Grain growth experiment on forsterite-enstatite system

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To know grain size in the earth's mantle, grain growth experiment of one-phase system of forsterite (Fo) and two-phase system of forsterite (major phase)-enstatite (second phase: En) was conducted. Method for synthesizing polycrystalline body of fine-grained and high density using nano-sized powder was developed to vary the grain size under experiment and to reduce the pore drug for the grain growth. We are successful for obtaining fine-grained and high density polycrystalline aggregates of the composition to from Fo100 to Fo58.5En41.5 by changing mixing ratio of starting materials of $Mg(OH)_2$ and SiO_2 powders. Using these materials, the grain growth experiments of 0, 0.5, 1, 3, 10 or 50 hours at 1370C were conducted. We observed grain growths of Fo and En following grain growth law of d^n-$d_0{}^n$=k_n(t-t_0) (d[micron] is average grain diameter at t[h], the d_0 is average grain diameter at t_0[h], n is a growth exponent, and k is a grain growth factor). Analyzing experimentally obtained n, k, grain radius ratio of first phase and second phase (R/r) and grain size distribution, we have obtained following results:

(1) Zener pinning occurred during all the period of grain growth experiments for the two-phase system. The values of R/r do not change with time, and the relationship of R/r = $0.83/f^{0.48}$ (f: volume fraction of En) is proposed. The relationship is comparable to the microstructure of mantle xenoliths.

(2) Grain growth factor k3 (n=3) of the first phase (Fo) and f is related as 5exp(-(28.1-49.1$*$f)$*$f)

(3) Grain growth law of d^3-$d_0{}^3$=t$*$5exp(-(28.1-49.1$*$f)$*$f).

(4) Grain size distribution does not change with time and the composition, and can be approximated as lognormal distribution, which is also observed in natural samples.

(5) Fraction of the second phase can change the mantle viscosity of more than 10^2.