Optimization of Insulator-Based Dielectrophoretic Devices

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Introduction: Insulator-based dielectrophoresis (iDEP) employs arrays of insulator posts to create forces that affect particle movement (Fig. 1) [1]. The ambitious goal is the integration of several laboratory functions in sub-milimetric devices. However, iDEP devices need hundred of volts to perform particle separation [2].

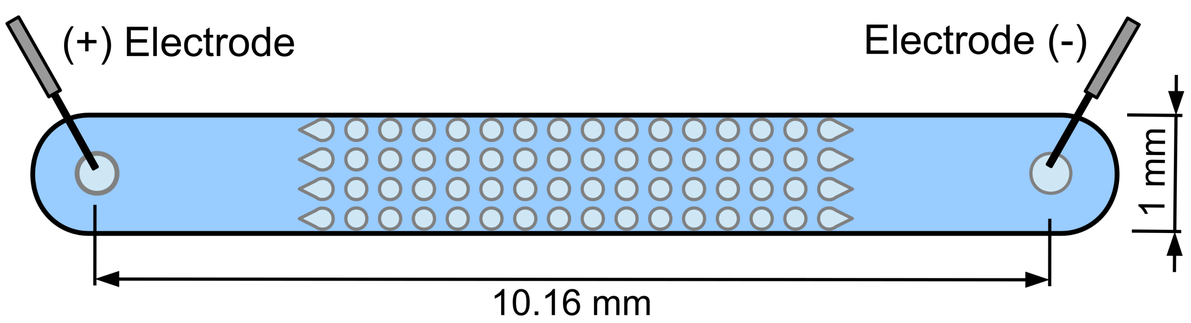

Figure 1. Microchannel with arrays of cylindrical insulator posts.

Computational Methods: The AC/DC module was used to estimate particle net force and velocity in a number of systems varying the geometrical parameters.

$$F_R = \frac{1}{A}\int \left| \frac{\vec{F}_{ek,y} - \vec{F}_{dep,y}}{\vec{F}_{ek,x} + \vec{F}_{dep,x}} \right| dA \qquad T_C = \frac{1}{A}\int \left| \frac{\nabla\left(\vec{E}\cdot\vec{E}\right)\cdot\vec{E}}{\vec{E}\cdot\vec{E}} \right| dA$$

Results: The parametric variation was used to design pseudo-optimal devices that enhance particle trapping and enrichment, decreasing the operational voltage.

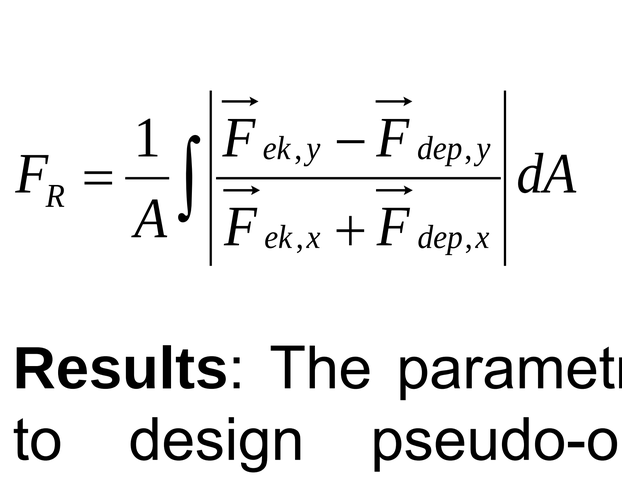

Figure 2. Post length effect.

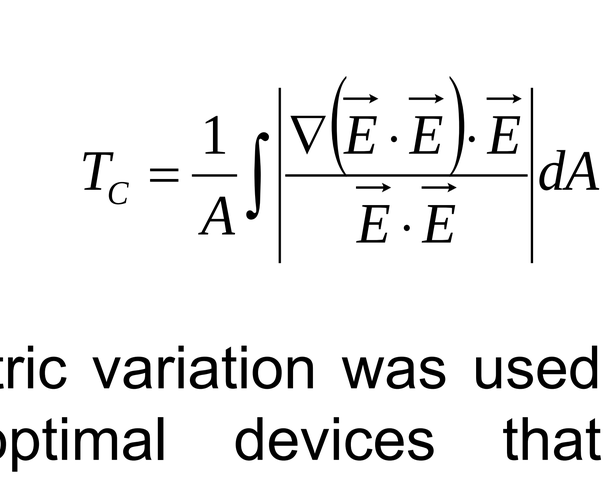

Figure 3. Hor. spacing effect.

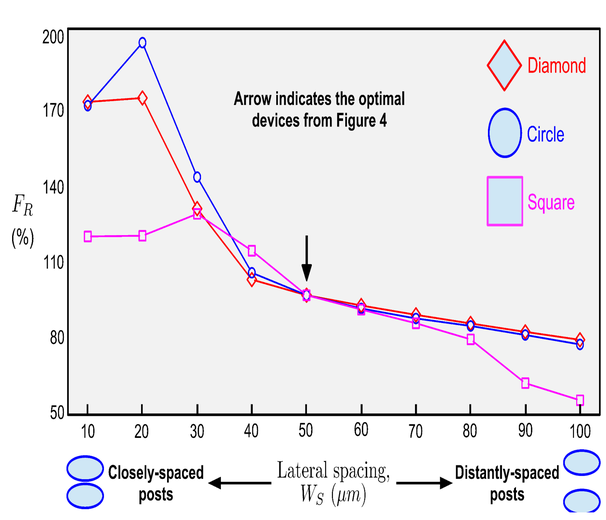

Figure 4. Ver. Spacing effect.

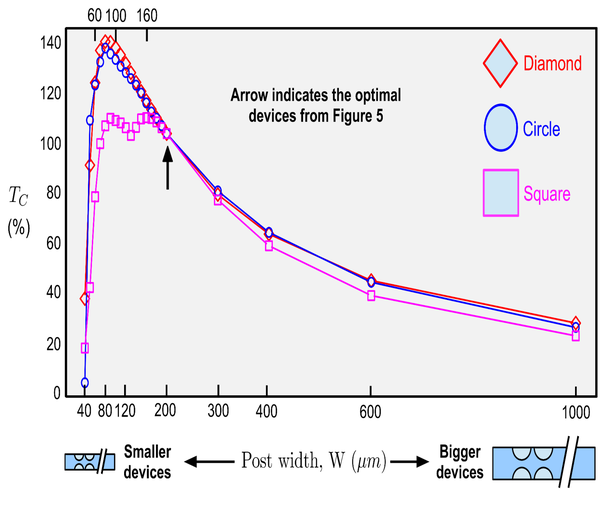

Figure 5. Post width effect.

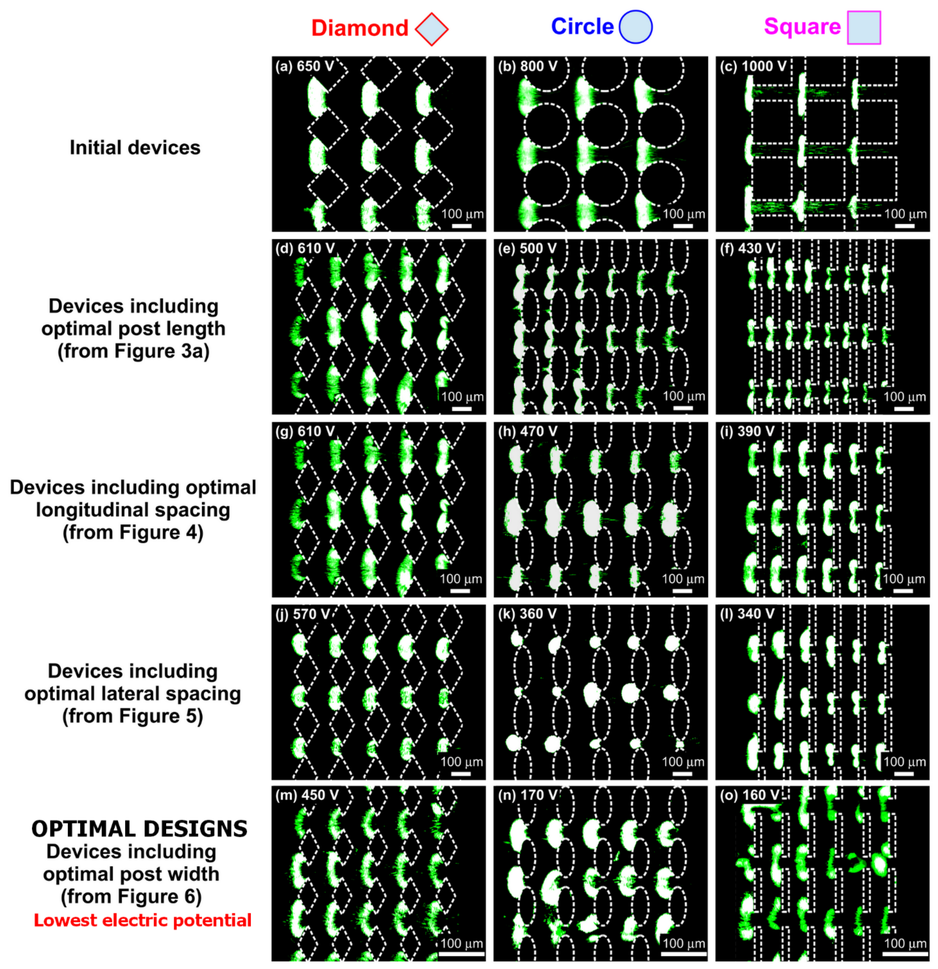

Figure 6. Experimental band of trapped 2-µm particles.

Conclusions: The importance of the geometrical parameters of iDEP devices was characterized. The voltage requirement was decreased in almost 84% for the best case (squared-shaped post).

References:

1. S. Masuda, M. Washizu, T. Nanba, Novel method of Cell Fusion in Field Constriction Area in Fluid Integrated Circuit, IEEE Transactions on Industry Applications, 25(4), 732-737, (1989).
2. M.A. Saucedo-Espinosa, B.H. Lapizco-Encinas, Experimental and theoretical study of dielectrophoretic particle trapping in arrays of insulating structures: Effect of particle size and shape, Electrophoresis, 36(9-10), 1086-1097, (2015).

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