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Chaotic fluid mixing by alternating microparticle topologies to enhance biochemical reactions YANG GAO, ALEXANDER VAN REENEN, MARTIEN HULSEN, ARTHUR DE JONG, MENNO PRINS, JAAP DEN TOONDER, Eindhoven University of Technology — We report experimental results on chaotic mass transport induced by alternating topological changes of magnetic particle chains actuated by a rotating magnetic field. Results on the induced fluid flows, through particle tracing and mixing experiments, are obtained for (1) the regime of rigid chain rotation and (2) the regime wherein chains periodically fragment and reform. In the case of rigid rotating chains, the overall tracer particle trajectories are steady circles around the center of the microparticle chains. In the regime of periodic chain breaking and reformation, the tracer particle trajectories become chaotic. The level of mixing is measured utilizing a mixing index (M) in a water-dye system, i.e. in a perfectly mixed system M=0 while in an unmixed system M=1. When particle chains periodically break and reform, we observe that M decreases from 1 to 0.1 within 15 rotational cycles. We also report the effects of the different mixing regimes on a biological (streptavidin-biotin) binding reaction in the solution. We conclude that the alternating topological change of microparticle chains is an effective mechanism to achieve chaotic mixing and thereby promote and homogenize reactions in lab-on-a-chip systems.

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