Single-Crystal Elasticity of Magnesiosiderite in the lower mantle

Suyu Fu[a], Jing Yang[a], Jung-Fu Lin[a,b]

[a]Department of Geological Sciences, Jackson School of Geosciences, The University of Texas at Austin, Austin, TX78712, USA
[b]Center for High Pressure Science and Technology Advanced Research (HPSTAR), Shanghai 130012, China

Carbon can be transported into deep Earth's interior via subduction of carbonated oceanic crust, hosted as Mg-Fe bearing carbonates [1, 2]. The existence of stable carbonate can significantly affect our understanding on geochemical and geophysical properties of the planet. Early studies have shown that iron spin-pairing transition could occur in the iron-enriched carbonates, generally called magnesiosiderite, under lower mantle conditions. The pressure-induced spin state change is accompanied by a sudden volume collaps [3, 4]. However, the effects of the spin-pairing transition on single-crystal elasticity of magnesiosiderite under high pressure conditions are still unclear. Understanding the elasticity of single-crystal magnesiosiderite at relevant lower mantle conditions plays an important role in better understanding the seismic signatures in the carbon-enriched region, and to constrain carbon storage and recycling in the mantle. In order to solve all individual elastic constants (C_{11}, C_{22}, C_{33}, C_{44}, C_{55}, C_{66}, C_{12}, C_{23}, and C_{13}) of magnesiosiderite at high pressures via Christoffel's equations, we employed Brillouin Light Scattering (BLS) to measure shear wave (Vs) and compressional wave velocities (Vp) as a function of the azimuthal angle under lower mantle pressures, accompanied by Impulsive Stimulate Light Scattering (ISS) to measure the Vp when pressures are too high to measure it by BLS. We have developed a general thermoelastic modelling to fit the elastic softening within the spin transition. We will further discuss the effects of pressures, as well as iron spin states, on the single-crystal elasticity and seismic parameters (Vp and Vs anisotropy AVp, AVs, etc) at lower mantle conditions. These results could provide clues in explaining regional seismic heterogeneities in deep mantle.

Reference:

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