

Focused ion beam preparation and characterization of single-crystal samples for high-pressure experiments in the diamond-anvil cell

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ABSTRACT

We show that the focused ion beam (FIB) technique is well suited to prepare single-crystal samples with defined dimensions and shape and excellent surface qualities for use in high-pressure experiments carried out in the diamond-anvil cell. The method allows for cutting and polishing delicate samples, including tiny, brittle, or metastable phases and thereby extends the range of materials that can be routinely probed at extreme pressures and temperatures. In addition, the technique is capable of producing electron-transparent foils from the same sample material that can be characterized on the nanometer scale by transmission electron microscopy (TEM). The application of the method to the preparation of various geomaterials is discussed with a focus on the preparation of double-side polished, transparent sample platelets for the use in Brillouin scattering experiments at extreme conditions. Using one of our FIB-prepared samples, we were able to perform direct experimental measurements of acoustic wave velocities of antigorite along crystallographic directions, which were previously inaccessible to direct Brillouin scattering measurements. At 0.6 GPa, we measure a 39% anisotropy of compressional wave velocities.

Keywords: Brillouin spectroscopy, focused ion beam, high-pressure, diamond-anvil cell, sample preparation, optical spectroscopy, antigorite