Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

On the dynamics of the flow in the vicinity of micro-scale coatings composed by organized elements ALI DOOSTTALAB, HUMBERTO BOCANEGRA EVANS, SERDAR GORUMLU, BURAK AKSAK, Texas Tech University, LEONARDO P. CHAMORRO, University of Illinois at Urbana-Champaign, LUCIANO CASTILLO, Purdue University — A set of high-resolution PIV experiments were carried out in a refractive index-matched facility under zero pressure gradient turbulent boundary layer to investigate the flow dynamics around two customized coatings composed of uniformly distributed fibers of different geometry. The two type of fibers shared a cylindrical shape and height $y^+ < 1$; however, one of those had diverging tip similar to that of a shark skin. Results evidence an inter-layer acting between the viscous-dominated flow within the pillars canopy (where $Re \sim 1$) and the inertia dominated flow in the boundary layer. Using averaged 2D N-S equations, it is possible to show that the inter-layer wall shear stress is $\tau^+_{oiw} = [\frac{\partial U^+}{\partial y^+} - \langle uv^+ \rangle] - [P^+_w h^+ (\frac{y^+}{h^+} - 1) + \langle u_{oi} v^+_{oi} \rangle]$, with first term in the RHS representing the wall shear stress and the second term indicating the inter-layer form drag. A wall-normal Reynolds stress exist which depends on the pressure difference across the boundary layer and at the wall, $\langle v^2 \rangle = \langle v^2_{oi} \rangle + (\langle P_w \rangle - \langle P \rangle)/\rho$. This reveals a basic mechanism where the flow is modulated by unsteady blowing and suction at the interface.

Ali Doosttalab
Texas Tech University

Date submitted: 01 Aug 2017 Electronic form version 1.4