Characterization of the Al-rich phase(s) in the garnet-perovskite phase transformation

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Introduction

Recently, it was shown that aluminous garnet transforms into Mg-silicate perovskite, stishovite and a new Al-rich phase with an unknown structure under the upper part of the lower mantle condition. However, the nature of this Al-rich phase is still not clear. This project was planned to clarify the structure of this Al-rich phase more precisely by the combined method of a laser-heated diamond anvil cell and synchrotron radiation.

Samples

Two kinds of samples, natural pyrope garnet ($(Mg,Fe,Ca)_3Al_2Si_3O_{12}$) (denoted as Py) and glass with the composition corresponding to the Al-rich phase (denoted as GL), were compressed to 37 Gpa and heated by a YAG laser at the laboratory of Prof. T. Yagi of ISSP of the University of Tokyo. These were used for the in situ X-ray diffraction experiments.

Synchrotron radiation experiments

High pressure in situ X-ray diffraction experiments were carried out at BL10XU of Japan Synchrotron Radiation Research Institute. Monochromatized X-rays (λ= 0.4188 Å) and an imaging-plate detector with the camera length of 300 mm were used.

Results and discussion

The in situ X-ray diffraction pattern of Py at 30 Gpa revealed that pyrope decomposed into Mg-silicate perovskite (denoted as MgPv), Ca-silicate perovskite (denoted as CaPv), stishovite and the Al-rich phase, while CaPv disappeared in the X-ray diffraction pattern at 0 GPa because of amorphization. However, the X-ray diffraction pattern of the Al-rich phase is overlapping with those of other phases, and it seems difficult to clarify the structute of the Al-rich phasae from these data.

In situ X-ray diffraction patterns of GL showed MgPv and corundum but no Al-rich phase at both 36 and 0 Gpa, probably because the chemistry of glass was slightly different from the Al-rich phase in terms of larger cations such as Na or K.