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DIA 型変形装置を用いたマントル遷移層温度圧力条件下でのウォズリアイトのクリープ強度その場測定
An in situ measurement of creep strength of wadsleyite in a D-DIA apparatus at P-T conditions of mantle transition zone

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In order to study creep strength of wadsleyite at P-T conditions of the mantle transition zone, technical developments have been made by optimization of a multi-anvil 6-6 (MA6-6) assembly for extending P-T conditions of in situ stress-strain measurements in a deformation-DIA (D-DIA) apparatus over 10 GPa and 600 K. Deformation experiments of wadsleyite were conducted using a cubic-anvil apparatus SPEED-Mk.II with a D-DIA system, which was newly installed in 2010, at BL04B1 beamline of SPring-8. We used second-stage anvils made of cubic BN and tungsten carbide with a truncated edge length of 2.5 mm. The stress and the strain of wadsleyite were quantitatively determined at experimental processes including deformation at high P-T conditions using in situ X-ray radial diffraction and radiography, respectively. In the optimization, efficiency of pressure generation was improved to adjust dimensions of a preformed gasket, and materials with low X-ray absorption were adopted for materials of second-stage anvils, columns of an anvil guide and an X-ray window in a LaCrO3 heater to reduce X-ray absorption. As a result of the optimization, the P-T conditions of the in situ stress-strain measurements in the D-DIA apparatus were extended to 15.3 GPa and 1700 K. Using the developed technique, uniaxial deformation on wadsleyite was achieved to the strain of 19 % at the strain rate of 3.7 x 10^-5 s^-1 and at 15.3 GPa and 1700 K. In this study, the stress-strain measurements on wadsleyite were succeeded at the P-T conditions of the mantle transition zone and at controlled strain rate. The present study extended the P-T range of the measurements in the D-DIA apparatus from 9.6 GPa in early studies to 15.3 GPa at high temperature corresponding to interior of the earth. The experimental results demonstrate potential of the present deformation system composed of the D-DIA apparatus and the MA6-6 assembly as an important tool to investigate the creep strength of deep mantle minerals under the P-T conditions of an upper part of the mantle transition zone.

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