Electrohydrodynamic Micropump Modeling for Performance Optimization

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Abstract

In this paper, we are presenting an optimized and efficient design of an electrohydrodynamic micropump for high performance in microscale and biological applications. The Electrohydrodynamic(EHD) micropump works on phenomenon of movement of microscale particles and fluids by presence of Electromagnetic field. It is found that performance and operation of pump are highly sensitive to changes in voltage, material and positioning of electrodes. We are considering designs from previous attempts to design an EHD micropump and are carrying out various tests on the micropump modeled in COMSOL Multiphysics® environment such as changing the Geometrical parameters (angle, distance, thickness, width of electrodes), Physical parameters (electric current, voltage range), Material parameters (resistivity, magnetic properties). Some of the tests include - effect on pump temperature with change in voltage and resistivity, effect on magnetic properties with change in voltage and geometrical parameters, effect on particle acceleration with change in geometrical and electrical parameters for which we are using following modules in COMSOL: AC/DC, Electrochemistry, CFD, Heat Transfer, Structural Mechanics.

The ultimate goal of this paper is to present a set of optimized parameters from each aforementioned sets to design a highly efficient EHD pump for biological & nanomedicinal applications.

Parylene-C is mostly used for biological applications as it is bio-compatible substrate while silicon is chosen for wide application as semiconductor substrate in electronics.

We are targeting two major applications of the EHD micropumps viz Parylene C substrate based design for electrically actuated medicine delivery and Silicon based pump design for on-chip cooling of microprocessors and SOCs.

Figure.1 Shows one such fabricated micropump during coursework at Northeastern University based on specifications in previous papers.
Figure.2 Shows COMSOL model of the pump that we are using for experimentation.

Reference

1. On-Chip Liquid Cooling With Integrated Pump Technology, Herman Oprins et al., Student Member, IEEE.
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3. An Electrohydrodynamic Micropump for On-Chip Fluid Pumping on a Flexible Parylene Substrate by Chia-Ling Chen et al., Proceedings of the 2nd IEEE International Conference on Nano/Micro Engineered and Molecular Systems January 16 - 19, 2007, Bangkok, Thailand.
4. Micro and Nano Fabrication Laboratory Manual ECE 5606 by Erfan Kheirkhahi, Yu Hui and Matteo Rinaldi, Kostas Center, Spring 2013.
5. Electrohydrodynamic Micropump powerpoint presentation by Matteo Rinaldi.
6. Micro Electrohydrodynamic Pump Driven by Traveling Electric Fields by Jin-Woo Choi and Yong-Kweon Kim.

Figures used in the abstract

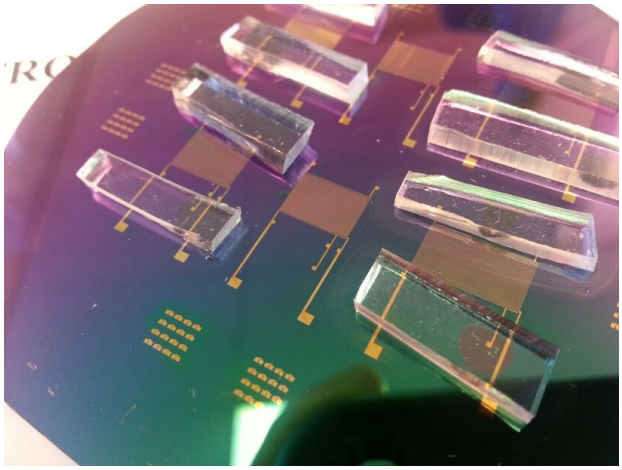

Figure 1: Fabricated EHDP Pump.

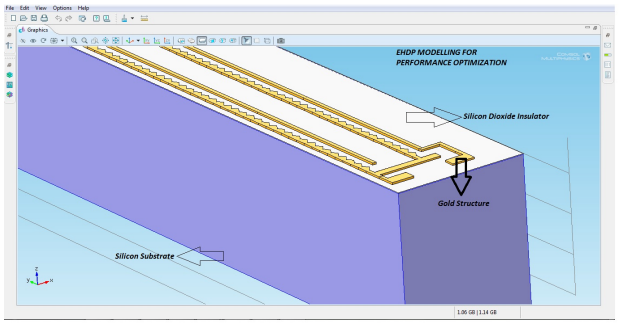

Figure 2: COMSOL Model of the EHDP Pump