Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Experimental study of permeability effects in a smooth-wall turbulent boundary layer[1] TAEHOON KIM, University of Illinois at Urbana-Champaign, GIANLUCA BLOIS, University of Notre Dame, JAMES BEST, University of Illinois at Urbana-Champaign, KENNETH CHRISTENSEN, University of Notre Dame — In natural and industrial flow systems, the flow is often bounded by a surface that can be both permeable and rough (e.g. river beds, bed reactors). In such scenarios, the wall boundary condition is complex as it involves both slip and penetration, which together induce significant structural modifications of the overlying flow due to momentum exchange across the wall interface. The current investigation explores the role of the wall permeability in such flows with no topographic effect from the wall. The present wall model was constructed by five layers of cubically arranged spheres (d =25.4mm, where d is a diameter) providing 48% of porosity. Surface topography was removed by cutting half of a diameter on the top layer of spheres to render the flow surface smooth and highlight the impact of the permeability on the overlying flow. An impermeable smooth wall was also considered as a baseline of comparison for the permeable wall flow. High-resolution PIV measurements were performed in the streamwise-wall-normal (x-y) plane and refractive-index matching was employed to optically access the flow within the permeable wall. A double averaging method based on the first-order velocity statistics was used to assess the global representation of the flow influenced by wall permeability across the overlying boundary layer.

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Date submitted: 01 Aug 2017 Electronic form version 1.4