Elasticity of nanocrystalline grossular up to 50 GPa

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Nanocrystalline grossular samples with different grain sizes are synthesized at 15 GPa, 1400 1500 and 1600-degree C using the 3,000 ton multi-anvil press (ORANGE-3000). The grain size varies from 90nm+/-36nm, 93nm+/-54nm, to 179nm+/-58nm. These samples show excellent optical quality and are ideal for Brillouin scattering experiments. We have performed sound velocity measurements of the two samples with averaged grain size 90nm and 179nm up to 50 GPa under ambient temperature in the Brillouin spectroscopy laboratory at University of New Mexico. X-ray diffraction experiments were performed at the same pressure range at GSECARS, Advanced Photon Source. All samples were double-side polished into pallets with thickness less than 15 um, and loaded with several ruby spheres inside diamond anvil cells. Ne is used as pressure medium to avoid possible large deviatoric stress developed within the sample chamber. For each sample, Vp and Vs velocities were measured at a minimum of 4 different Chi angles on both sides to avoid any asymmetrical effect to the measured Brillouin frequency shifts. We find out that although the absolute values of the measured velocities are very similar between the two grossular samples, especially considering the experimental uncertainties, some systematic trends do exist. Our preliminary results show that the grossular sample with 179nm average grain size has higher velocities than the sample with ~90nm averaged grain size under ambient condition. However, the differences diminish with increasing pressures, and the velocity crossover eventually takes place at about 30 GPa. Such observation is unexpected for nanocrystalline samples with grain size larger than 30-50 nm. The elastic behavior of nanocrystalline materials at high-pressure condition is probably more complicated than what we thought before.