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Viscous water meniscus under nano-confinement

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Abstract

Water molecules confined between interfaces with nanoscopic separation are of critical importance in many fields. Examples include, among others, hydration forces in biology and colloid science, stiction in microelectromechanical systems, swelling of layered clays, and capillary forces in scanning probe microscopy and nanolithography. Here we use interfacial force microscopy (IFM) to measure normal and lateral forces between two surfaces nanometers apart, with water confined between them. For two hydrophilic –COOH terminated surfaces, both friction and attractive normal forces peak at ~ 0.6 nm separation, owing to the water meniscus; this meniscus has an estimated viscosity nearly seven orders of magnitude greater than that of bulk water. Grand canonical Monte Carlo simulations confirm the presence of a nanoscopic meniscus and indicate an enhancement of the tetrahedral water structure in the meniscus as source for the enhanced friction force.