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Absence of molecular slip on ultraclean and SAM-coated surfaces

JUSTIN PYE, CLAY WOOD, JUSTIN BURTON, Emory University — The liquid/solid boundary condition is a complex problem that is becoming increasingly important for the development of nanoscale fluidic devices. Many groups have now measured slip near an interface at nanoscale dimensions using a variety of experimental techniques. In simple systems, large slip lengths are generally measured for non-wetting liquid/solid combinations, but many conflicting measurements and interpretations remain. We have developed a novel pseudo-differential technique using a quartz crystal microbalance (QCM) to measure slip lengths on various surfaces. A drop of one liquid is grown on the QCM in the presence of a second, ambient liquid. We have isolated any anomalous boundary effects such as interfacial slip by choosing two liquids which have identical bulk effects on the QCM frequency and dissipation in the presence of no-slip. Slip lengths are –less than 2 nm– for water (relative to undecane) on all surfaces measured, including plasma cleaned gold, SiO2, and two different self assembled monolayers (SAMs), regardless of contact angle. We also find that surface cleanliness is crucial to accurately measure slip lengths. Additionally, clean glass substrates appear to have a significant adsorbed water layer and SAM surfaces show excess dissipation, possibly associated with contact line motion. In addition to investigating other liquid pairs, future work will include extending this technique to surfaces with independently controllable chemistry and roughness, both of which are known to strongly affect interfacial hydrodynamics.

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