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CRYSTALLIZATION OF METASTABLE QUARTZ TO COESITE

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Morphological development of coesite crystal obtained at 550~900°C under 23~55 kb was strongly influenced by the state of aggregates of intermediate quartz. The sizes of quartz aggregates and coesite crystals decreased with increaseing pressure and with decreasing temperature.

The crystallization kinetics of coesite from amorphous silica was found to be expressed by a consecutive one through the intermediate phase of quartz.1,2) The crystallization rate of coesite depended strongly on the starting materials and was explained by the difference in the state of intermediate quartz.3) In this work, morphology of coesite crystals was also found to be influenced by the state of metastable quartz.

The girdle type high pressure apparatus was used. The details on the experiment have been reported.1,4) Coesite crystals were obtained from amorphous silica and quartz under 23~55 kb at 550~900°C in the absence of water and were observed under optical microscope by using thin sections.

The crystallization process of coesite from metastable quartz, which was formed from starting amorphous silica as an intermediate phase, is shown in Fig. 1.

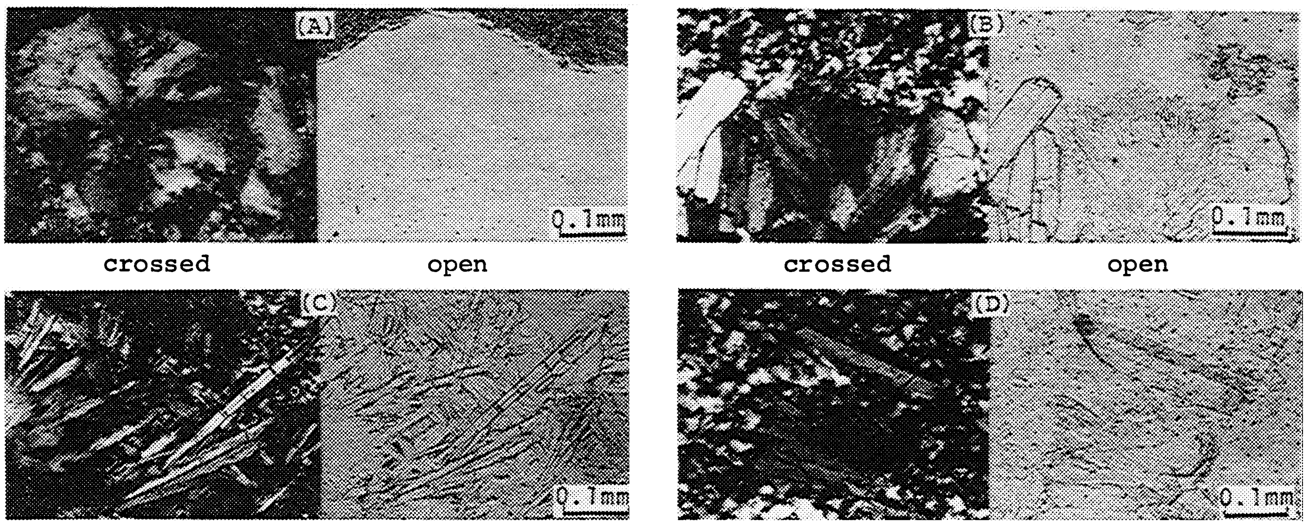

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Fig. 1 Crystallization of metastable quartz to coesite.
Starting material was amorphous silica and conditions of crystallization were 23 kb, 900°C, 300 min (A, B) and 600 min (C, D).

The spherulitic quartz aggregates with the size of less than 0.3 mm were found (Fig. 1-A), as reported previously.[3] The spherulitic coesite crystals (Fig. 1-B) were also found in the same specimen, which seemed to be formed from the quartz spherulites. On the top of the spherulites of coesite, many lath-shaped coesite crystals elongate along the c-axis into quartz matrix with the increasing of heating time (Figs. 1-B and 1-C). This suggests the rapid growth of coesite in expenditure of quartz matrix. In addition to quartz spherulites, many small particles with the size of 1~5 μm were formed and made matrix (Figs. 1-B and 1-D). Large coesite crystals of 0.15 mm long were also found in these quartz matrix, some of them having well-defined crystal havit (Fig. 1-B), but some being still obscure (Fig. 1-D).

In Fig. 2, crystallization of coesite under various conditions are shown. Size of quartz aggregates became small as pressure increased; 0.2 mm under 30 kb (Fig. 2-A) and less than 0.05 mm under 55 kb (Fig. 2-B). Coesite crystals with the size of 0.02 mm long were found to crystallize in needle-like shape at the center of the quartz aggregates under 30 kb (Fig. 2-A). The similar phenomenon was reported on the reverse transformation of coesite to quartz.[5] Under high pressure 55 kb, small spherulitic coesite crystals were observed (Fig. 2-B), but no quartz spherulites. Under 40 kb at 900°C, coesite crystallized in lath-shaped crystals with the size of 0.1 mm long (Fig. 2-C). The crystal size of coesite decreased with increasing pressure and with decreasing temperature.

When quartz was used as a starting material, needle-like crystals of 0.1 mm long were observed (Fig. 2-D). These crystals were much smaller than those obtained from amorphous silica (Fig. 1-C). This difference in crystal size of coesite seemed to be resulted from the difficulty for aggregation of quartz particles and the many nucleation possibilities of coesite from starting quartz.

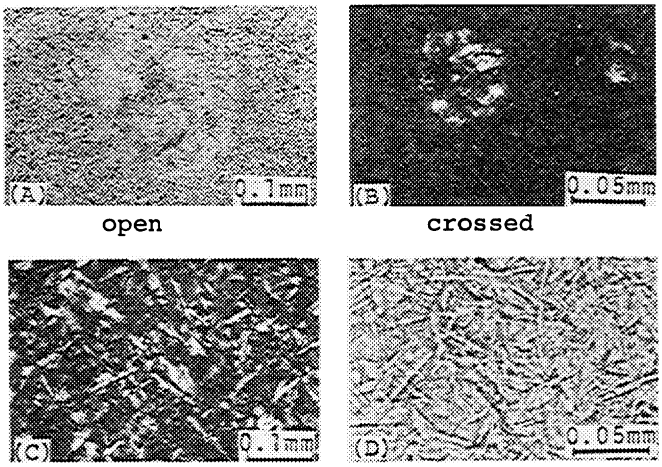

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Fig. 2 Crystallization of coesite under various conditions;

Starting materials	Conditions
(A) amorphous silica	30 kb, 550°C, 180 min
(B) amorphous silica	55 , 550 , 210
(C) amorphous silica	40 , 900 , 60
(D) quartz	23 , 900 , 580

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