An aluminous phase of MORB in the lower mantle

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The phase relation of mid-oceanic ridge basalt (MORB) at high pressures and high temperatures has attracted attention in the geophysical community because MORB is one of the rocks in the oceanic crust that seems to subduct into the lower mantle. The aluminous phase appears in the MORB composition at pressures corresponding to the lower mantle conditions, and has now been investigated from both the multi-anvil and diamond-anvil cell experiments. These studies have reported that the aluminous phase has a calcium ferrite-type structure with orthorhombic symmetry. Recently, it was reported that the aluminous phase possesses a hexagonal symmetry with space group $P6_3/m$ which is proposed as one of the potassium host phases in the lower mantle. The difference in crystal structure affects the physical properties of the subducted slab. Therefore, it is important to determine the crystal structure of the aluminous phase in the MORB composition.

High-pressure X-ray diffraction experiments were performed using the LHDAC high-pressure apparatus. The powdered gel-type MORB was loaded into 100 μm holes drilled in rhenium gaskets preindented to a thickness of 50-100 μm. The samples were heated with a multimode continuous wave Nd:YAG laser using double-sided laser heating techniques which minimized temperature gradients of the heated area. The sample temperature was measured from one side of the sample using the spectroradiometric method. The heated samples were probed by angle-dispersive X-ray diffraction using the synchrotron beam line BL10XU. The incident X-ray beam was monochromatized to wavelength of about 0.4 Å. The X-ray beam size was collimated to about 20 μm diameter. Angle-dispersive, X-ray diffraction patterns were obtained on an imaging plate. The observed intensities on the imaging plates were integrated as a function of 2 θ in order to give conventional, one-dimensional diffraction profiles.

There is a question whether the structure of the aluminous phase is the calcium ferrite-type orthorhombic structure or the hexagonal structure at high pressure and high temperature. The hexagonal phase does not have a diffraction peak corresponding to the 220 (d = 3.2Å) of the calcium ferrite-type structure. However, this peak was observed at high pressure and high temperature in our study (Fig. 1). Moreover, the low-angle distinctive diffraction peaks of 100 (d = 7.3Å) and 200 (d = 3.6Å) of the hexagonal structure were not observed in N-MORB sample. These results strongly suggest that the aluminous phase in the MORB composition is not the hexagonal structure, but is the calcium ferrite-type orthorhombic structure.

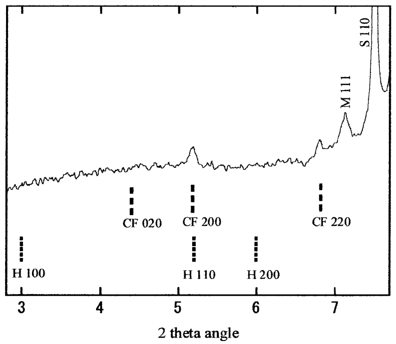

Fig. 1. Comparison of X-ray diffraction pattern for N-MORB at 26 GPa and 300 K, with peaks of aluminous phases. Abbreviations as follows: CF, calcium ferrite-type aluminous phase; H, hexagonal aluminous phase; M, Mg-perovskite; S, stishovite.

Local structure around In atoms in $In_xGa_{1-x}N$ single-quantum-wells by XAFS

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InGaN is a key material in high-brightness blue/green light emitting diodes and purplish-blue laser diodes. Although such devices have very high densities of threading dislocations, they show high quantum efficiency. In mole fluctuation in InGaN active layers is proposed as its origin.[1)] In this work, EXAFS measurements were carried out to study local structures around In atoms in InGaN.

The samples used are $In_xGa_{1-x}N$ (x=0.02) single-quantum-wells (SQWs) of 5 nm thickness, and were grown by metalorganic chemical vapor deposition on a sapphire (0001) substrate.[2)] XAFS data were collected with a Si(111) double-crystal monochromator. Since the concentration of In is rather low, we use the high brilliance X-ray beam at BL10XU. In K_α-fluorescence emission was measured using a 19-element Ge detector. The samples were set in both horizontal and vertical directions to electric field of incident X-ray.

Figures 1 and 2 show the EXAFS $k\chi(k)$ oscillation functions and their Fourier transforms of In K-edge for $In_{0.02}Ga_{0.92}N$ in horizontal and vertical directions analyzed by XANADU code.[3)] We find clear differences between them. The phenomenon observed in the present study is seemed to be analogous to that in previous Green InGaN result.[4)] More detailed analyses are in progress.

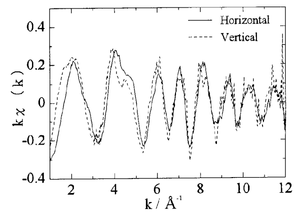

Fig. 1 The EXAFS $k\chi(k)$ spectra of In K-edge for $In_{0.02}Ga_{0.92}N$ SQW in horizontal (solid line) and vertical (dashed line) directions.

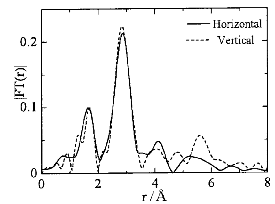

Fig. 2 The Fourier transforms of the EXAFS shown in Fig.1.

References

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