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Simultaneous measurements of the elastic wave velocities and the volume for amorphous materials under pressures

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Combined ultrasonic and microtomographic measurements were conducted for simultaneous determination of elastic property and density of noncrystalline materials at high pressures. A Paris?Edinburgh anvil cell was placed in a rotation apparatus, which enabled us to take a series of xray radiography images under pressure over a 180? angle range and construct accurately the three-dimensional sample volume using microtomography. In addition, ultrasonic elastic wave velocity measurements were carried out simultaneously using the pulse reflection method with a 10? Y-cut $LiNbO_3$ transducer attached to the end of the lower anvil. Combined ultrasonic and microtomographic measurements were carried out for SiO_2 glass up to 2.6 GPa and room temperature. A decrease in elastic wave velocities of the SiO_2 glass was observed with increasing pressure, in agreement with previous studies. The simultaneous measurements on elastic wave velocities and density allowed us to derive bulk (Ks) and shear (G) moduli as a function of pressure. Ks and G of the SiO_2 glass also decreased with increasing pressure. The negative pressure dependence of Ks is stronger than that of G, and as a result the value of Ks became similar to G at 2.0?2.6 GPa. There is no reason why we cannot apply this new technique to high temperatures as well. Hence the results demonstrate that the combined ultrasonic and microtomography technique is a powerful tool to derive advanced (accurate) P?V?Ks?G?(T) equations of state for noncrystalline materials.

Keywords: x-ray tomography, ultrasonic, high pressure, glass