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The Common Mechanism of Turbulent Skin-Friction Drag Reduction with Super-Hydrophobic Micro-Grooves and Riblets AMIRREZA RASTEGARI, RAYHANEH AKHAVAN, University of Michigan, Ann Arbor —
Drag Reduction (DR) with Super-Hydrophobic (SH) longitudinal Micro-Grooves (MGs) and riblets was investigated by DNS using lattice Boltzmann methods. The liquid/gas interfaces on the SH MGs were modeled as curved, stationary, shear-free boundaries, with the meniscus shape determined from the Young-Laplace equation. For comparison, the same geometries were also studied as riblets. DRs of 35% to 63% with SH MGs, and 10% to -17% with riblets, were realized in DNS in turbulent channel flow at $Re_b = 7200$, with MGs of size $14 \leq g^{+0} \leq 56$; $g^{+0}/w^{+0} = 7$, and protrusion angles of 0^o to 90^o, where g^{+0} and w^{+0} denote the widths and spacings of the MGs in base flow wall units. It was found that 100% of the DR with riblets, and 95% to 100% of the DR with SH MGs, arises from the effective slip on the walls and the resultant drop in the friction Reynolds number of the flow due to this effective slip. Modifications to the turbulence dynamics were always drag enhancing (DE) with riblets and generally DE with SH MGs. Increasing the riblet wall curvature significantly increased the wall slip velocity at the riblet tips. But this translated to an increase in DR only for $g^{+0} \approx 14$, due to significant enhancement of turbulence production at larger MG widths.

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