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Sorption-Ultrasonic Characterization of Water-Filled Xerogels

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Many studies have proven that elastic properties of fluids confined in nanopores deviate from the values observed in bulk [1]. Interactions between the solids (pore wall) and fluids, and pore geometry are the key factors that determine the deviation in the elasticity of nanoconfined fluids. Therefore, experimental measurements of elastic properties of confined fluids can provide information about the porous solids themselves. In this work, we studied the elasticity of carbon xerogels when they are gradually saturated with water. Here, a novel adsorption-ultrasonic experimental setup [2] was employed to measure the ultrasonic wave speeds through the water-saturated carbon xerogel sample while measuring its water sorption isotherm. The measured water sorption isotherm follows type V isotherm [3], which describes the mechanisms of fluid adsorption to the nanopores. Elastic moduli of the xerogel-water composite, derived from the measured ultrasonic wave speeds, were then used to calculate the bulk modulus of the confined water using the Gassmann theory. The resulting elastic properties differ noticeably from those measured on water-saturated Vycor glass [2]. We found that the measured elastic properties of the water saturated carbon xerogels are strongly affected by adsorption-induced deformation [4].

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Primary author: KARUNARATHNE, Ashoka (New Jersey Institute of Technology)

Co-authors: KHALIZOV, Alexei (Department of Chemistry and Environmental Science, New Jersey Institute of Technology, 323 Dr. Martin Luther King Jr. Blvd, Newark, NJ 07102, USA); Prof. GOR, Gennady (Princeton University, NJIT); Dr REICHENAUER, Gudrun (Center for Applied Energy Research e.V. (CAE)); Mr BRAXMEIER, Stephan (Center for Applied Energy Research e.V. (CAE))

Presenter: KARUNARATHNE, Ashoka (New Jersey Institute of Technology)

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