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Ultrasonic Study of Water Adsorbed in Nanoporous Glasses

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Thermodynamic properties of fluids confined to nanopores differ from those observed in the bulk. To investigate the effect of nanoconfinement on compressibility of water, we measured water adsorption isotherm concurrently with compressional and shear ultrasonic velocities for two nanoporous glass samples. These measurements yield the longitudinal and shear moduli of the water-saturated nanoporous glass as a function of relative humidity and allow estimation of the bulk modulus of the confined water using the Gassmann theory. The modulus estimated from the experimental data is noticeably higher than that of bulk water at the same temperature and exhibits a linear dependence on the Laplace pressure derived from the relative humidity. Our findings obtained for water, which is a polar fluid, agree with previous experimental and numerical data reported for non-polar fluids, suggesting that irrespective of their structure, confined fluids are stiffer than bulk fluids. Accounting for fluid stiffening in nanopores may be important for accurate interpretation of wave propagation measurements in fluid-filled nanoporous media, including in petrophysics, catalysis, and other applications in process sensing.

Participation

In-Person

References

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