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ABSTRACTS

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Keynote: Structured Surfaces – from Super-repellency to Drag Reduction

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Keywords: microstructured surface, superomniphobic, superhydrophobic, drag reduction

A solid surface may be geometrically structured in microscale or below, where liquid-gas interfacial tension plays an important role, to exhibit unusual properties to a liquid placed on it. Typical superhydrophobic (SHPo) surfaces are made of a hydrophobic material with microscale roughness to super-repel water drops. However, to super-repel low-energy liquids, such as oils and solvents, which partially wet all materials, the role of the roughness should increase to compensate for the material wettability. To super-repel all available liquids, including fluorinated solvents, which completely wet all materials, the repellency should be accomplished entirely by the roughness. Such superomniphobic surfaces may be considered a "mechanical" surface because the material or chemistry of the surface has no role. Although the apparent contact angle is commonly used to describe SHPo surfaces, different applications require different measures for different types of structured surfaces. Consider, for example, the widely anticipated drag reduction on SHPo surfaces. Unlike the common impression, the large contact angle on SHPo surfaces has not much to do with their ability to reduce the friction drag. Instead, the ability of the surface microstructures to retain air under water and the ability of the surface micropatterns to induce a large slip were found to determine the amount of drag reduction, as supported by many flow experiments including the recent high Reynolds number tests with a motorboat on the ocean water.

SLIPSs with Reduced Skin-Friction Resistance

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Keywords: SLIPS, skin-friction, marine applications

Skin-friction drag is a crucial problem for naval and maritime industries, accounting for over 50% of the total drag of many ships and submarines [1]. Thus, researchers have devoted their efforts to the quest for surfaces with reduced drag to be applied on marine vessels.
Bioinspired, liquid-repellent surfaces have been intensively investigated for this application. However, the well-known superhydrophobic surfaces have proven unsuitable for underwater conditions, due to the loss of trapped air pockets. On the other hand, Slippery Liquid-Infused Porous Surfaces (SLIPSs) have provided encouraging results in terms of drag resistance reduction and long-term stability [2]. However, further studies are needed to establish more solid relationships between SLIPS engineering and their drag resistance properties.
In this work, we have fabricated and tested SLIPSs with different infused oils. All these SLIPSs were based on a randomly oriented, nanostructured boehmite coating combined with an organic layer to promote retention of the infused liquid. Perfluoropolyethers, silicone oils and n-hexadecane were used as infused liquids. The drag resistance behavior of SLIPSs has been tested in three experiments involving different scales and flow régimes:

- Visualization of the rolling/sliding motion of a single drop on a tilted surface
- Measurement of the torque in a Couette-like flow apparatus (laminar conditions)
- Measurement of the wall shear force in a high-speed boundary layer over a large flat plate (turbulent conditions).

Preliminary results indicate that a careful design of SLIPSs is necessary to achieve the best compromise between drag reduction and long-term stability, particularly when the more challenging requirements typical of real, high-Reynolds number flows must be considered.

[1] Perlin, M.; Dowling, D. R.; Ceccio, S. L. Freeman Scholar Review: Passive and Active Skin-Friction Drag Reduction in Turbulent Boundary Layers. *J. Fluids Eng*. **2016**, *138 (9)*, 091104.
[2] Rosenberg, B. J.; Van Buren, T.; Fu, M. K.; Smits, A. J. Turbulent Drag Reduction Over Air- and Liquid-Impregnated Surfaces. *Physics of Fluids* **2016**, *28*, 015103.

Keyword Index