Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SCG58-11 Room:203 Time:May 25 16:15-16:30

Size effect on the phase transition between protoenstatite and clinoenstatite

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[Introduction]

Protoenstatite(PEN, space groupe:*Pbcn*), one of the polymorph of enstatite($MgSiO_3$), is the stable phase at high temperature above 1000 ℃ below 1557 ℃ at atmospheric pressure. It is generally known that protoenstatite is the unquenchable phase. Actually, PEN has never been reported from natural specimens to date. However, Foster (1951), Lee and Heuer(1987), and so on reported PEN was observed at room temperature from experimental generative materials.

Smyth(1974) studied in detail the transformations among polymorphs of enstatite using high temperature single-crystal X-ray techniques. He showed that in rapid quench PEN transformed to clinoenstatite(CEN, $P2_1/c$) and in slow cooling rate PEN transformed to orthoenstatite(OEN, *Pbca*), and concluded that the rapid transformation between PEN and CEN occurs martensitically . On the martensitic transformation, in general, it is known that the transformation starting temperature is effected by the grain size that is i.e. the smaller grain has the lower starting temperature.

It is inferred that grain size affect the PEN-to-CEN transformation because the transformation is considered martensitic. The purpose of this study is to make clear the condition PEN can retain at room temperature which associated with grain size.

[Experiments]

The starting material of experiments was OEN synthesized by the flux method according to Ozima(1982). We crushed and assorted synthetic OEN as grain size (˜3μm, ˜10μm, 35˜51μm, 32˜63μm, 51˜73μm, 73˜96μm, 63˜125μm, 96˜105μm), and heated these samples by the box electric furnace at 1200 ℃ for 20 hours, and after that cooling rate was 5 ℃/min. And furthermore at the synchrotron radiation institution Photon Factory we examined the in situ observation of the PEN to CEN transformation at high temperature to obtain the transformation starting temperature.

[Results]

Only CEN peaks existed in the larger sample than 73˜96μm, on the other hand both CEN and PEN peaks existed in the smaller than 51˜73μm. In 73˜96μm sample the PEN to CEN transformation started at about 700 ℃, however in the ˜3μm sample the transformation started at about 600 ℃. These results indicate that the grain size evidently affect the phase transition temperature between PEN andCEN, that is, the PEN-to-CEN transformation is martensitic. Furthermore these suggest that PEN can retain at room temperature if its size is on the order of several 10μm and less.

[1]Foster(1951), *J. Am. Ceram. Soc.* 34 [9], 255-259.
[2]Lee end Heuer(1987), *J. Am. Ceram. Soc.* 70 [5], 349-360.
[3]Ozima(1982), *Ganseki Koubutsu Kousyogaku Gakkaishi Tokubetsugo* (Japanese) 3, 97-103.

Keywords: enstatite, phase transition, size effect