Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Sustainable Drag Reduction in Turbulent Taylor-Couette Flows using Sprayable Superhydrophobic Surfaces SIDDARTH SRINIVASAN, JUSTIN KLEINGARTNER, JONATHAN GILBERT, ANDREW MILNE, ROBERT COHEN, GARETH MCKINLEY, Massachusetts Institute of Technology — We demonstrate a reduction in the measured inner wall shear stress in moderately turbulent Taylor-Couette (TC) flows by depositing sprayable superhydrophobic (SH) microstructures on the inner moving rigid surface rotor. The surface morphology and the liquid meniscus are characterized using confocal microscopy from which we determine the initial overall wetted solid fraction. We find that the magnitude of drag reduction on our SH coating in turbulent TC flow becomes progressively larger at higher Reynolds numbers up to a maximum of 22% at $Re = 8 \times 10^4$. We show that the mean skin friction coefficient C_f in the presence of the SH coating can be expressed by a modified Prandtl-von Karman type relationship of the form $(C_f/2)^{-1/2} = M \ln Re(C_f/2)^{1/2} + N + (b/\Delta r)Re(C_f/2)^{1/2}$. From this relationship we extract an effective slip length of $b = 19\mu$m which remains constant provided the air-layer is not depleted. Thus, a single value of the slip length b is shown to account for the observed drag reduction over the entire range of Re. Finally, we show that the dimensionless effective slip length $b^+ = b/\delta_\nu$ is the key parameter that governs the drag reduction, and scales as $b^+ \sim Re^{1/2}$ in the limit of high Reynolds number.

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Date submitted: 31 Jul 2014 Electronic form version 1.4