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Statistical and Structural Features of Wall Turbulence at the Microscale KENNETH CHRISTENSEN, VINAY NATRAJAN, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — Measurements of instantaneous velocity fields are made using micro-PIV in the streamwise–wall-normal plane of a 536 μm glass capillary at Re = 4500 to study the statistical and structural features of wall turbulence at the microscale. Single-point velocity statistics are found to agree well with established direct numerical simulations of turbulence in the same geometry at Re = 5300, thereby validating the efficacy of micro-PIV as an experimental technique for studying instantaneous and unsteady flow behavior at the microscale. The instantaneous micro-PIV velocity fields reveal multiple spanwise vortices that streamwise-align to form larger-scale interfaces inclined away from the wall at a shallow angle. These observations are consistent with the signatures of hairpin vortices and their alignment into hairpin vortex packets that are observed in instantaneous PIV realizations of macroscale wall turbulence. Further, the hairpin structures and their organization into larger-scale vortex packets are shown to be statistically-significant features of wall turbulence at the microscale using two-point velocity correlations and estimates of the conditionally-averaged velocity fields given a spanwise vortex core.

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