

High-pressure phase transformation in lutetium sesquioxides at room temperature

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Introduction

Among the rare earth sesquioxide structures, the A-type was recognized as a high temperature phase in light rare earth sesquioxides [1, 2]. The A-type stabilization area expands to the heavy rare earth sesquioxides under high pressure. To date, many in-situ x-ray diffraction experiments revealed the unquenchable A-type phase in Sm_2O_3 , Eu_2O_3 , Gd_2O_3 and Yb_2O_3 under high pressure [e.g 3-6]. Recently, a few groups conducted compression experiments of a lutetium sesquioxide which is the heaviest lanthanide sesquioxides to establish the C – B – A-type phase transformation sequences [7,8]. However, they have not found the A-type in lutetium sesquioxides. In this work, we re-examined the pressure-induced phase transformation of lutetium sesquioxides using an angle dispersive in-situ x-ray diffraction method.

Experimental

Powder form of lutetium sesquioxide sample (99.99% pure: C-type structure) was prepared for the high-pressure experiments using a diamond anvil cell. The sample mixed with a small amount of gold powder was put into the hole in the rhenium gasket with a methanol: ethanol: water (16:3:1) pressure medium. The in-situ x-ray diffraction experiments were done at AR-NE1. A monochromatic x-ray beam (30keV) was focused and collimated to the sample within 30 microns size. Diffracted x-rays were detected by an imaging plate. The LeBail analysis in the GSAS package was used for the profile fitting of the x-ray profiles. Pressure was determined from the lattice parameters of gold [9].

Results and discussion

As well as the compression experiments on Yb_2O_3 , the C-type starts to convert into the B-type at 14 GPa. Further compression facilitates the transition to the B-type. However, the A-type did not appear up to 25 GPa, although the B-type in Yb_2O_3 almost converts to the A-type at this pressure. According to the recent publications [7,8], no transformation from B-type to A-type was reported even compression to 39.5 and 46.9 GPa. We also apply the pressure of 47 GPa to reproduce their experiments. After the compression to 30 GPa, the C-type completely disappeared and the A-type was gradually emerged. Finally, at 47 GPa, we mostly observed the A-type. Due to the metastability, the A-type completely reverts to B-type during decompression to 1 atm. The evident difference between the diffraction

profiles of (Fig.2e) and (Fig.2f) also indicates the formation of A-type under high pressure.

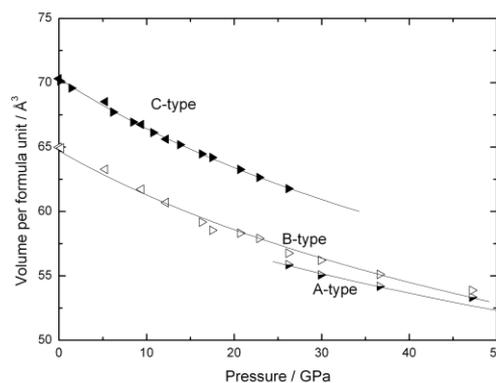


Fig. 1. :P-V data (triangles) and compression curves (solid lines) of Lu_2O_3 polymorphs. The right and left pointing of triangles indicate the compression and decompression, respectively

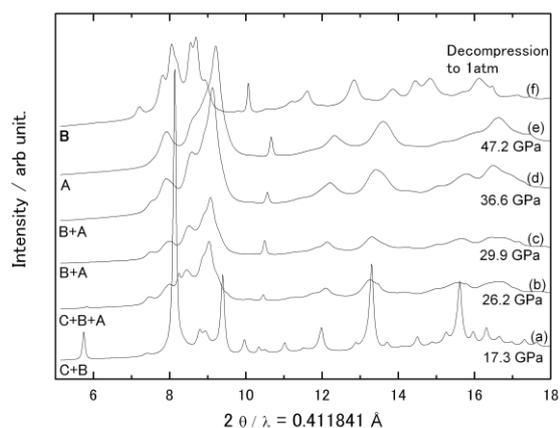


Fig. 2. X-ray diffraction profiles from Lu_2O_3 samples under pressure.

References

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