Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Nonlinear Dynamics of Electrokinetic Instabilities JONATHAN POSNER, Arizona State University, JUAN SANTIAGO, Stanford University —

Electrokinetic instabilities (EKI) are caused by a coupling of electric fields and ionic conductivity gradients. Electrokinetic flows become unstable when the advection of conductivity fields due to electric body forces dominates over the dissipative effects of viscosity and molecular diffusion. EKI's are relevant to on-chip electrokinetic flows with conductivity gradients such as FASS, multi-dimensional assay devices, and sample streams with poorly specified chemistry. Here, we present an experimental study of the nonlinear fluid flow and mixing dynamics of convective electrokinetic instabilities. This experimental study was performed in a cross-pattern chip with 50 μm wide microchannels. We obtained instantaneous concentration fields of electrically neutral, rhodamine B dye using epifluorescence microscopy and DC applied electric fields. When a critical electric Rayleigh number is exceeded, sinuous scalar patterns develop and advect downstream resulting in a single spectral peak at $\nu = 42$ sec^{-1}. As the applied electric field increases above a critical value, the flow exhibits sub-harmonics and higher-order harmonics, frequency bifurcations, and continuous power spectra. We will also show spatiotemporal concentration maps that exhibit strong aperiodicity. These flow phenomena are consistent with strong nonlinear dynamics and chaos.

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Date submitted: 12 Aug 2005 Electronic form version 1.4