Experimental study on friction drag modification induced by a Liquid-Infused Surface in a turbulent flow

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Liquid infused surfaces (LISs) are a new class of materials that have received significant attention in recent years due to their unique ability to repel liquids and reduce friction[1]. These surfaces consist on a textured solid substrate that is coated with a thin layer of lubricant fluid, which creates a barrier between the surface and any contacting liquid. As a result, LISs prevent liquid droplets from adhering to the surface, which can be useful for a variety of applications such as self-cleaning, anti-fouling, and anti-icing coatings. Although LISs have shown promising results for reducing friction, their robustness and durability in turbulent waters is still being studied and face critical obstacles such as expensive large-scale production and lubricant drainage[2]. Various manufacture expedients have been proposed to limit drainage, for example by adding chemical barriers[3] or lubricant reservoirs to the substrate, at the cost of a more laborious and expensive fabrication. In this work, a new design for LISs that does not require additional coatings and is easily scalable to large sizes was developed and tested in a high aspect-ratio water channel. We show that, owing to the substrate energy properties, our LIS can stably retain the lubricating fluid in a turbulent flow. The effective application of LISs to achieve drag reduction is widely debated, mainly because of their limitation in maintaining a stable lubricant layer. Here, the change in frictional drag induced by our LIS in a turbulent flow is quantified and compared with the drag exerted by a smooth wall. The investigation is conducted by measuring the pressure drop along the water channel and deriving the associated shear stress. By running the system at different Reynolds numbers, it is possible to understand under which flow conditions the LIS retains enough lubricant to reduce drag and under which conditions lubricant retention is not sufficient to achieve a beneficial effect, but is instead detrimental.

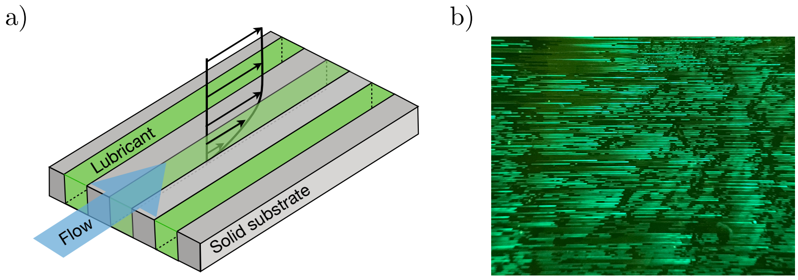

Figure 1: (a) Design of LIS for drag reduction.(b) Lubricant retained on a LIS in a turbulent flow at $Re_\tau = 460$.

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[1] Rosenberg et al., *Physics of Fluids* **28**, 015103 (2016).
[2] Wexler et al., *Physical review letters* **114**, 168301 (2015).
[3] Wexler et al., *Soft Matter* **11**, 5023 (2015).