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Effects of Superhydrophobic Surface on Laminar and Turbulent Flows[1] HYUNWOOK PARK, JOHN KIM, University of California, Los Angeles

— The recent development of superhydrophobic surfaces (SHSs) has attracted much attention as it leads to a possibility of achieving substantial skin-friction drag reduction at high Reynolds number (Re) turbulent flows. A SHS, consisting of a hydrophobic surface combined with micro- or nano-scaled topological features, can yield an effective slip length on the order of several hundred microns. In this presentation, the effects of SHSs on both laminar and turbulent channel flows are investigated numerically. A SHS is modeled through no-slip boundary condition on top of micro-scaled features and stress-free boundary condition on gas-liquid interfaces. In laminar flows, the effective slip length depends on the geometry only independent of Re, consistent with the analysis of Lauga and Stone (2003)[2], while in turbulent flows it depends on Re, thus indicating its dependence on flow conditions near the surface. The resulting drag reduction is much larger in turbulent flows and near-wall turbulence structures were significantly modified. We conclude that this indirect effect plays a more significant role in reducing drag in turbulent flows than the direct effect of the shear-free condition that led to drag reduction in laminar flows.

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[2]E. Lauga and H.A. Stone, JFM 489 (2003) 55-77

Hyunwook Park
University of California, Los Angeles

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