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Structural Characteristics of Flow Over a Highly-Irregular Surface Topology Y. WU, K.T. CHRISTENSEN, Mech. Science and Engineering Dept., Univ. of Illinois — The structural character of a zero-pressure-gradient turbulent boundary layer over highly-irregular surface roughness is investigated. Two-dimensional PIV measurements are made in the streamwise–wall-normal plane of this flow and stereoscopic PIV measurements are performed in wall-parallel planes both within and at the outer edge of the roughness sublayer. The roughness under consideration is replicated from a turbine blade damaged by deposition of foreign materials and contains a broad range of topological scales. Previous analysis of the streamwise–wall-normal data reveals that the single-point turbulence statistics collapse with those of smooth-wall flow outside the roughness sublayer, consistent with the notion of outer-layer similarity. This similarity also appears to extend to the spatial structure of the outer-layer turbulence. The wall-parallel measurements within the roughness sublayer reveal strong, yet local, heterogeneities in the turbulence statistics that occur spatially-coincident with the most intense surface defects. Two-point correlations and conditional averaging are employed to contrast the spatial footprints of the dominant vortical structures within and outside the roughness sublayer to those of smooth-wall turbulence.

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