Diffusion Constant Measurement of Oxygen Atom in Silicon Melts

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Abstract

The preliminary studies for measurements of oxygen diffusion constant in silicon melts have been carried out. It has been recognized that the SiO partial pressure is much required during experiments to suppress the SiO evaporation from silicon melts.

1.Introduction

Many researchers have focused on the oxygen distribution in silicon crystals due to its ability as a getter of heavy metal in the device process by the generation of extended defects. The researchers of crystal growth have paid much attention to control the oxygen concentration and its distribution. However it is much required to understand the oxygen atom behavior in silicon melts. There is no accurate date about diffusion constant of oxygen atom in silicon melts. This report describes the preliminary study for the measurements of the oxygen diffusion constant in silicon melts. We tried to survey some experimental conditions, while the accurate data have not yet been obtained. The experimental conditions and preliminary results are described.

2.Experimantal

The experimental furnace is shown in Fig.1a). This is the same as the furnace for experiments in space. This furnace enables us to heat up rapidly and quench the samples. The silicon melts were hold in a BN ampoule as is shown in Fig.1b). There were two capillaries in one BN ampoule for accurate measurements with high reproducibility. As the source of oxygen atom a

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fused quartz rod was used by contacting it with a silicon rod in the initial set up. To study the influence of atmosphere, some BN ampoules containing the samples were sealed in evacuated quartz tubes, others were heated up in a furnace with an evacuated atmosphere. The oxygen distribution was measured by SIMS.

3.Results and discussion

The oxygen distribution of the samples hold at 1430℃ and 1470℃ for 30 minutes, respectively, are shown in Fig.2. The closed circles and triangles denotes the results of the sample heated at 1430℃ and 1470℃, respectively. The position D is the 1mm from the face contacted with quartz. The distance AB, BC and CD are 5mm, respectively. The maximum value of the oxygen concentration in Fig.2 is slightly higher than $5x10^{18}cm^{-3}$, which is the solubility of oxygen in undoped silicon melts. This is due to the effect of the boron atoms incorporated from BN ampoules. These results indicate that the oxygen distribution is clearly detectable. Next, the results of the samples heated under evacuated conditions are shown in Fig.3. This sample was heated at 1450℃ and hold for 5 minutes. The sample edge contacted with quartz is denoted zero in Fig.3. The oxygen concentration abruptly decreases inside the silicon melts. This is due to the evaporation loss of SiO during experiments. This result indicates that the partial pressure of SiO is needed to obtain the accurate diffusion constant of oxygen atoms in silicon melts. The equilibrium SiO partial pressure at the melting point (1414℃) is about 12 Torr. The experimental procedure is now under developing.

4.Summary

The preliminary studies for measurements of oxygen diffusion constant in silicon melts have been carried out. It has been found that the oxygen atoms easily evaporate from silicon melts under vacuum conditions. The SiO partial pressure must be kept to be higher during experiments.

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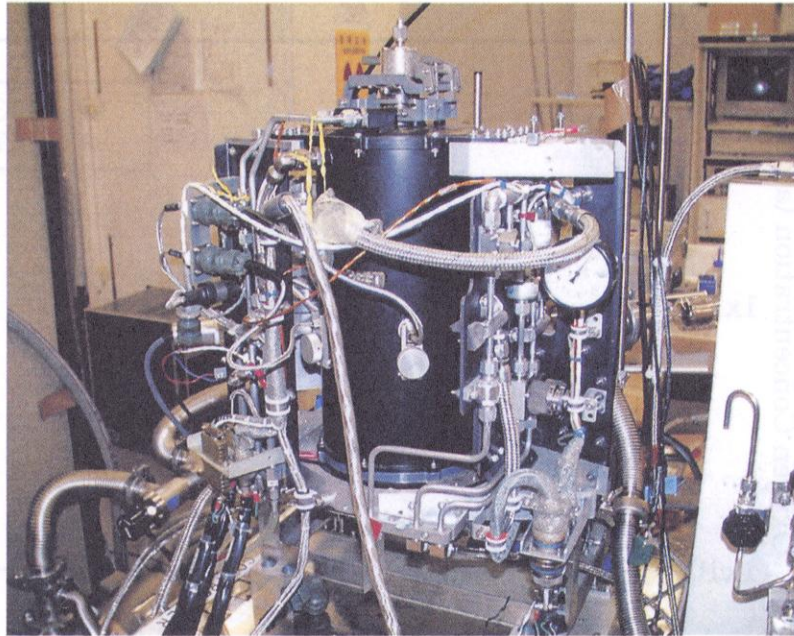

Fig.1a) Experimental furnace

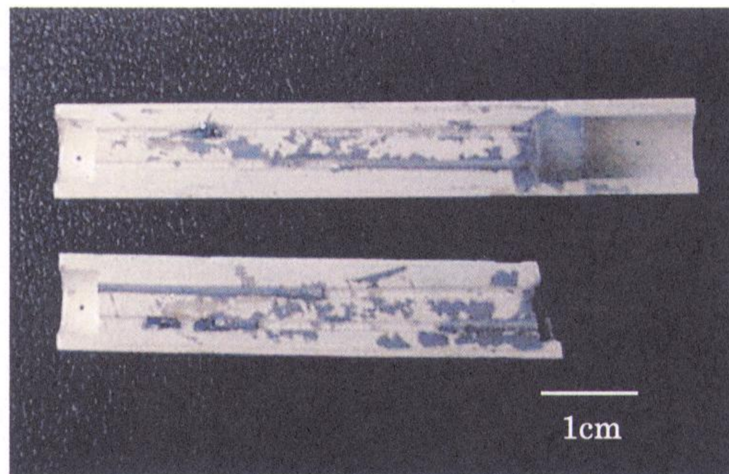

Fig.1b) BN ampoule after experiments

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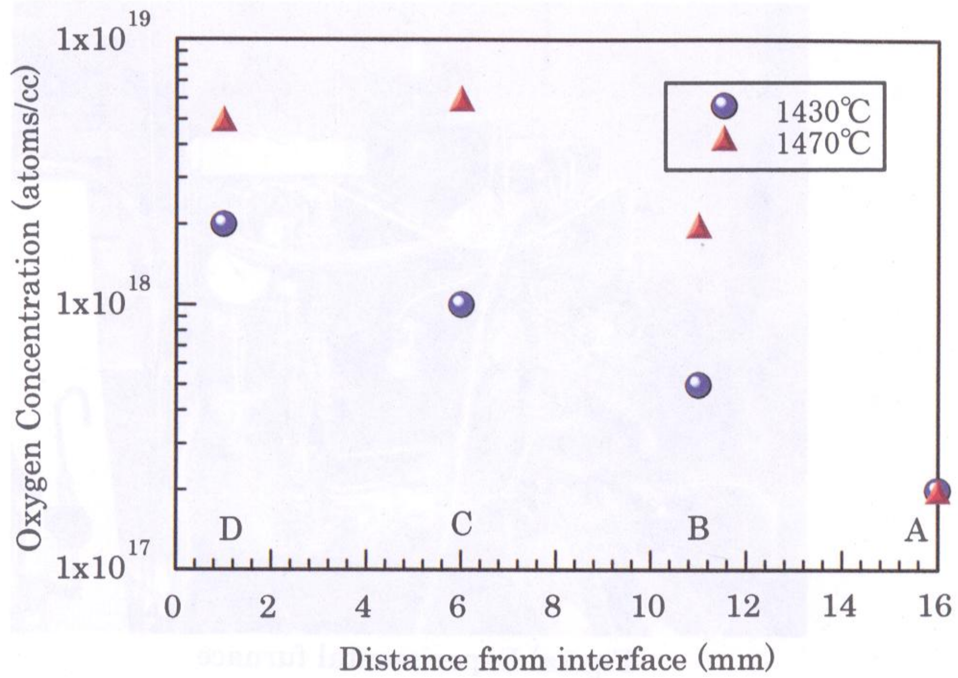

Fig.2 Oxygen distribution

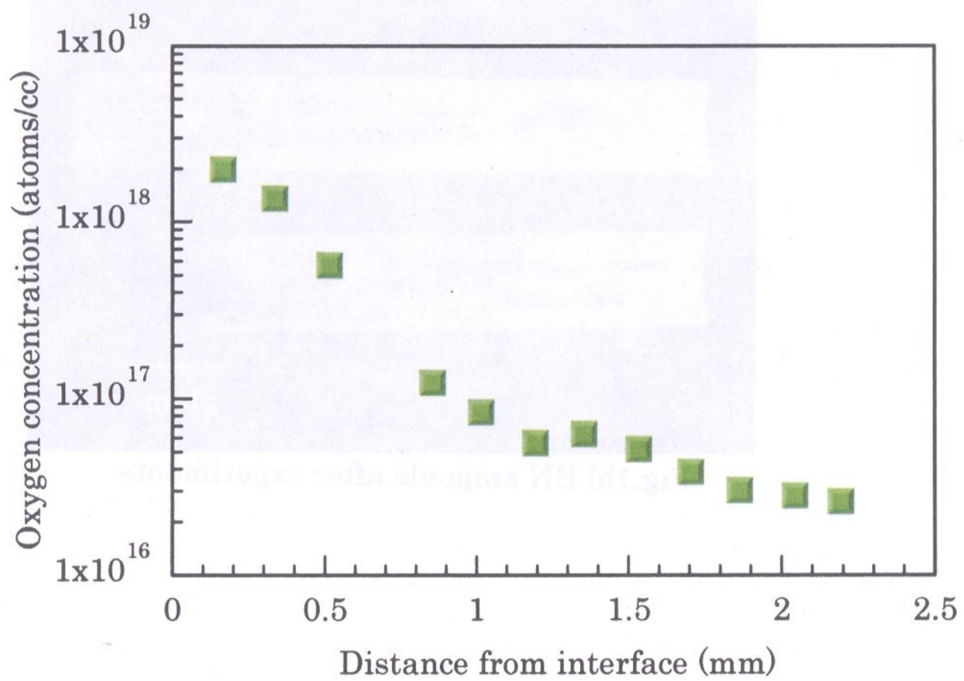

Fig.3 Oxygen distribution

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