Investigation of acoustic streaming patterns around oscillating sharp edges

Nitesh Nama, Po-Hsun Huang, Tony Jun Huang, and Francesco Costanzo

Department of Engineering Science and Mechanics, The Pennsylvania State University, University Park, PA 16802, USA. E-mail: junhuang@psu.edu

Department of Bioengineering, The Pennsylvania State University, University Park, PA 16802, USA.

Center for Neural Engineering, The Pennsylvania State University, University Park, PA 16802, USA. E-mail: costanzo@engr.psu.edu

I. First Order Fields:

Fig.1: (a) Plot of the first-order pressure field (b) Plot of the first-order velocity field. The channel dimensions $L = 300 \, \mu m$, $H = 600 \, \mu m$, $\alpha = 15^0$, and $h = 200 \, \mu m$. The wall displacement was only in the $y$ direction with magnitude $1 \, \mu m$. The plots shown are for a particular time instant since the first-order fields are time-harmonic in nature.
II. First Order Fields:

Fig. 2: (a) Plot of the second-order pressure field. The channel dimensions $L = 300 \, \mu m$, $H = 600 \, \mu m$, $\alpha = 15^\circ$, and $h = 200 \, \mu m$. The wall displacement was only in the $y$ direction with magnitude $1 \, \mu m$.

III. Comparison of Lagrangian velocity for different frequencies:

Fig. 3: Plot of the mean Lagrangian velocity, $v_L$, for (a) 4.75kHz, (b) 4.75 MHz. The channel dimensions $L = 300 \, \mu m$, $H = 600 \, \mu m$, $\alpha = 15^\circ$, and $h = 200 \, \mu m$. The wall displacement was only in the $y$ direction with magnitude $1 \, \mu m$ in case (a) and $1 \, \text{nm}$ in case (b). The wall displacement amplitude was reduced by a factor of 1000 in case (b) so that the channel walls are subject to same velocity in both the cases.
IV. Effect of Power:

Fig. 4: Experimentally observed trajectories of 1.9 µm diameter fluorescent polystyrene beads in our acoustically oscillated micro-mixer with sharp edges for different power, (a) 10 V\text{pp}, (b) 20 V\text{pp}, (c) 30 V\text{pp}, (d) 40 V\text{pp}, (e) 50 V\text{pp}. The geometry of the micro-channel is as described in Fig.1. The driven oscillation is harmonic with a frequency equal to 4.75 kHz.