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Single-crystal elasticity of brucite, $Mg(OH)_2$, to 15 GPa by Brillouin scattering

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ABSTRACT

The second-order elastic constants of brucite were determined by Brillouin scattering to 15 GPa in a diamond anvil cell. The experiments were carried out using a 4:1 methanol-ethanol mixture as pressure medium, and ruby as a pressure standard. Two planes, one perpendicular to the *c* axis (basal plane) and the other containing the *c* axis (meridian plane), were measured at room pressure and 10 elevated pressures. Individual elastic stiffnesses, aggregate moduli, and their pressure derivatives were obtained by fitting the data to Eulerian finite strain equations. The inversion yields individual elastic constants of C_{11} = 154.0(14) GPa, C_{33} = 49.7(7) GPa, C_{12} = 42.1(17) GPa, C_{13} = 7.8(25) GPa, C_{14} = 1.3(10) GPa, C_{44} = 21.3(4) GPa, and their pressure derivatives of $(\partial C_{11}/\partial P)_0$ = 9.0(2), $(\partial C_{33}/\partial P)_0$ = 14.0(5), $(\partial C_{12}/\partial P)_0$ = 3.2(2), $(\partial C_{13}/\partial P)_0$ = 5.0(1), $(\partial C_{14}/\partial P)_0$ = 0.9(1), $(\partial C_{44}/\partial P)_0$ = 3.9(1). Aggregate moduli and their pressure derivatives are K_{S0} = 36.4(9) GPa, G_0 = 31.3(2) GPa, $(\partial K_S/\partial P)_{T0}$ = 8.9(4), $(\partial G/\partial P)_0$ = 4.3(1) for the Reuss bound, and K_{S0} = 43.8(8) GPa, G_0 = 35.2(3) GPa, $(\partial K_S/\partial P)_{T0}$ = 6.8(2), $(\partial G/P)_0$ = 3.4(1) for the Voigt-Reuss-Hill average. The ratio of the linear compressibility along the *c* and *a* axes decreased from 4.7 to 1.3 over the examined pressure range. The shear anisotropy (C_{66}/C_{44}) decreased from 2.6(1) at ambient condition to 1.3(1) with increase of pressure to 12 GPa. Axial compressibilities and a compression curve constructed from our Brillouin data are in good agreement with previous X-ray diffraction data. The increased interlayer interactions and hydrogen repulsion that occurs as brucite is compressed produce a continuous variation of elastic properties rather than any abrupt discontinuities.

Keywords: Brucite, elasticity, high pressure, brillouin scattering