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X-Ray Diffraction Study of NiAl₂O₄ at High Pressure

J. Chen and J. Zhang (SUNY, Stony Brook)

Beamline(s): X17B1

Introduction: Oxide spinels have been investigated extensively in the solid state sciences for several decades because of its usefulness as magnetic materials, semiconductors, pigments, catalysts, refractories, and as convenient model compounds to explore the relative stabilities of ions in octahedral and tetrahedral coordination. As common accessory minerals, petrogenetic indicators, and ores, they are ubiquitous geologic materials. For these reasons, crystal structure of NiAl₂O₄ spinel and temperature effect on the structure have been studied previously[1-3]. However knowledge about the crystal structure change at high pressures is little. We carried out monochromatic x-ray diffraction experiments at high pressure to study the high-pressure behavior of NiAl₂O₄ spinel.

Methods and Materials: The experiments are conducted by using a cubic-type multi-anvil press SAM85 at the X17B1 beamline[4]. The translating imaging plate system[5] at the beamline is used to collect monochromatic diffraction data. Starting material is NiAl₂O₄ spinel powder. The sample is compressed at room temperature and then heated up step wise at high pressures. X-ray diffraction patterns are collected at each temperature step.

Results: Two experiments have been conducted. In both runs, we observed instability of the spinel structure. Most likely the spinel structure is unstable with respect to a mixture of nickel oxide and aluminum oxide. Density measurements show that the spinel structure has a large volume than the oxides. Structural distortion before the decomposition is expected to be revealed by structure refinements based on the data collected.

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References:

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