

Organization(s): University of California, Berkeley

Title: Mixing and Processing of Complex Biological Fluids in Mflumes

Duration of Effort: September 1999 - August 2001

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MTO

Composite
CAD

Objective

There are two critical factors that control fluidic behavior and micro-biological processes in mFLUMES: large surface-to-volume ratios and extreme gradients. The former amplifies the effects of fluid properties such as viscosity compared to standard, macro-scale fluid systems. The extreme velocity and temperature gradients that can exist in MEMS devices will significantly affect the behavior and processing of biological fluids especially those containing large molecules such as DNA or have a complex second phase such as red blood cells.

In this research project, BSAC will team with CFD Research Corporation to investigate, understand, and predict the transport behavior of complex biological fluids in micro-fluidic devices including incubators, mixers, channels, valves, and pumps. These issues include:

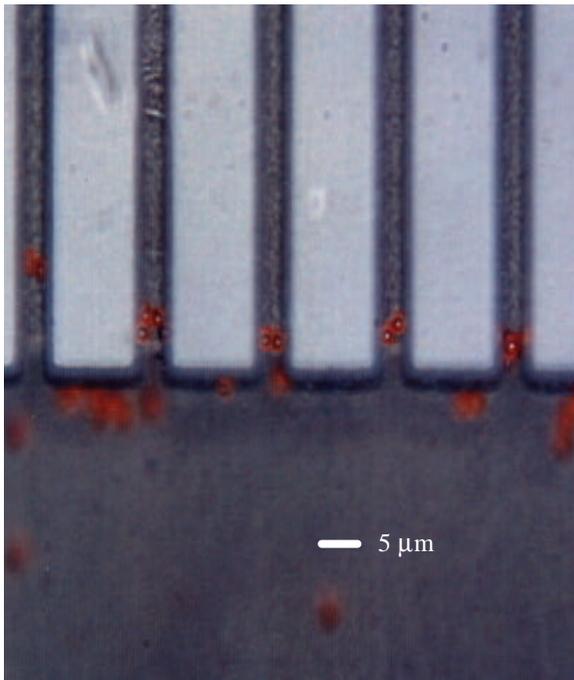
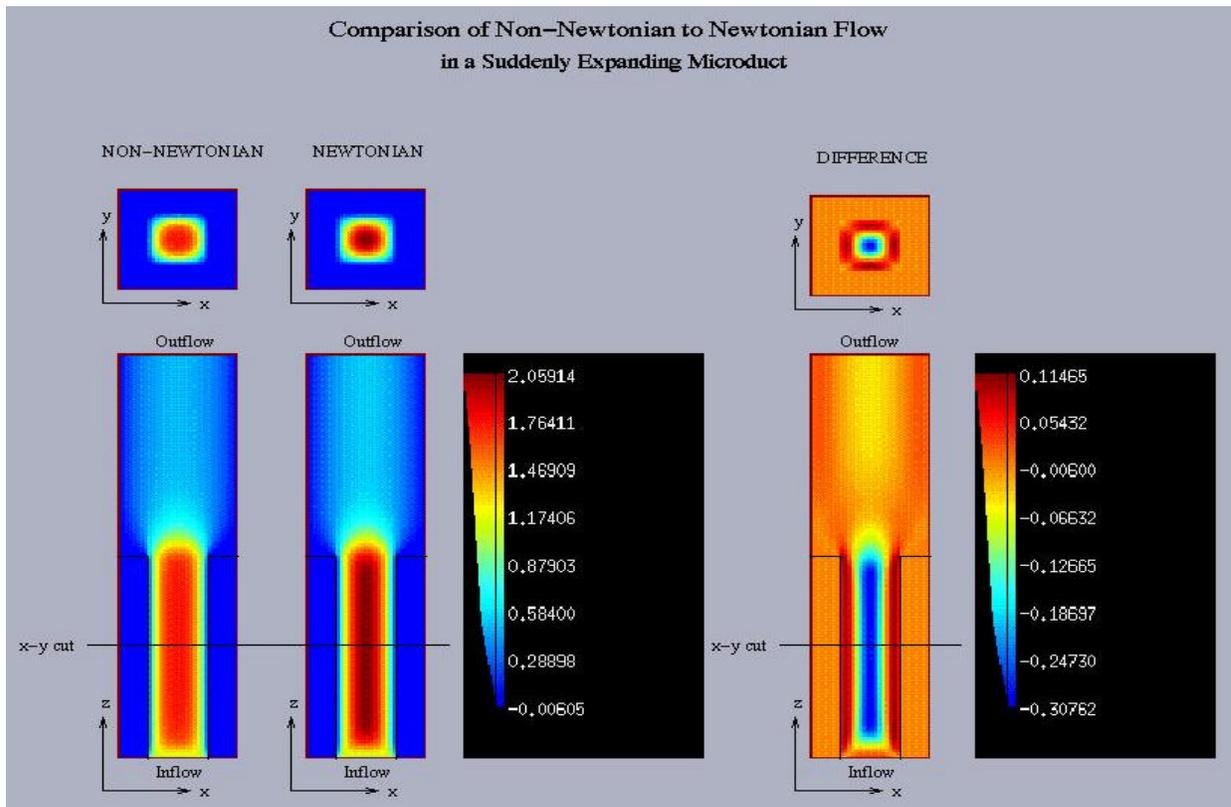
1. viscoelastic behavior due to nanomolar concentrations of large molecules in a Newtonian solvent and its effect on transport properties of the fluid,
2. non-Newtonian behavior due to the presence of red blood cells,
3. transport of large molecules and cells, even in simple channels, resulting in a non-isotropic distribution of biological materials that may change processing characteristics,
4. damage caused by high velocity gradients near the walls,
5. mixing, which is a major challenge in micro-devices, in the presence of viscoelastic materials which may require different mixing schemes,
6. temperature gradient control to reduce molecular damage due to the temperature-cycling required for PCR and incubation for other reaction processes.

Progress/Results

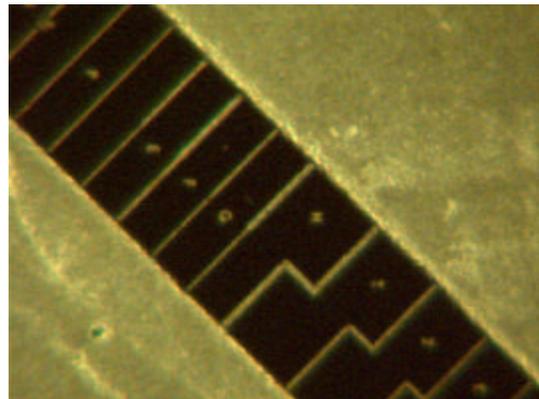
- Started experiments visualizing DNA molecules and their transport in microchannels
- - Developed a CFD code to investigate flows in microchannels
- - Added a Carreau-Yasuda model to the CFD code to simulate viscoelastic fluid
- - Fabricated initial test structures and started initial flow experiments for two phase flows
- - Developed teflon micro-optical components for an integrated blood analysis systems

Status

- Currently we are determining the rheological properties of DNA-laden fluids and blood for input to computer models
 - Conducting flow experiments with DNA and particles in fluid to obtain flow measurement and deformation information
 - Completing fabrication of blood flow velocity meter
 - Starting flow experiments on disease-free animal blood
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Two-phase flow through 5 μm micro-channels.



Flow channels for the investigation of geometrical effects on blood flow.