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Experimental Study of Electrothermal 3D Mixing using 3D microPIV PAUL KAUFFMANN, SOPHIE LOIRE, CARL MEINHART, IGOR MEZIC, UCSB — Mixing is a keystep which can greatly accelerate bio-reactions. For thirty years, dynamical system theory has predicted that chaotic mixing must involve at least 3 dimensions (either time dependent 2D flows or 3D flows). So far, 3D embedded chaotic mixing has been scarcely studied at microscale. In that regard, electrokinetics has emerged as an efficient embedded actuation to drive microflows. Physiological mediums can be driven by electrothermal flows generated by the interaction of an electric field with conductivity and permittivity gradients induced by Joule heating We present original electrothermal time dependant 3D (3D+1) mixing in microwells. The key point of our chaotic mixer is to generate overlapping asymmetric vortices, which switch periodically. When the two vortex configurations blink, flows stretch and fold, thereby generating chaotic advection. Each flow configuration is characterized by an original 3D PIV (3 Components / 3 Dimensions) based on the decomposition of the flows by Proper Orthogonal Decomposition. Velocity field distribution are then compared to COMSOL simulation and discussed. Mixing efficiency of low diffusive particles is studied using the mix-variance coefficient and shows a dramatic increase of mixing efficiency compared to steady flow.

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