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Enhanced mixing in laminar flows with ultrahydrophobic surfaces

JIA OU, GEOFFREY MOSS, JONATHAN ROTHSTEIN, Department of Mechanical and Industrial Engineering, University of Massachusetts, Amherst — Ultrahydrophobic surfaces have recently been shown to produce significant drag reduction in laminar flows. In this presentation, we will talk about current research aimed at engineering these ultrahydrophobic surfaces to produce mixing enhancement in laminar flows. Our research utilizes the slip velocity along the shear-free air-water interface formed between the surface structures to produce secondary flows which stretch and fold fluid elements to produce enhanced mixing. The surfaces are fabricated with PDMS casted from silicon mold with hydrophobic patterns of microridges in different spacing and at various angles to the flow direction. The effectiveness of the surfaces is tested in micro mixing flow cell using a confocal microscope to track fluorescent dye. At the inlet, two streams of fluid are brought together at a y-junction, one stream is tagged with fluorescent dye. The normalized fluorescence intensity is used in experiments to calculate the degree of mixing and compared directly to the mixing predictions from numerical simulations. The kinematical mechanism of this laminar mixing enhancement method is studied through both experimental and simulations. The mixing length is shown to be dramatically reduced when compared to smooth channels and can be optimized through the design of the microridges.

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