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Trapped aqueous films lubricate a highly-hydrophobic surface.

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Friction at hydrophobic surfaces in aqueous media is ubiquitous (e.g. prosthetic implants, contact lenses), but is not well understood. Here we measure directly both normal forces and sliding friction in an aqueous environment between a hydrophilic surface (single-crystal mica) and a stable, smooth, strongly hydrophobic surface (a spin-cast fluoropolymer film), using a surface force balance. Normal-force vs. surface-separation profiles indicate a high negative charge density on the hydrophobic surface, in line with previous studies where it is commonly attributed to adsorbed –OH- ions. Sliding of the compressed surfaces under water or in salt solution (0.1M NaCl) reveals remarkably low friction (friction coefficient $\mu \approx 0.003 - 0.009$) up to contact pressures of at least 50 atm (ca. 5 MPa). This is attributed to hydration lubrication mediated by hydrated counterions trapped between the surfaces: hydronium ions in the case of water or Na+ ions in the salt solution. Our results show that lubrication at a hydrophobic surface under water can occur via mechanisms hitherto associated only with hydrophilic surfaces.

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