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Effects of roughness height, pressure and streamwise distance on stress profiles in the inner part of turbulent boundary layer over super-hydrophobic surfaces.[1] HANGJIAN LING, JOSEPH KATZ, Johns Hopkins University, SIDDARTH SRINIVASAN, GARETH MCKINLEY, Massachusetts Institute of Technology, KEVIN GOLOVIN, ANISH TUTEJA, University of Michigan, VENKATA PILLUTLA, ABHIJEET ., WONJAE CHOI, University of Texas at Dallas — Digital holographic microscopy is used for measuring the mean velocity and stress in the inner part of turbulent boundary layers over sprayed or etched super-hydrophobic surfaces (SHSs). The slip velocity and wall friction are calculated directly from the mean velocity and its gradient along with the Reynolds shear stress at the top of SHSs "roughness". Effects of the normalized rms roughness height k_{rms}^+, facility pressure p and streamwise distance x from the beginning of SHSs on mean flow are examined. For $k_{rms}^+<1$ and $pk_{rms}/\sigma<1$ (σ is surface tension), the SHSs show 10-28% wall friction reduction, 15-30% slip velocity and λ^+ =3-10 slip length. Increasing Reynolds number and/or k_{rms} to establish $k_{rms}^+>1$, and increasing p to achieve $pk_{rms}/\sigma>1$ suppress the drag reduction, as roughness effects and associated near wall Reynolds stress increase. When the roughness effect is not dominant, the measurements agree with previous theoretical predictions of the relationships between drag reduction and slip velocity. The significance of spanwise slip relative to streamwise slip varies with the SHSs texture. Transitions from a smooth wall to a SHS involve overshoot of Reynolds stress and undershoot of viscous stress, trends that diminish with x.

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