with the generation and transport of CO in Ar gas. Thus, the prerequisite for the reduction of C contamination is the understanding of species transport in Ar gas.

CO generation and C contamination are triggered prior to the crystal growth stage. C accumulation during the melt process is crucial to the C level in the growing crystal. To study the generation and accumulation of C during the melting process, a transient global model for melting process was developed, including the coupled impurity transport in Ar gas and Si feedstock. Parameter studies on furnace pressure and gas flow rate were conducted on the C accumulation during the melting stage.

Flux and concentration of C in gas/melt interface are plotted as a function of furnace pressure in Fig.1. In the low pressure range, C concentration in the melt went up with the pressure increase, while C concentration almost kept constant in the high pressure range. Effects of gas flow rate on C contamination are plotted in Fig.2. C flux and C concentration both went down significantly with the flow rate increase. At the gas/melt interface, pressure and flow rate affected the C flux in different ways. The increase of gas flow rate could reduce the C contamination more effectively than the decrease of pressure.

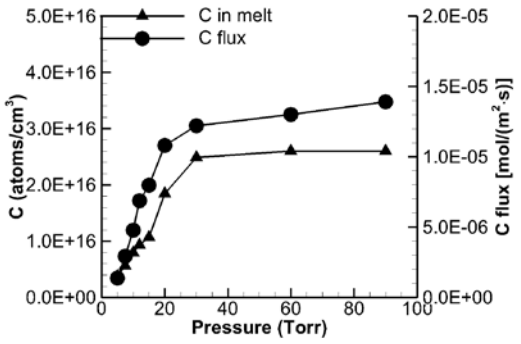

Fig. 1 Effects of pressure on C contamination.

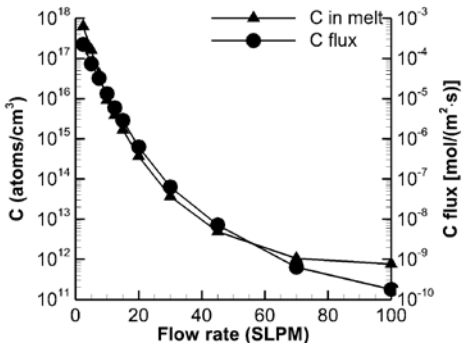

Fig. 2 Effects of flow rate on C contamination