Sintering of fine-grained polycrystalline clinopyroxene

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The rheology of lower crust and upper mantle has been determined by deformation experiments of polycrystalline samples of rock-forming minerals. In these experiments, the samples were often synthesized to obtain fine-grained polycrystalline. In this study, we investigates a method for preparing the fine-grained polycrystalline clinopyroxene from nano-sized natural powders of clinopyroxene.
The starting materials for the experiment were prepared from two types of diopside single crystals (Di97Hed3:$Ca_{0.99}Na_{0.01}Mg_{0.97}Fe_{0.03}Si_2O_6$, Di99Hed1:$Ca_{0.97}Na_{0.02}Mg_{0.86}Fe_{0.13}Si_2O_6$) and a salite single crystal (Di87Hed13:$Ca_{0.97}Na_{0.02}Mg_{0.86}Fe_{0.13}Al_{0.02}Si_2O_6$) . They were crushed and milled into nano-sized powders. The milled powders were uniaxially pressed and sintered at 1230 - 1280 ℃ in atmospheres of argon or vacuum for 2-6h. After the sintering, sample surfaces were polished and thermally etched to expose grain boundaries. Grain size and porosity were determined from the microstructure of scanning electron microscope (SEM) .
After sintering at 1230℃, the relative density increased with increasing sintering time and reached the value of 98.0% and 93.5% of the theoretical density for Di97Hed3 and Di99Hed1 samples respecrively. The grain size of the each sample remains about <2μm. On the other hand, only 94.1% and 90.5 vol% of theoretical density were obtained from samples sintered at 1280℃ and the grain size increased to 5μm. Abnormally large grains and large porosities were found in Di87Hed13 sample. We found that the sintering temperature of 1230℃ is more suitable for densification and grain growth of polycrystalline clinopyroxene than 1280℃.

Keywords: sintering, clinopyroxene

