# Tunable Large Surface Dielectrophoretic Tweezer Array: Simulations And Experimental Validation

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## Abstract

The ability to separate and isolate living microparticles such as phytoplankton is crucial for biological analysis, yet remains technically demanding [1]. Traditional microseparation and isolation methods often rely on physical membranes which can only separate particles by size. While effective in some contexts, these membranes introduce fabrication complexity, are prone to clogging and can induce unwanted mechanotransduction.

In response to these limitations, we introduce a new membrane-less alternative based on dielectrophoresis (DEP) able to selectively separate and isolate one to two microparticles at specific controlled trapping sites. Our approach leverages recent advances in large-surfaces microfabrication, particularly High Precision Capillary Printing (Hummink), to construct complex electrode architectures rapidly and with high fidelity.

Thanks to Finite Element (FE) simulations (COMSOL), we show that crossing the electrode arrays creates a field-induced virtual pillars and field minima grid which functioning principle is closed to that of optical tweezer arrays but at low frequency and compatible with large surfaces designs. This system exhibits two key modes of operation in negative DEP: selective particle trapping at precise stagnation sites and focusing along specific lines passing between the field-induced virtual pillars. We precisely identify the key parameter responsible for the switch between both modes that we have named "critical DEP mobility".

Using parametric analysis and optimization studies (COMSOL), we show that we can accurately control this critical DEP mobility by tuning the system geometry, the imposed voltage and flow rates. This tuning possibility is very important because it allows to tailor the device to a specific targeted microparticle and medium. Finally, we experimentally validate this concept by performing the selective capture of polystyrene particles by size with two different electrode geometry variations. For all additional information see our recently published paper [2].

Thumbnail image reproduced from reference [2] in the paper.

## Reference

[1] Lylian, Challier et al. Printed Dielectrophoretic Electrode-Based Continuous Flow Microfluidic Systems for Particles 3D-Trapping, Particle & Particle Systems Characterization, 38(2), 2000235.

[2] Nicolas, Ruyssen et al. Tunable membrane-less dielectrophoretic microseparation by crossing interdigitated electrodes. Journal of Physics D: Applied Physics, 58(18), 185309.