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The Character of Wall Turbulence in the Presence of Highly-Irregular Surface Roughness YANHUA WU, KENNETH CHRISTENSEN, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — PIV measurements are made in the streamwise–wall-normal plane of a zero-pressure-gradient turbulent boundary layer over both smooth and rough ($\delta/k = 25 - 28$; $\delta/k_s > 40$) walls at $\mathrm{Re}_\theta = 3900$ (transitionally rough) and $\mathrm{Re}_\theta = 11000$ (fully rough). The roughness studied herein is replicated from surface scans of a turbine blade damaged by deposition of foreign materials and contains a broad range of topological scales. The mean velocity defect profiles as well as the Reynolds normal and shear stress profiles for the rough- wall flows collapse with the smooth-wall profiles in the outer region when scaled by their respective u_τ values. This collapse is consistent with Townsends wall similarity hypothesis. Quadrant decomposition of contributions to the mean Reynolds shear stress also reveal similarity between the smooth- and rough-wall flows. However, the two-point spatial velocity correlation coefficients appear to be more sensitive to the surface topology as the smooth- and rough-wall data show measurable differences.

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