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3D tomographic reconstruction of the internal velocity field of an immiscible drop in a shear flow PAUL KERDRAON, Ecole polytechnique, STUART B. DALZIEL, RAYMOND E. GOLDSTEIN, JULIEN R. LANDEL, FRANCOIS J. PEAUDECERF, University of Cambridge — We study experimentally the internal flow of a drop attached to a flat substrate and immersed in an immiscible shear flow. Transport inside the drop can play a crucial role in cleaning applications. Internal advection can enhance the mass transfer across the drop surface, thus increasing the cleaning rate. We used microlitre water-glycerol drops on a hydrophobic substrate. The drops were spherical and did not deform significantly under the shear flow. An oil phase of relative viscosity 0.01 to 1 was flowed over the drop. Typical Reynolds numbers inside the drops were of the order of 0.1 to 10. Using confocal microscopy, we performed 3D tomographic reconstruction of the flow field in the drop. The in-plane velocity field was measured using micro-PIV, and the third velocity component was computed from incompressibility. To our knowledge, this study gives the first experimental measurement of the three-dimensional internal velocity field of a drop in a shear flow. Numerical simulations and theoretical models published in the past 30 years predict a toroidal internal recirculation flow, for which the entire surface flows streamwise. However, our measurements reveal a qualitatively different picture with a two-lobed recirculation, featuring two stagnation points at the surface and a reverse surface flow closer to the substrate. This finding appears to be independent of Reynolds number and viscosity ratio in the ranges studied; we conjecture that the observed flow is due to the effect of surfactants at the drop surface.

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