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Visualizing millisecond chaotic mixing in droplets moving through a serpentine microchannel SHUHUAI YAO, LIGUO JIANG, YAN ZENG, HONGBO ZHOU, JIANAN QU, The Hong Kong University of Science and Technology — We have developed a two-photon excitation fluorescence lifetime imaging technique to accurately and quantitatively measure mixing of two fluorescence dyes inside microdroplets. The line scanning along the microfluidic channel is passively achieved via the droplets flowing through the excitation focal point. Because the periodically generated droplets are identical, we scan multiple droplets and sum up the line signals of each droplet by cross/autocorrelation to obtain the line signal with a high signal-to-noise ratio. The droplets are scanned line by line by moving the focal point across the channel using a translation stage. The cross-sectional image of the droplet is then formed by aligning the scanning lines across the channel. A non-fitting method based on the ratio of fluorescence signals in lifetime decay is used for mixing ratio calibration. With this new imaging technique, we visualize millisecond chaotic mixing dynamics in microdroplets with 5 microsecond time resolution. The mapped chaotic mixing patterns match well with the 2D numerical simulation, performed based on the coupled Laminar two-phase flow level set model and transport of diluted species model, and also validate the characteristics of the alternative asymmetric vortex flow in droplets moving through a serpentine channel.

Shuhuai Yao
The Hong Kong University of Science and Technology

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