Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Effect of Interface Deformation and Contact Line Motion on Drag Reduction with Superhydrophobic and Liquid-Infused Surfaces in Laminar and Turbulent Flow[1] RAYHANEH AKHAVAN, AMIRREZA RASTEGARI, The University of Michigan — Effect of interface deformation and contact line motion on drag reduction (DR) with super-hydrophobic (SH) and liquid-infused (LI) surfaces is investigated in laminar and turbulent flow by direct numerical simulation (DNS) using a two-phase, single relaxation time, free-energy lattice Boltzmann method. In this method, the dynamics of a diffuse interface is incorporated into the governing equations using a Peng-Robinson free-energy functional. This obviates the need for interface tracking. DNS studies were performed in channel flows with longitudinal microgrooves of width $0.16 \leq g/H \leq 0.64$ in laminar flow and $15 \leq g^{+0} \leq 64$ in turbulent flow, at solid fractions of $\phi_s = 1/16$ or $1/2$. Viscosity ratios of $\mu_{ext}/\mu_{int} = 10$, 20 and 55 were studied at Weber numbers of $10^{-2} \leq We = \rho U_{bulk}\nu/\sigma \leq 10^{-1}$ in laminar flow and $10^{-3} \leq We_{\tau_0} = \rho u_{\tau_0}\nu/\sigma \leq 10^{-2}$ in turbulent flow. The results show that, in both laminar and turbulent flow, interface deformation and contact line motion can significantly modify the magnitude of DR compared to results obtained with 'idealized', flat SH or LI interfaces. The conditions under which the contact line depins and the interface breaks down are identified by DNS.

[1]Supported by M. R. Prince Foundation and NSF XSEDE Allocation TG-CTS070067N.

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Date submitted: 29 Jul 2019

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