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Lattice Boltzmann Simulations of Interface Deformation and Breakup in Turbulent Flow Over Superhydrophobic and Liquid-Infused Surfaces[1] AMIRREZA RASTEGARI, RAYHANEH AKHAVAN, The University of Michigan — Interface deformation and breakdown in turbulent flow over Super-Hydrophobic (SH) and Liquid-Infused (LI) surfaces is investigated 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 explicit tracking of the interface or pinning of the contact line. DNS studies were performed in turbulent channel flows with longitudinal microgrooves of width $15 \leq g^{+0} \leq 64$ in base flow wall units, at solid fractions of $\phi_s = 1/16$ or $1/2$ on both walls. Simulations were performed at a base flow friction Reynolds number of $Re_{\tau_0} \approx 222$, with viscosity ratios of $\mu_{ext}/\mu_{int} = 10$, 20 and 55, and Weber numbers of $10^{-3} \leq We_{\tau_0} = \rho u_{\tau_0} \nu / \sigma \leq 10^{-2}$. Analysis of the results shows that interface deformation and contact line motion can significantly reduce the magnitude of drag reduction compared to DNS results obtained in turbulent flow with 'idealized', flat SH or LI interfaces. In addition, the simulations identify the conditions for contact line depinning and interface breakdown.

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