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Drag reduction inhibited by hydrophobic roughness distribution in the laminar regime[1] PIERRE-YVES PASSAGGIA, MARCO CASTAGNA, NICOLAS MAZELLIER, AZEDDINE KOURTA, PRISME Lab., Univ. of Orleans — Super-hydrophobic treatments of surfaces allow for minimizing friction by mean of a thin air layer separating the wall from the surrounding liquid. This interface induces a partial slip which decreases friction at the wall. However, the randomly distributed roughness in the case of a settling sphere in the laminar regime was found to produce no significant drag reduction. We begin by ruling out detrimental effects to super hydrophobic surfaces such as Marangoni-induced stresses, adsorption/desorption kinetics of surfactancts and air/liquid interface deformation using a time-scale analysis. Instead, we propose a new mechanism accounting for losses induced by the motion of the gas encapsulated around the sphere within the surface corrugations. This flow is modeled using an isotropic porous medium approach and uses the surface tortuosity and porosity as geometric parameters. Results from the model compare favorably with experiments performed by our group in glycerin and data from Modak & Bauhmik (2017) who considered honey and syrup as working fluids. Preliminary results of spheres manufactured to control both the tortuosity and the porosity show promising drag-reduction. These results are finally discussed in the context of turbulent wall-bounded flows.

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