DESIGN AND OPTIMIZATION OF AN ELECTROOSMOTICALLY STIRRED CONTINUOUS MICRO MIXER

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We present theoretical and numerical studies of mixing in a straight micro channel with zeta potential patterned surfaces. A steady pressure driven flow is maintained in the channel in addition to a time dependent electroosmotic flow, generated by a stream-wise AC electric field. The zeta potential patterns are placed critically in the channel to achieve spatially asymmetric time-dependent flow patterns that lead to chaotic stirring. Fixing the geometry, we performed parametric studies of passive particle motion that led to generation of Poincaré sections and characterization of chaotic strength by finite time Lyapunov exponents. The parametric studies were performed as a function of the Womersley number (normalized AC frequency) and the ratio of Poiseuille flow and electroosmotic velocities. After determining the non-dimensional parameters that led to high chaotic strength, we performed spectral element simulations of species transport and mixing at high Peclet numbers, and characterized mixing efficiency using the Mixing Index inverse. Mixing lengths proportional to the natural logarithm of the Peclet number (*Pe*) are reported at fixed Reynolds number (*Re*) conditions, corresponding to the Stokes flow regime. Using the optimum non-dimensional parameters and the typical magnitudes involved in electroosmotic flows, we were able to determine the physical dimensions and operation conditions for a prototype micro-mixer, where 95% mixing in less than a millimeter mixing length is reported at *Re*=0.01 and *Pe*=1,000.

Keywords: micro mixer, chaotic stirring, optimization