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Experimental investigation of turbulent flow-roughness interaction over surfaces of rigid and flexible roughness MOSTAFA TOLOUI, JIARONG HONG, University of Minnesota — The influence of flexible surface roughness on wall-bounded turbulent flows is examined experimentally via simultaneous 3D fluid velocity and roughness deformation measurements using Digital inline holographic PTV (i.e. DIH-PTV, Toloui et al. Meas. Sci. & Tech 2017). The experiments are conducted in a refractive-index-matched turbulent channel over two rough surface panels of similar geometry but with an order of magnitude difference in elastic modulus (1.8 Mpa vs. 0.2 Mpa). The roughness elements (i.e. tapered cylinders of 0.35 mm in base diameter, 3 mm in height, 4 mm spacing) are designed such that the rough surface with higher modulus shows no deformation (namely rigid roughness) while the one with lower elasticity deforms appreciably under the same flow conditions ($Re_{\mathrm{h}} \approx 32500$, based on centerline velocity and channel width). The concurrent fluid velocity and roughness deformation measurements are acquired with 160 μs temporal, 1.1 mm/vector velocity, and $<$20 μm deformation resolutions from a 10 50 10 mm^3 sampling volume. Despite minimal influence on mean velocity fields, the effect of roughness compliance on turbulence kinetic energy is observed and linked to roughness deformation. The fingerprint of this energy exchange on shortening the instantaneous flow structures, reduction of Reynolds stresses as well as flow features in energy spectra are examined and will be presented in detail.

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