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# Simulation and Characterization of Stretching and Folding in Microchannel Electrokinetic Flows

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**Abstract :** The detection, treatment, and control of rapidly propagating, deadly viruses such as COVID-19, require the development of inexpensive, fast, and accurate devices to address the urgent needs of the population. Microfluidics-based sensors are amongst the different methods and techniques for detection that are easy to use. A micro analyzer is defined as a microfluidics-based sensor, composed of a network of microchannels with varying functions. Given their size, portability, and accuracy, they are proving to be more effective and convenient than other solutions. A micro analyzer based on the concept of "Lab on a Chip" presents advantages concerning other non-micro devices due to its smaller size, and it is having a better ratio between useful area and volume. The integration of multiple processes in a single microdevice reduces both the number of necessary samples and the analysis time, leading the next generation of analyzers for the health-sciences. In some applications, the flow of solution within the microchannels is originated by a pressure gradient, which can produce adverse effects on biological samples. A more efficient and less dangerous way of controlling the flow in a microchannel-based analyzer is applying an electric field to induce the fluid motion and either enhance or suppress the mixing process. Electrokinetic flows are characterized by no less than two non-dimensional parameters: the electric Rayleigh number and its geometrical aspect ratio. In this research, stable and unstable flows have been studied numerically (and when possible, will be experimental) in a T-shaped microchannel. Additionally, unstable electrokinetic flows for Rayleigh numbers higher than critical have been characterized. The flow mixing enhancement was quantified in relation to the stretching and folding that fluid particles undergo when they are subjected to supercritical electrokinetic flows. Computational simulations were carried out using a finite element-based program while working with the flow mixing concepts developed by Gollub and collaborators. Hundreds of seeded massless particles were tracked along the microchannel from the entrance to exit for both stable and unstable flows. After post-processing, their trajectories, the folding and stretching values for the different flows were found. Numerical results show that for supercritical electrokinetic flows, the enhancement effects of the folding and stretching processes become more apparent. Consequently, there is an improvement in the mixing process, ultimately leading to a more homogenous mixture.

**Keywords :** microchannel, stretching and folding, electro kinetic flow mixing, micro-analyzer
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