Fluid slip and drag reduction on liquid-infused surfaces under high static pressure

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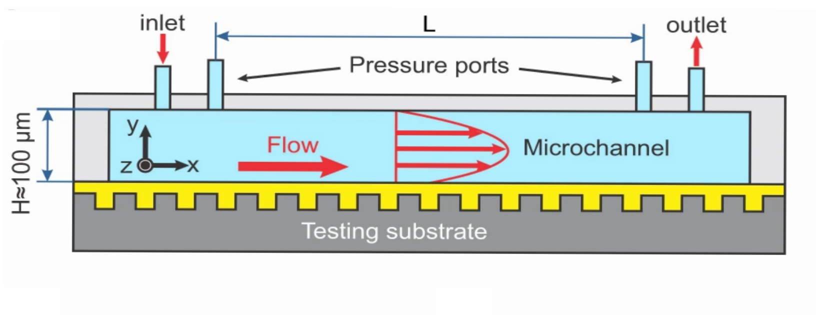
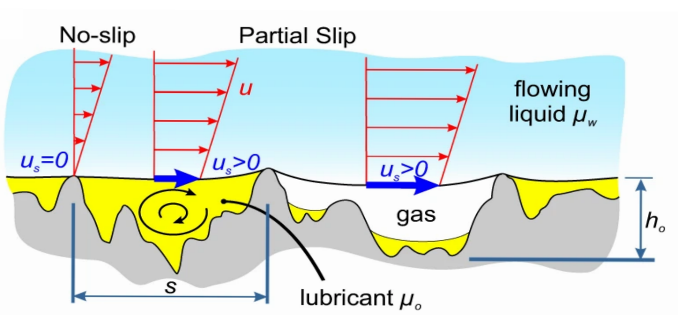
Liquid-infused surfaces (LIS) have been shown to reduce the huge frictional drag affecting microfluidic flow and are expected to be more robust than superhydrophobic surfaces when exposed to external pressure, as the lubricant in LIS is incompressible. Here we investigate the effect of applying static pressure on the effective slip length measured on Teflon wrinkled surfaces infused with silicone oil, through pressure measurements in microfluidic devices. 1 The effect of static pressure on LIS was found to depend on air content in the flowing water: for degassed water, the average effective slip length was b eff =2.16 +/- 0.90 µm irrespective of applied pressure. In gassed water, the average effective slip length was b eff =4.32 +/- 1.06 µm at zero applied pressure and decreased by 55% to 2.37 +/- 0.90 µm when the pressure was increased to 50 kPa, and then remained constant up to 200 kPa. The result is due to nanobubbles present on LIS, 2, 3 which are compressed or partially dissolved under pressure, and the effect is more evident when the size and portion of surface nanobubbles is higher. In contrast, on superhydrophobic wrinkles the decline in b eff was more sensitive to applied pressure, with b eff =6.8 +/- 1.4 µm at 0 kPa and, on average, b eff =−1 +/- 3 µm for pressures higher than 50 kPa, for both gassed and degassed water. Large fluctuations in the experimental measurements were observed on superhydrophobic wrinkles, suggesting nucleation of large bubbles on the surface. The same pressure increase did not affect the flow on smooth substrates, on which gas nanobubbles were not observed. Contrary to expectations, drag reduction in LIS is affected by applied pressure, for the same reason as in superhydrophobic surfaces, because they lose the real lubricant which makes them slippery, i.e. interfacial gas.





Lunedì 24 giugno 2024 - ore 10:30
Aula Videoconferenze, DIMA - Via Eudossiana 18, Roma
Link Google Meet: meet.google.com/xsd-gmaq-vnp

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