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Flow-enhanced mixing in nanoscale channels: Linking changes in shape to flow kinematics HOWARD STONE, SEAS, Harvard University, MYOUNG-WOON MOON, Future Fusion Technology Laboratory, Korea Institute of Science and Technology, KYU HWAN OH, Dept Matls Sci. and Eng., Seoul National University, JOHN HUTCHINSON, SEAS, Harvard University, EMMANUEL VILLERMAUX, IRPHE, Marseille — We first experimentally study mixing of miscible liquids during pressure-driven flow in nanoscale channels that are created by patterned buckling in compressed films on silicone substrates. The buckled films display the telephone cord morphology with a characteristic configuration of a zig-zag shape along the length direction, where the cross-sectional shape, which is almost semi-circular, has a periodic asymmetry. The experiments demonstrate flow enhancement of the mixing. Second, we present a model for the low Reynolds number mixing based on an asymptotic (lubrication) analysis of the flow accounting for the periodic axial changes in cross-sectional shape. The variations in shape produce secondary flows that give rise to exponential stretching of material lines. The theory that thus describes the nanoscale mixer provides a complete kinematical characterization of the flow, which mixes using transverse shears that are out-of-phase. We compare the theoretical predictions to the experimental measurements.

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