

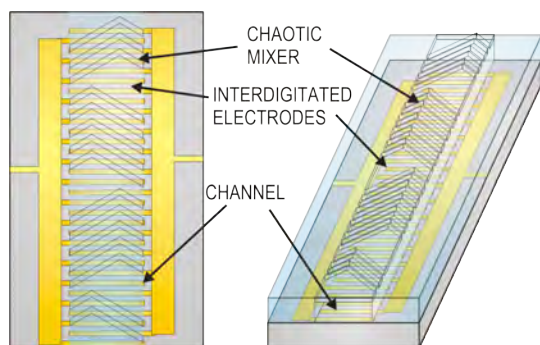
# Combined Microfluidic/Dielectrophoretic Microorganism Concentrators

H.-Y. Lee, K. Puchala, J. Voldman  
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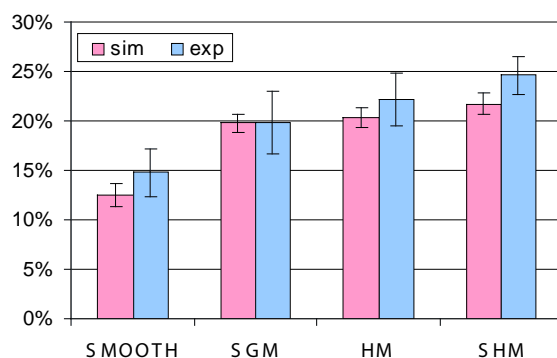
This project focuses on the development of microfabricated microfluidic/dielectrophoretic devices capable of concentrating micron-size particles from complex liquids. The concentrated particles of interest, such as pathogenic bacteria and spores, can then be delivered in small aliquots to the appropriate sensor for identification. Our micro-concentrator exploits the phenomenon of dielectrophoresis (DEP)—the force on polarizable particles in spatially non-uniform electric field [1]—to trap particles from the flow stream in order to subsequently concentrate them by release into a smaller volume of liquid. We create the non-uniform electric field using interdigitated electrodes (IDE) at the bottom of the flow channel (Figure 1).

To maximize the exposure of particles to the DEP field, we employ a passive microfluidic mixer to circulate the liquid (Figure 1). One question that arises is how to determine the optimal mixer geometry for circulating the liquid, which may differ from the ideal geometry for mixing two liquids. To answer this question we

developed modeling tools and an experimental methodology to quantitatively predict the trapping behavior of particles in these systems. As Figure 2 shows, our modeling is able to predict the efficiency of different mixer configurations, without any fitting parameters. Among the four mixers tested (herringbone mixer (HM) slanted groove mixer (SGM), staggered herringbone mixer (SHM), and smooth channel (SMOOTH)), the HM and SHM perform similarly. This result is unexpected, as the HM is known to be a poor mixer of two liquids, while here we show that it is fine for circulating one liquid [2].



▲ Figure 1: Device overview. Illustration of the assembled devices, showing the PDMS channel and gold interdigitated electrodes (IDEs) on the Pyrex substrate.



▲ Figure 2: Comparison of simulated and experimental trapping efficiency. The fabricated devices have 16- $\mu\text{m}$  wide electrodes with 24- $\mu\text{m}$  spacing and a groove-to-channel aspect ratio of 0.22 (SGM), 0.23 (HM), and 0.25 (SHM).

## REFERENCES

- [1] J. Voldman, "Electrical forces for microscale cell manipulation," *Annu. Rev. Biomed. Engr.*, vol. 8, pp. 425-454, 2006.
- [2] H.-Y. Lee and J. Voldman, "Optimizing micromixer design for enhancing dielectrophoretic microconcentrator performance," *Analytical Chemistry*, vol. 79, no. 5, pp. 1833-1839, Mar. 2007.