Supplementary Material (ESI) for Lab on a Chip
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Low Frequency Flexural Wave Based Microparticle Manipulation

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Supplemental Figures

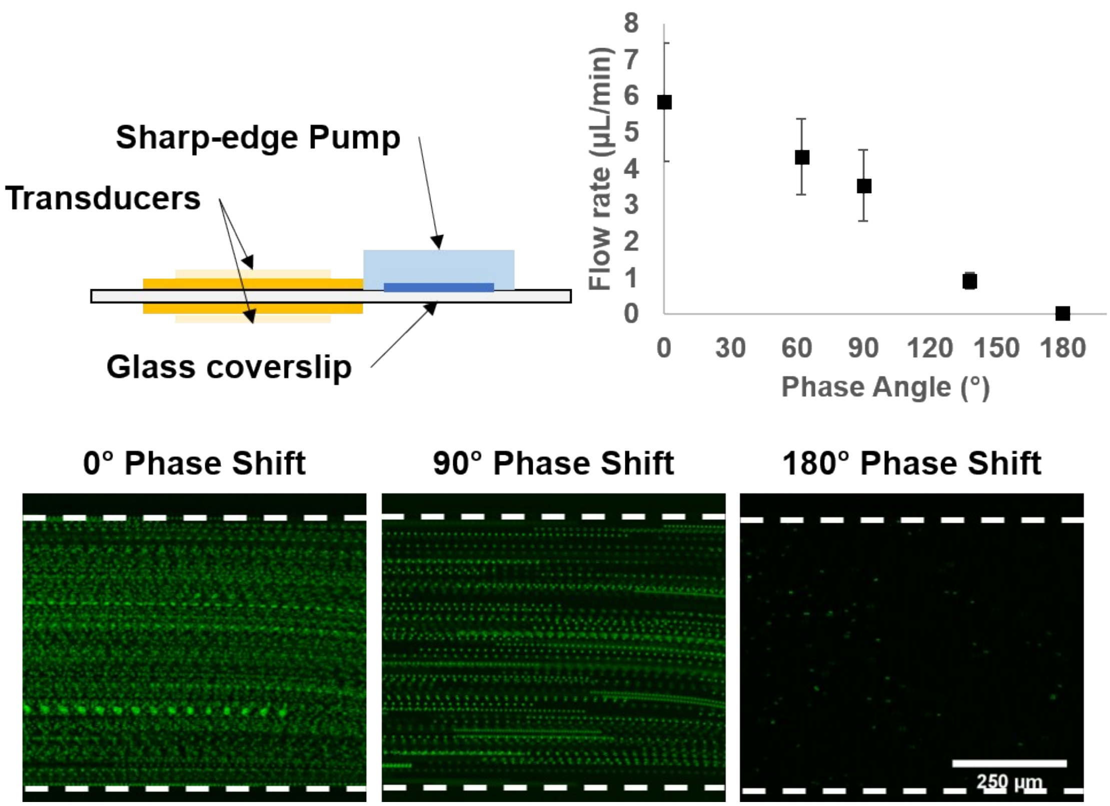

Fig. S1 (Upper Left) Schematic of the dual transducer pumping system. (Upper right) Plot of the flow rate generated by the pump when operating both transducers with a 5V, 7.5 kHz signal and the specified phase difference between the two channels. (Bottom) Stacked images showing the relative motion of particles with different phase differences. The signals destructively interfered at 180° to yield no fluid motion.

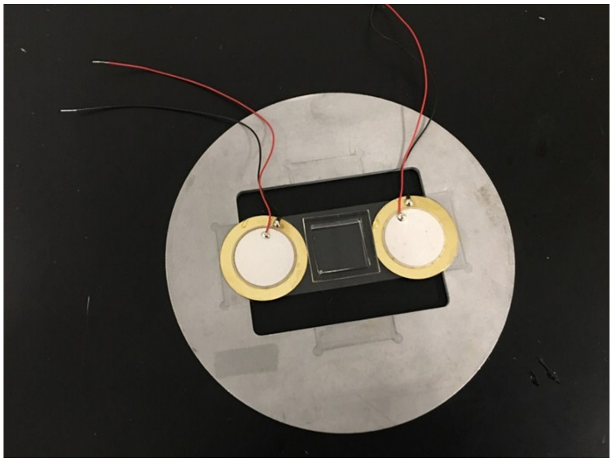

Fig. S2 Photo of our acoustofluidic particle manipulation platform on its customized holder.

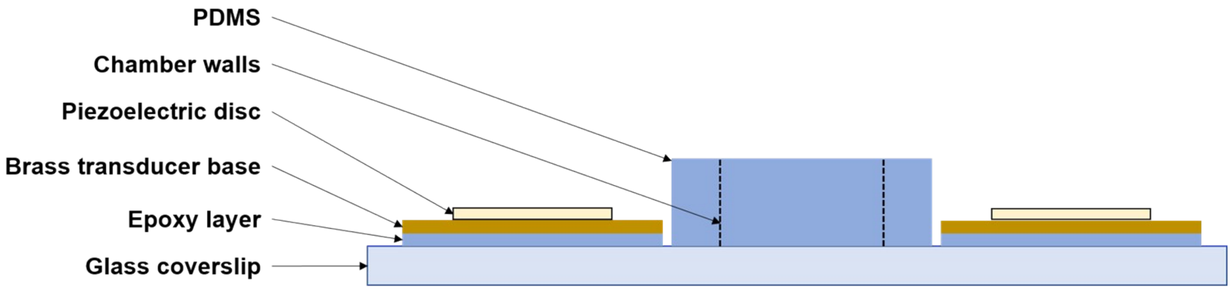

Fig. S3 Schematic of the Comsol model for modeling device vibration patterns.

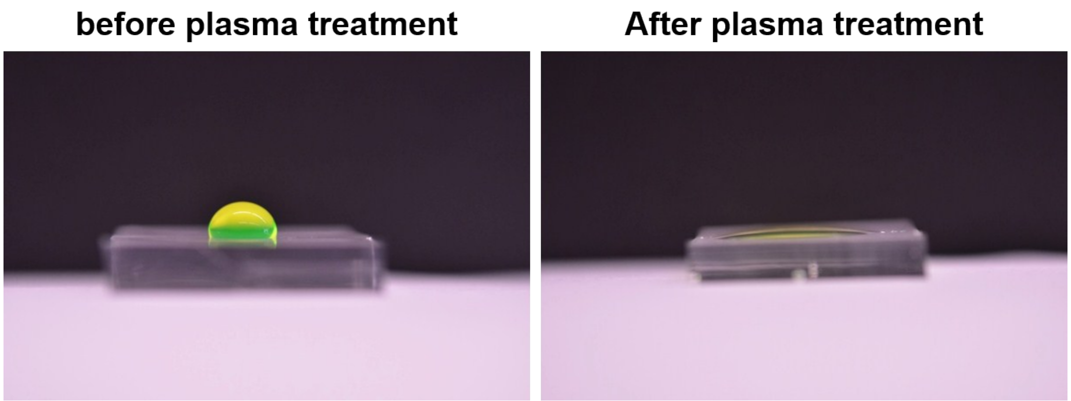

Fig. S4 Photo showing the relative contact angles between PDMS and water before and after plasma treatment. After plasma treatment, the surface is significantly more hydrophilic, and the droplet spreads out across the PDMS surface.

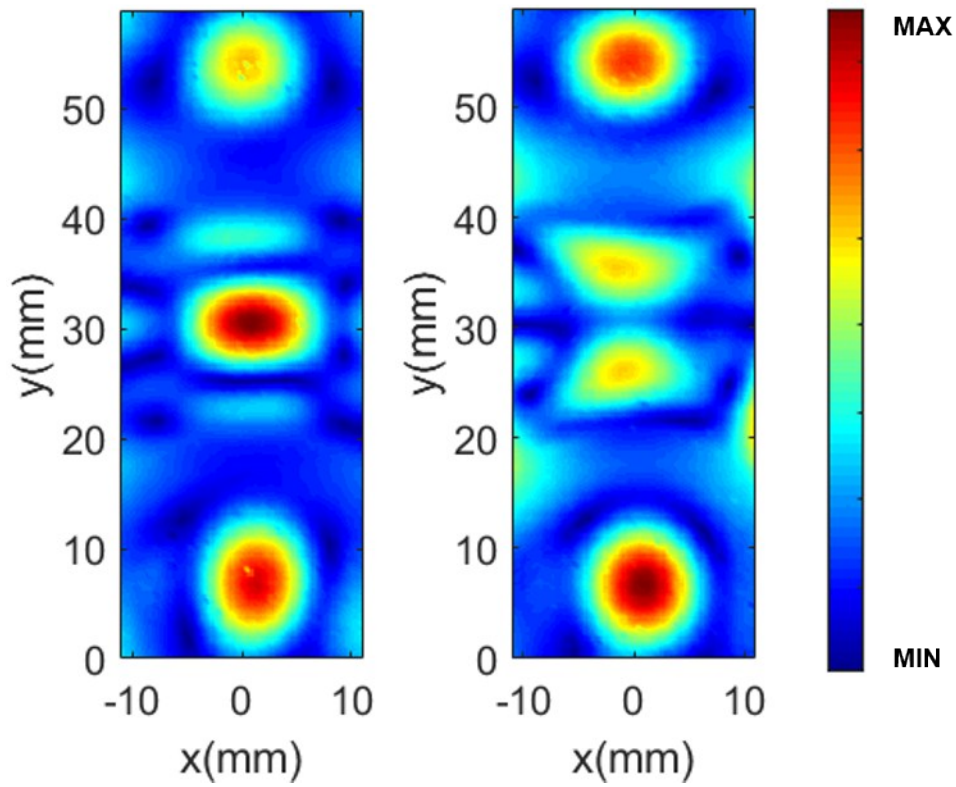

Fig. S5 (Left) Wave amplitude measured by the vibrometer with a 5.42 kHz excitation signal applied to both transducers with the same phase. (Right) Wave amplitude measured by the vibrometer with a 5.42 kHz excitation applied to the transducers 180° out of phase. The pressure node trapped between the two antinodes in the out of phase scenario provides a stronger trap for particles than the pattern in the in-phase scenario.

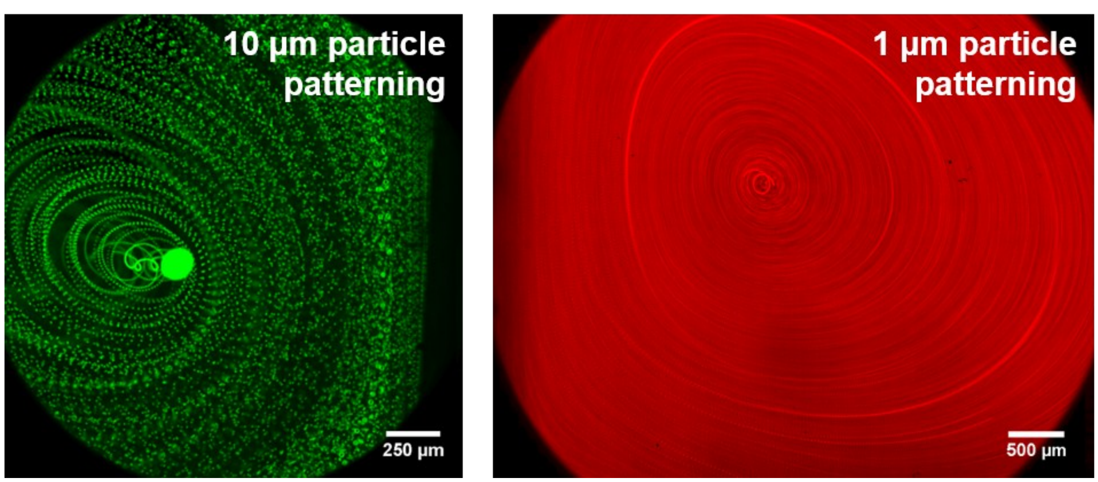

Fig. S6 Concentration of 10 μm (Left) and 1 μm (Right) fluorescent microparticles using the acoustofluidic vortex device.

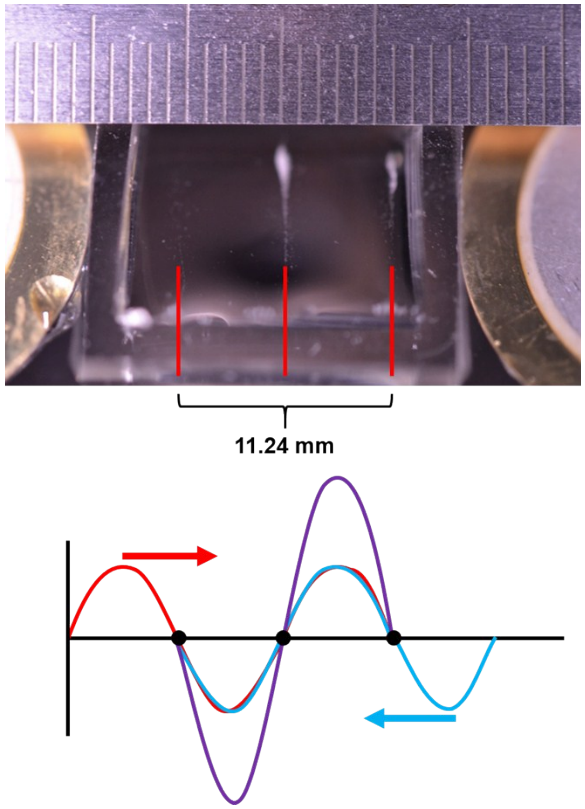

Fig. S7 (Top) Photos showing the 3 rows of particles patterned by a 5.42 kHz signal applied to the transducers 180° out of phase. The central and right rows of particles are more clearly defined, suggesting a stronger node at these locations. (Bottom) Schematic of a standing wave which has the same 11.42 mm wavelength as the particles patterned in the top photo.

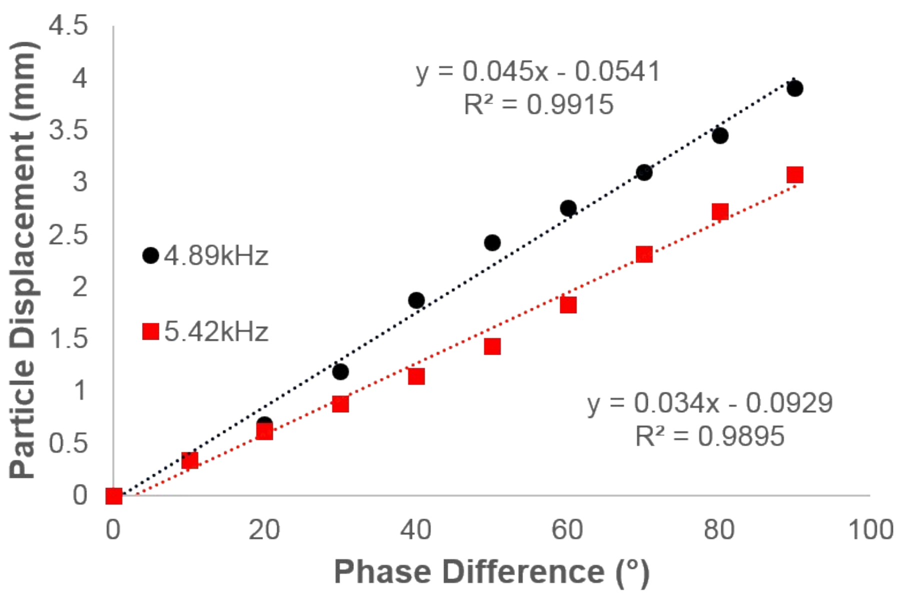

Fig. S8 Plot showing the difference in translation distance produced using the same device and varied excitation frequencies. As expected, the smaller frequency corresponds to a larger wavelength and inherently greater slope per degree of phase change.

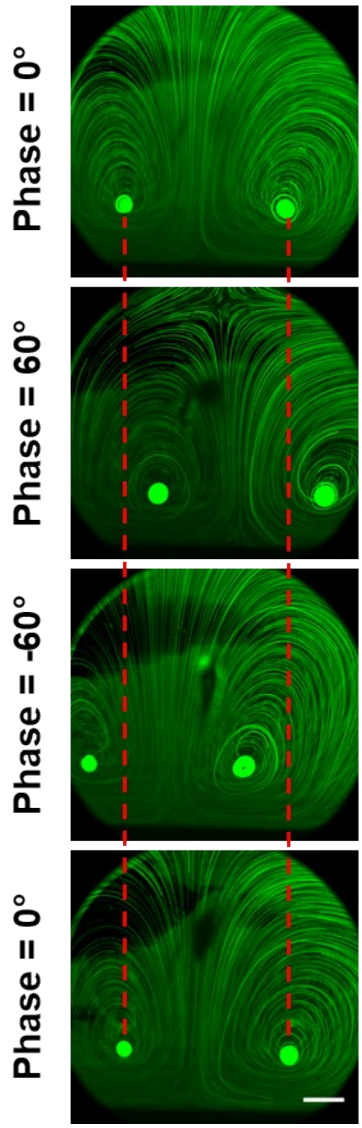

Fig. S9 Photos showing the concentration and movement of 10μm particle clusters. After changing the phase difference to +60°, and then -60°, the particle cluster returns to the initial condition for no phase difference.

Supplemental Videos

Video S1: Side by side video of the wave pattern measured using the vibrometer when the transducers were excited (left) in-phase, and (right) out of phase.

Video S2: Side by side video showing the particle concentration effect when either a single transducer (left), or both transducers (right) were activated.

Video S3: Video showing the translation of a particle vortex dependent upon a phase change.