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Velocity and Reynolds Stress Profiles in The Inner Part of a Turbulent Boundary Layer over Super-Hydrophobic Surfaces[1] HANGJIAN LING, JOSEPH KATZ, Johns Hopkins University, SIDDARTH SRINIVASAN, GARETH MCKINLEY, Massachusetts Institute of Technology — Digital holographic microscopy is used to perform high-resolution velocity and Reynolds stress measurements in the inner parts of turbulent boundary layers over super-hydrophobic surfaces (SHSs) and compare them to those of smooth walls. The SHSs are created by spray-coating perfluorodecyl polyhedral oligomeric silsesquioxane (F-POSS) dispersed in a poly (methyl methacrylate) binder onto a porous base which facilitates replenishment of air under a controlled pressure difference (ΔP). The measurements are performed at friction Reynolds numbers of 1400-4300, surface roughness of k =10-20 μm (k^+ =1-3), and ΔP<0 or >0. The wall stress τ_w is calculated from the velocity gradients in the viscous sublayer and total shear stress at the top of "roughness" elements. Results reveal that compared to a smooth wall, the SHS τ_w is reduced by $\sim$ 10% for k^+<1, but increases for k^+>2 when roughness overcomes super-hydrophobicity. Accordingly, the log-layer shifts upward when τ_w is reduced, and downward when τ_w increases. For a SHS-dominated inner flow, the Reynolds stresses remain similar to that of the smooth wall. The measured relationship between slip length and reduction in wall viscous stress agrees with theoretical predictions involving both streamwise and spanwise slips.

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Hangjian Ling
Johns Hopkins University

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