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Marangoni stresses due to surfactant traces can severely limit the drag reduction of superhydrophobic surfaces P. LUZZATTO-FEGIZ, UC Santa Barbara, F. PEAUDECERF, University of Cambridge, J. LANDEL, University of Manchester, R. GOLDSTEIN, University of Cambridge, F. TEMPRANO-COLETO, F. GIBOU, UC Santa Barbara — Real liquids include traces of surfactants, which can be redistributed unevenly by a nonuniform flow near a gas-liquid interface. The nonuniformities in surface tension will yield Marangoni stresses opposing the motion. Since this effect arises from dynamically-established surfactant gradients (rather than from background levels) it can be almost inevitable. A canonical example is given by the surprisingly slow rise of small bubbles in water. Here we examine the hypothesis that Marangoni stresses can impair drag reduction with superhydrophobic surfaces (SHS). To prescribe surfactant concentration with precision higher than can be achieved experimentally, we perform simulations inclusive of surfactant. These reveal that Marangoni stresses can be significant for concentrations below typical environmental values. We also perform microchannel experiments, which confirm our numerical predictions; in addition, we introduce an unsteady test of surfactant effects. When we remove the driving pressure following a loading phase, a backflow develops at the plastron, which can only be explained by surfactant gradients. This demonstrates the significance of surfactants in deteriorating drag reduction, and thus the importance of including surfactant stresses in SHS models (Peaudecerf et al., PNAS 2017).

Paolo Luzzatto-Fegiz
UC Santa Barbara

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