

# AC Electroosmosis and Dielectrophoresis for Trapping Spherical Particles between Rectangular and Triangular Electrodes

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**Introduction:** Our aim is to trap a DNA molecule suspended in a solution under an electric field. In its coiled form, the DNA molecule is assumed spherical in shape [1]. We have simulated the system for rectangular and triangular electrodes. To achieve trapping, we exploit two forces: Dielectrophoretic force and AC Electroosmotic drag [2][3]. We investigate the presence of trapping points in the system.

**Results:** The forces were found concentrated at the vertex V which points towards the plane of symmetry for the triangular electrodes. We observed that the forces were smeared along the edges of this vertex. Refer to Figure 4. We observed the presence of a trapping point near the vertex V. See Figure 5,6,7. The X, Y and Z axes are shown in Figure 1. A similar force diagram exists for the rectangular case in Figure 3.

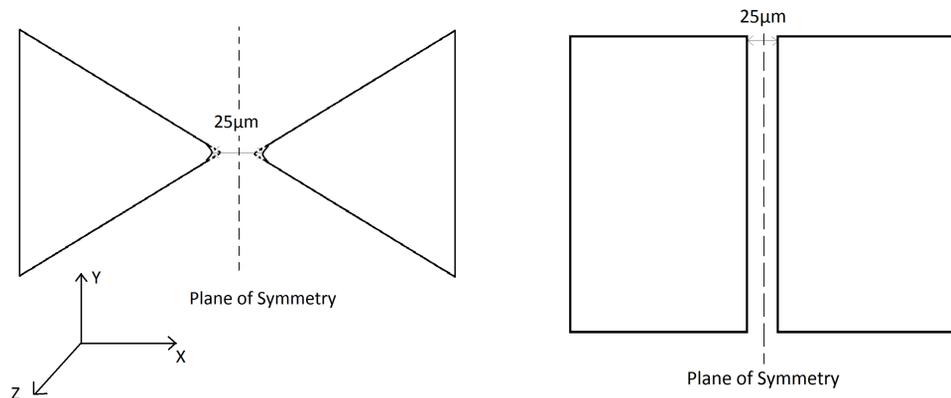


Figure 1. – Top view of the triangular and rectangular setups

**Computational Methods:** The geometry is shown in Figure 1. The equation for the dielectrophoretic force is given by :

$$F(\omega) = 2\pi\epsilon_m r^3 \text{Re}(f_{CM}) \nabla |E_{rms}|^2$$

where  $r$  is the radius of the particle and  $f_{CM}$  is the real part of the Clausius - Mosotti factor [2].

The electric field was calculated using the Electric Currents Module. For AC Electroosmosis, the double layer potential formed over the electrode was modeled as a distributed impedance.

$$\sigma \nabla \phi_{ep} = \frac{\phi_{ep} - V_0}{Z_{DL}}$$

The flow velocity was then calculated by solving the Navier Stokes equation with the Laminar Flow module [3].

To find the overall effect, the components of both forces were summed and plotted.

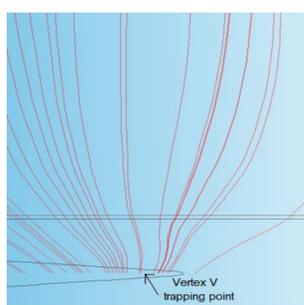


Figure 2. Streamlines around vertex

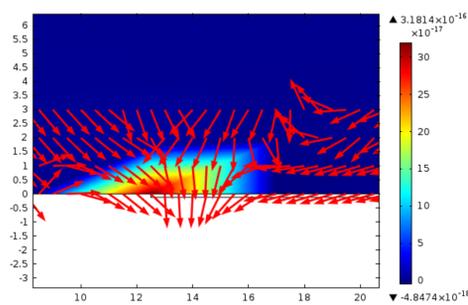


Figure 3. Force plot for rect. electrodes

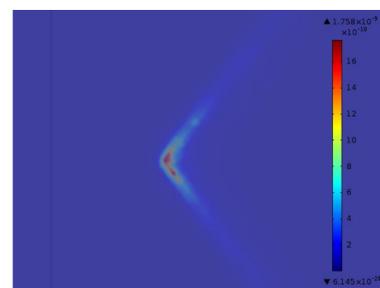


Figure 4. Smeared Forces

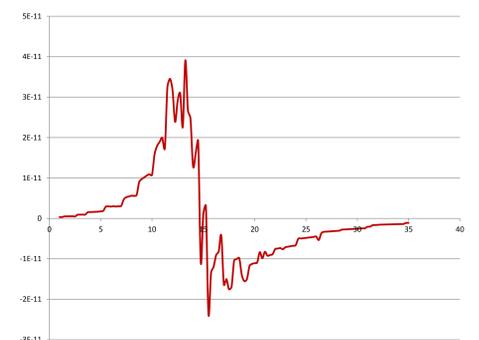


Figure 5. Force along X

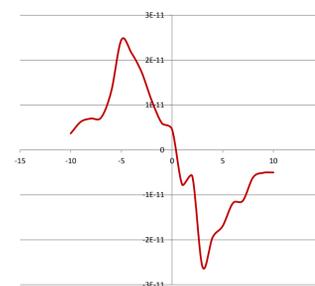


Figure 6. Force Along Y

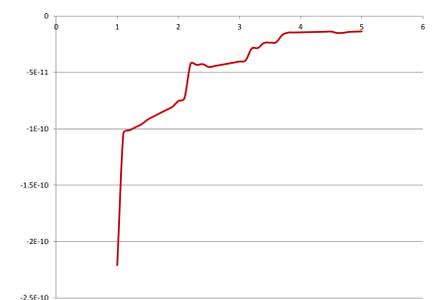


Figure 7. Force along Z

**Conclusions:** In the case of triangular electrodes, we conclude that a trapping point exists where X and Y component of the net force is vanishing. The non zero component of the force which is in the negative Z direction pushes the particle down towards the electrode. Further work can be done to investigate the nature of trapping points in terms of their stability and extension of these results to non spherical particles by including higher order moments in the expression for the dielectrophoretic force.

## References:

1. Zheng et al. "Electronic manipulation of DNA and proteins for potential nano-bio circuit assembly." , Biomedical Optics 2004, 126-135, (2004)
2. Pethig, Ronald. "Review Article--Dielectrophoresis: Status of the theory, technology, and applications." Biomechanics 4 (2010)
3. Green et al. "Fluid flow induced by nonuniform ac electric fields in electrolytes on microelectrodes. III. Observation of streamlines and numerical simulation." Physical review E 66, no. 2 (2002)