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Drag Reduction with Super-Hydrophobic Surfaces in Turbulent Channel Flow AMIRREZA RASTEGARI, RAYHANEH AKHAVAN, University of Michigan, Ann Arbor — Drag reduction (DR) with super-hydrophobic (SH) surfaces is investigated using DNS in turbulent channel flow with SH walls. Both channel walls were covered with longitudinal arrays of SH micro-grooves of width g separated by distances of w. The liquid/gas interfaces on these walls were modeled as idealized, flat, shear-free boundaries. DRs of $5-83\%$ were obtained with $4 \leq g^{+0} \leq 128$ and $g/w = 1$, 7 & 15 at $Re_{bulk} = 3600$. By analysis of the Navier-Stokes equations, it is shown that the magnitude of DR is given by $DR = U_{slip}/U_{bulk} + O(\varepsilon)$, where U_{slip}/U_{bulk} represents the contribution of surface slip to DR, and the $O(\varepsilon)$ term represents DR arising from other sources, such as modifications to turbulence dynamics. Comparison with DNS results shows surface slip to be the 'dominant' mechanism of DR even in turbulent flows, and responsible for over 80% of the DR in both the high and low DR regimes. The effect of the SH surface on the dynamics of turbulence is found to be small and confined to additional production of turbulence kinetic energy within a thin surface layer of size on the order of the width of the surface micro-grooves. Beyond this effect, the normalized dynamics of turbulence proceeds as with no-slip walls.

Rayhaneh Akhavan
University of Michigan, Ann Arbor

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