Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

"Electrokinetic" mixing instability: The sharp interface limit
HUA-YI HSU, NEELESH PATANKAR, Department of Mechanical Engineering, Northwestern University — An instability between two miscible liquid regions, of identical mechanical properties but different electrical conductivities, stressed by an external electric field parallel or perpendicular to the interface is studied. The problem is of interest due to its applications to mixing in microchannels. It is modeled by considering a sharp interface. The transport of the electrical conductivity is governed by a convection-diffusion equation. A shallow channel geometry is considered. It is shown that any velocity perturbation at the interface leads to a varying electrical conductivity, in its vicinity, due to the electromechanical coupling in the jump condition for the electrical conductivity. This in turns leads to a bulk charge density that gives a body force in the fluid equations. The body force generates a cellular motion that results in the instability. The critical condition for the instability is given in terms of a non-dimensional parameter P_Σ, which is a product of the Peclet number and another non-dimensional parameter that depends on the conductivity ratio of the two liquids. The results compare favorably with the experimental data and the diffuse interface based model by Santiago and co-workers.

Neelesh Patankar
Northwestern University

Date submitted: 01 Sep 2005 Electronic form version 1.4