Elastic properties of fayalite

Frédéric Béjina*†[1], Misha Bystricky[2], Nicolas Tercé[3], Neil Meunier-Mili[3], Matthew Whitaker[4], and Haiyan Chen[5]

[1]Institut de Recherche en Astrophysique et Planétologie (IRAP) – Université Paul Sabatier - Toulouse III, Centre National de la Recherche Scientifique - CNRS, Observatoire Midi-Pyrénées - OMP (FRANCE) – 14 avenue Edouard Belin 31400 TOULOUSE, France

[2]Institut de recherche en astrophysique et planétologie (IRAP) – Université Paul Sabatier - Toulouse 3, Observatoire Midi-Pyrénées, Centre National de la Recherche Scientifique : UMR5277 – 14 avenue Edouard Belin, 31400 Toulouse, France

[3]Institut de recherche en astrophysique et planétologie (IRAP) – Université Paul Sabatier - Toulouse 3, Observatoire Midi-Pyrénées, Centre National de la Recherche Scientifique : UMR5277 – France

[4]Mineral Physics Institute, Stony Brook University, Stony Brook National Synchrotron Light Source, Brookhaven National Laboratory – Brookhaven, N.Y., U.S.A., United States

[5]Advanced Photon Source [ANL] (APS) – Argonne National Laboratory Building 401 9700 S. Cass Avenue Argonne, IL 60439, United States

Abstract

Olivine, a solid-solution between forsterite (Mg2SiO4) and fayalite (Fe2SiO4) is one of the most abundant minerals in the mantles of terrestrial planets. The knowledge of its thermo-elastic parameters is essential to understand and model planetary interiors. Because the accepted average composition of Earth's mantle olivines is around [Fe0.1,Mg0.9]2SiO4, Mg-rich olivines have been extensively studied. In comparison Fe-rich olivines have received little attention. We performed a series of experiments in orde to measure equations of state of olivines with compositions ranging from [Fe0.4,Mg0.6]2SiO4 to Fe2SiO4. The purpose is to better constrain the effect of Fe content on elastic properties of olivines. We will mostly present our results obtained on fayalite Fe2SiO4.

Our fayalite samples were synthesized from nano-size powders of elementary oxides mixed with the proper stoichiometries and reacted at room pressure and 1000∘C under controlled atmosphere. The fully reacted powders were then sintered using Spark Plasma Sintering in order to minimize the porosity of our samples. The resulting olivine aggregates have homogeneous grain sizes, close to 2 μm. High-pressure high-temperature experiments (up to about 7 GPa and 600∘C) coupled with synchrotron X-ray diffraction and X-radiographic imaging were conducted using the DIA apparatus at the X17B2 beamline at NSLS (Brookhaven, N.Y., U.S.A). This setup allowed us to estimate the deviatoric stress present in both the sample and NaCl, the pressure calibrant. We also performed ultrasonic interferometry measurements in order to obtain P- and S-wave travel times using the DIASCoPE setup at X17B2. The sample density was determined in situ using X-ray diffraction, the sample length was measured under extreme conditions using the X-radiographic image, and the acoustic travel times were measured using the ultrasonic interferometer. The travel times combined with

*Speaker

†Corresponding author: frederic.bejina@irap.omp.eu

sample lengths yield the P- and S-wave velocities in the sample, and these data combined with the density gives a direct measurement of the elastic bulk and shear moduli under all conditions of the experiment.

Our presentation will focus on results obtained on Fe2SiO4 samples from X-ray diffraction and ultrasonics experiments, in particular the role of the deviatoric stress on the elastic properties will be discussed.