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Acoustophoretic microfluidic device for high throughput DNA sequencing

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Introduction: The ultrasound induced control of motion of particles in the microfluidic channel which can be used in lab on chip devices for high throughput separation and manipulation of particles in the medium (such as blood, DNA sequencing)

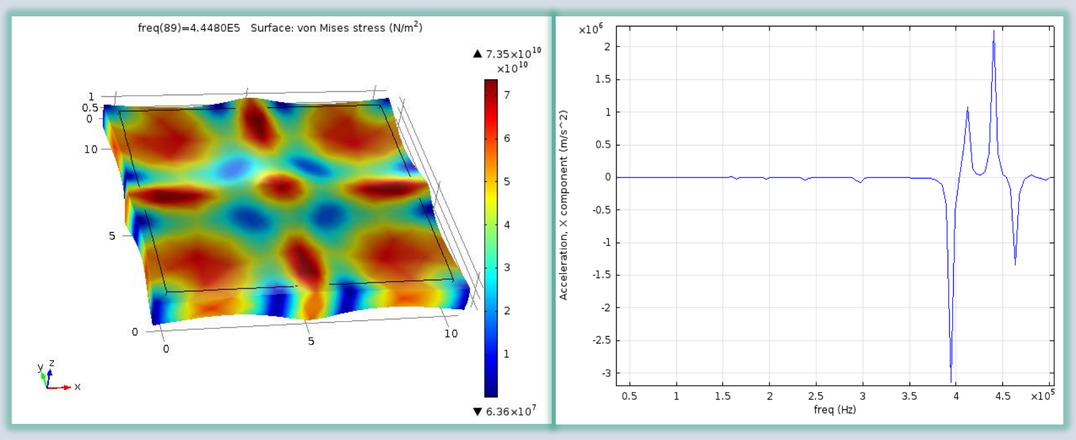
Computational Models:

Acoustophoretic transport can be modeled by Continuity equation, Navier-Stokes equation, and Convection – Diffusion equation. The primary acoustic force can be described by equation

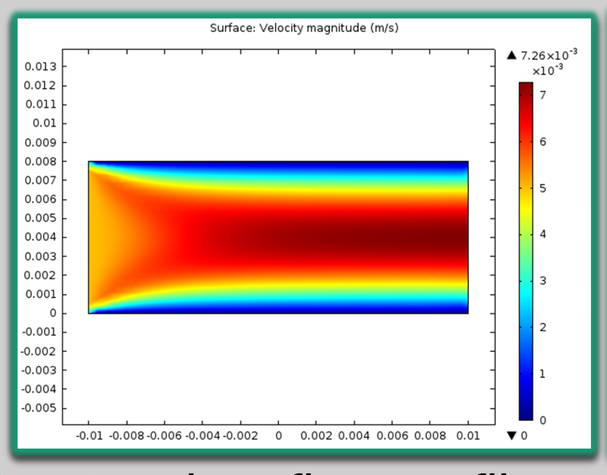
$$F_r = -\left(\frac{\left(\pi {p_0}^2 V_c \beta_m\right)}{2\lambda}\right).\phi(\beta,\rho).sin(2kx) \quad \text{where} \quad \phi(\beta,\rho) = \frac{(5\rho_c - 2\rho_m)}{(2\rho_c + \rho_m)} - \frac{\beta_c}{\beta_m}$$

The number of nodes and antinodes (n) corresponds to the frequency of the signal used **C=nvλ**

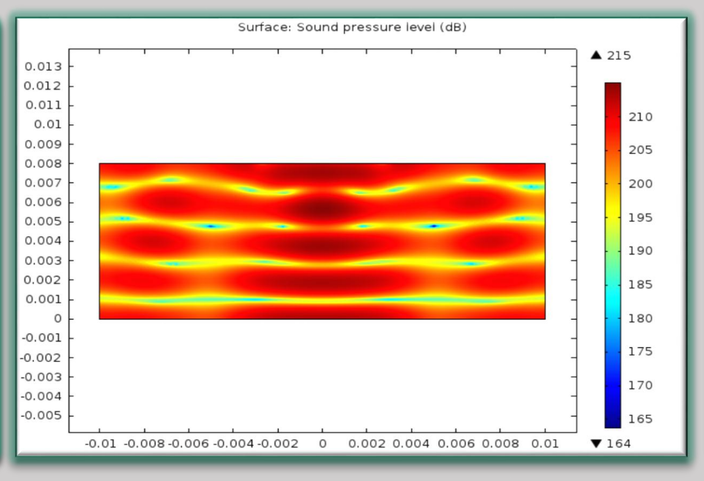
The resonant frequency of piezo-crystal corresponding to maximum pressure or acceleration, depends on the piezo-material, size and voltage applied to it. Resonant frequency of piezo-crystal PZT-5H 10mm*10mm*1mm, Vcc 10V



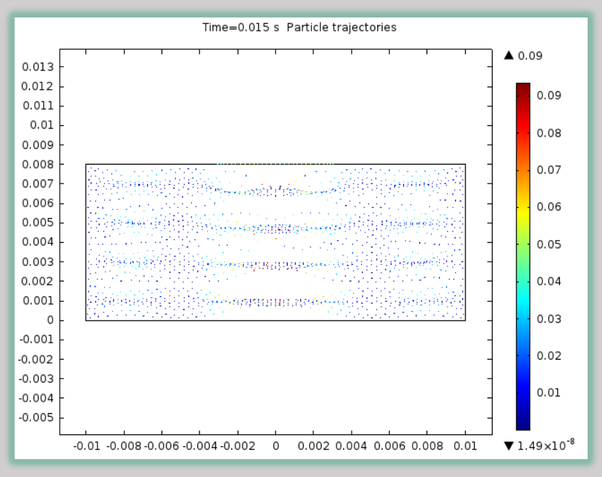
Results: We induced laminar flow, Ultrasound, particle tracing in the channel with channel specifications Medium water, Particle density = 1050kg/m^3, Fluid density = 1000kg/m^3, Particle diameter = 10^{-5} m, Initial velocity = 5mm/s, Width of channel= 8mm, Frequency = 400 kHz, Speed of sound = 1497 m/s, Wave acceleration = 10^7 m/s^2 and we got the results as

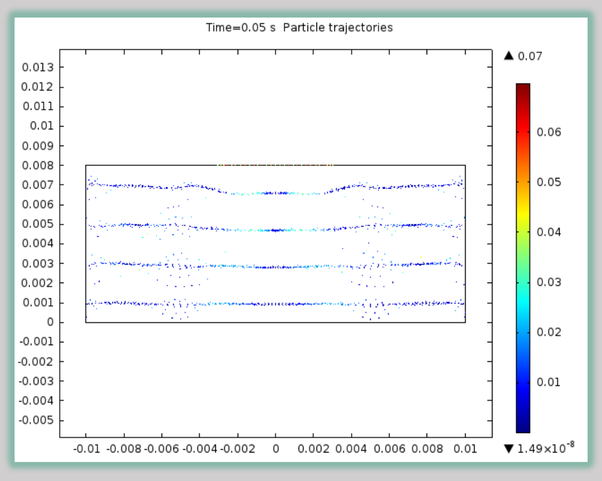


Laminar flow profile



Acoustic pressure





Particle concentrations at 0.015 s & 0.05s

Conclusions: Acoustic standing wave technology combined with micro technology opens up new areas for the development of advanced particle separating microfluidic systems with reasonable throughput and ability to separate particles that helps us to make an automated device for preparing purifying and analyzing DNA.

Reference :

[1] Chip integrated strategies for acoustic separation and manipulation of cells and particles Thomas Laurell*a Filip Peterssona and Andreas Nilssona , 2007
[2] H. Bruus, Theoretical Microfluidics, Oxford University Press, Oxford, 2008
[3]T. Ikeda,Fundamentals of Piezoelectricity(Oxford University Press, New York, 1996)