Particle Trapping Using Dielectrophoresis

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Site Specific Drug Delivery

Dielectrophoresis: “May the force be with you”

Low Electric Field
Medium Electric Field
High Electric Field
Modeling Fluid Dynamics and Electromagnetism

**Navier Stokes:**

Velocity & Pressure Distributions

\[ \sigma = -pI + \mu (\nabla \mathbf{u}_{\text{fluid}} + (\nabla \mathbf{u}_{\text{fluid}})^T) - \frac{2}{3} \mu (\nabla \cdot \mathbf{u}_{\text{fluid}})I \] + \mathbf{F} \]

Force at all points on the geometry

\[ \mathbf{F} = \int \sigma \cdot \mathbf{n} \, dS \]

**Maxwell’s Equations:**

Implement Electrodes

Produce Electric Field

Dielectrophoretic Force

Microfluidic Channel

Electrodes
Electric Field Distribution
Velocity Distribution

High Velocity

Zero Velocity
Pressure Distribution
2D Particle Motion
Polymer Bilayer Membrane Encapsulates Drug for Delivery

\[ \varepsilon_{1_{\text{eff}}} = \varepsilon_2 \left( \frac{r_2}{r_1} \right)^3 + 2 \frac{\varepsilon_1^* - \varepsilon_2^*}{\varepsilon_1^* + 2 \varepsilon_2^*} \left( \frac{r_2}{r_1} \right)^3 - \frac{\varepsilon_1^* - \varepsilon_2^*}{\varepsilon_1^* + 2 \varepsilon_2^*} \]
Finding Conductivity and Permittivity of Bilayer Membranes

Syringe Pump

Microfluidic Channels
Microfluidic Channels:

Lipid Solution

Aqueous Solution

Lipid Solution
Microfluidic Channels:

Lipid Solution

Aqueous Solution

Lipid Solution
Future Work

• Model 3D Particle Motion.
  • Incorporate buoyancy into fluid flow simulations.
• Find stress and force at all points throughout the channel.
• Implement electrodes; the DEP force will result in zero net force on the particle.
• Coat PDMS to prevent reaction
  • Flow through channels and cure with UV
• Make membranes in microfluidic channels
  • Take measurements for COMSOL simulations
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