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Effect of interface deformation and contact line motion on turbulent skin-friction drag reduction with superhydrophobic surfaces[1] AMIR-REZA RASTEGARI, RAYHANEH AKHAVAN, The University of Michigan —
Effect of interface deformation and contact line motion on turbulent skin-friction Drag Reduction (DR) with SuperHydrophobic (SH) surfaces is investigated by DNS using a two-phase free-energy lattice Boltzmann method. DNS studies were performed in turbulent channel flows at $Re_{\tau 0} \approx 222$ with SH longitudinal microgrooves of width $15 \leq g^{+0} \leq 64$ at solid fractions of ϕ_s =1/16 & 1/2 on both walls. Simulations were performed at viscosity ratios of $\mu_{ext}/\mu_{int} = 50$, Weber numbers of $We_{\tau 0} \equiv \rho u_{\tau 0} \nu / \sigma \approx 2 \times 10^{-3}$ and dynamic contact angles of $\theta_{adv} = 112°$ and $\theta_{rec} = 106°$. Two initial configurations of SH interfaces were investigated, corresponding to contact angles of $\theta_c = 90°$ and 120°. Contact line motion was found to magnify the apparent wetted surface area of the microgrooves, thus reducing the effective streamwise slip velocities by 7-50%. Interface deformation was found to enhance the effective spanwise slip velocities by up to 200% with initially curved interfaces. These combined effects lead to drops of 7-32% and 16-50% in the magnitude of DR with initially flat and curved interfaces, respectively, compared to 'idealized' flat SH walls.

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Rayhaneh Akhavan
The University of Michigan

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