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Recent Advances in Understanding Elasticity of the Mantle and Core

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Elasticity of the candidate materials at the relevant P-T conditions of the Earth's mantle and core provides critical information in understanding seismic profiles and anisotropies, in building reliable compositional and mineralogical models, and in deciphering geodynamic processes and thermal history of the Earth's interior. Here I will discuss recent advances and research results in using laser and X-ray spectroscopic techniques to investigate the elasticity of candidate mantle and core materials in a high-pressure diamond anvil cell. The use of combined Brillouin and Impulsive Stimulated Scattering (ISS) results permits direct measurements of both Vp and Vs and derivation of full elastic constants of single-crystal ferropericlase and silicate perovskite up to megabar pressures. These results show that Vp of ferropericlase displays significant softening across the spin transition, while Vs is only slightly affected. The derived single-crystal C_{ij} of Bridgmanite at lower mantle pressures display relatively small elastic Vp and Vs anisotropies as compared to the ferropericlase counterpart. Furthermore, research results on the elasticity of single-crystal, polycrystalline, and textured iron alloys at high P-T conditions show that bcc-Fe and Fe-Si alloy crystals display extremely high Vp and Vs anisotropy while hcp-Fe exhibits only a few percent Vp anisotropy. Based on the expansion of the Christoffel equation, a new method to derive full elastic constants (C_{ij}) of single crystals using Vs or Vp alone will also be presented. Using thermoelastic modelling, I will discuss the elastic constants, sound velocities, elastic anisotropies, and seismic parameters of ferropericlase, Bridgmanite, and iron alloys at relevant conditions of the Earth's interior. These recent elasticity results are compared to seismic models to advance our understanding on seismic structures, mineralogical models, and geodynamic processes of the deep Earth's interior.

Keywords: Elasticity, Ferropericlase, Bridgmanite, Diamond Anvil Cell, High Pressure, Lower Mantle