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Nanomechanics and dynamics of confined water and other liquids

PETER HOFFMANN, Wayne State University — From oil recovery to molecular biology, nanoconfined water plays an important role in many areas of research. However, the mechanics and dynamics of nanoconfined water are not well understood. Over the last ten years, a number of groups have measured the mechanics of confined water using atomic force microscopy (AFM) or surface force apparatus (SFA) - often with contradictory results. At Wayne State University, we have developed high resolution AFMs for ultra-small amplitude, linear measurements of the mechanics and dynamics of confined liquids. We have shown that water shows a distinct slow-down in dynamics under confinement (PRB 2004), co-discovered a dynamic "solidification" in a model liquid (Langmuir 2006), and showed that normal and shear stiffness are closely related in confined liquids (Rev. Sci. Instr. 2008). Recently, we found dynamic solidification also in water layers (PRL 2010), a finding that explains the contradictory findings in earlier measurements and points to surprisingly complex behavior in this seemingly simple system. Here we will review these findings, as well as present new findings that show the profound effects of ion concentration on these dynamical effects, as well as measurements of colloidal systems, which illustrate that some findings at the molecular scale can be understood from purely geometric considerations and are not dependent on molecular-scale interactions.

Peter Hoffmann
Wayne State University

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