171f Chaotic Mixing in a Microfluidic Device Driven by Oscillatory Electroosmotic Flow

Frederick R. Phelan Jr., Jai A. Pathak, D.J. Ross, and J. Obrzut

Chaotic mixing is studied by numerical modeling and experiment in a star cell geometry. The star cell is a cross flow geometry, in which three channels intersect at 60 degrees with respect to one another about a central point. Flow in the horizontal (throughput) direction is driven by steady, pressure driven flow. Flow in the crossed vertical channels is driven in a sinusoidal manner, 90,,a out of phase with each other. Numerical analysis of the oscillatory cross channel flow shows that chaotic mixing is generated by a periodic combination of stretching (which occurs via shear in the channels), and rotation (which occurs by means of the timing of the oscillations), making the system an effective tendril-whorl (TW) type flow. The size and characteristics of the chaotic region and the downstream dispersion patterns are a function of a Strouhal number and the ratio of the throughput and oscillatory flow velocities. Evidence of chaotic mixing in the system is presented based on the analysis of experimental data, and comparison with the predictions of numerical computations.