Supplementary Material (ESI) for Lab on a Chip
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An Acoustofluidic device for efficient mixing over a wide range of flow rates

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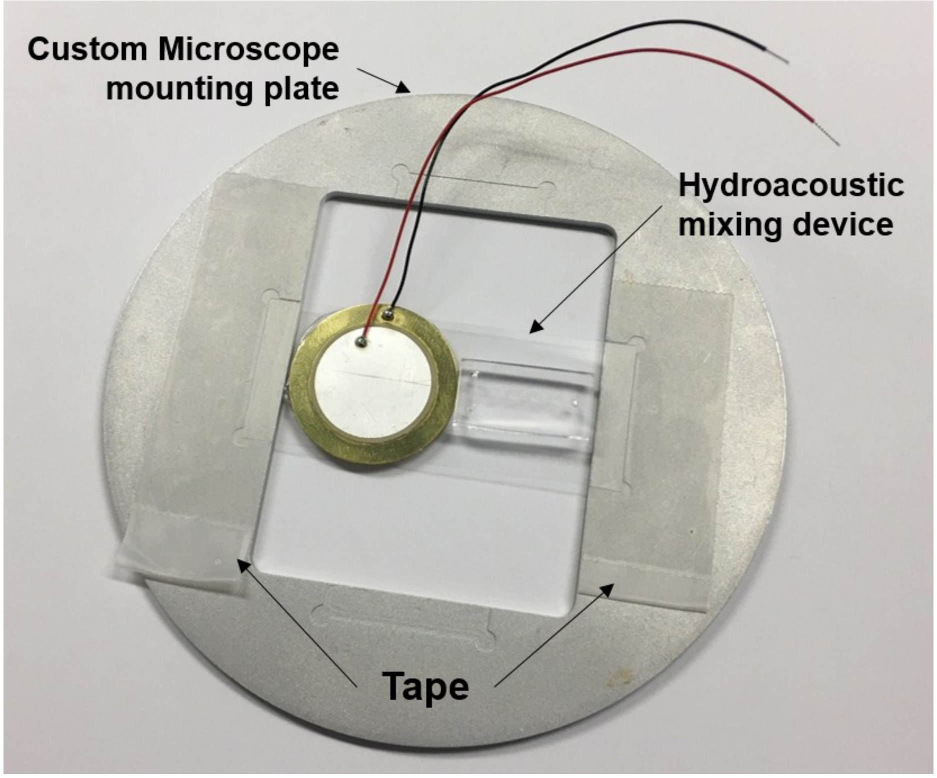

Fig. S1 Photo of an acoustofluidic mixing device mounted onto the customized microscope mounting plate that ensures consistent alignment. The device is secured to the plate using standard single-sided tape which absorbs the waves that propagate out from the transducer and reduces reflection.

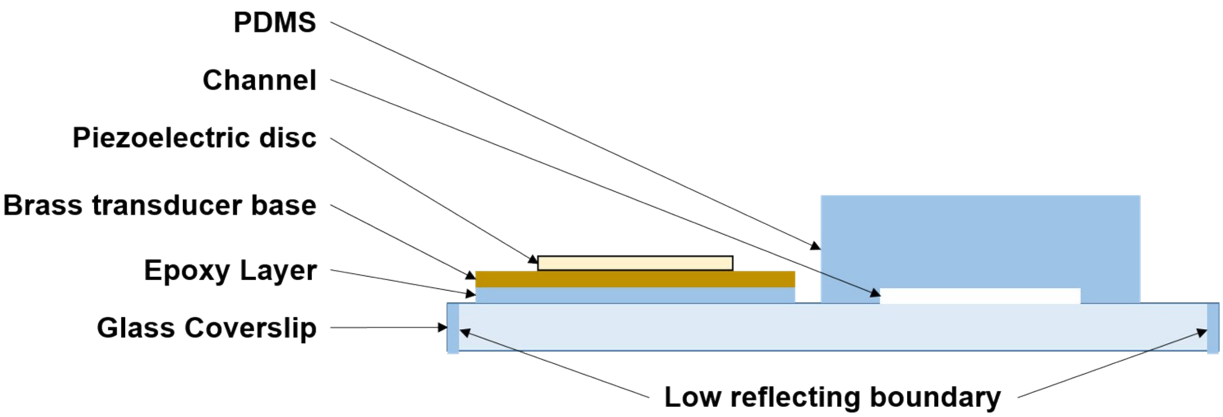

Fig. S2 Schematic of the acoustofluidic mixing device model built in COMSOL Multiphysics®. Model is not to scale.

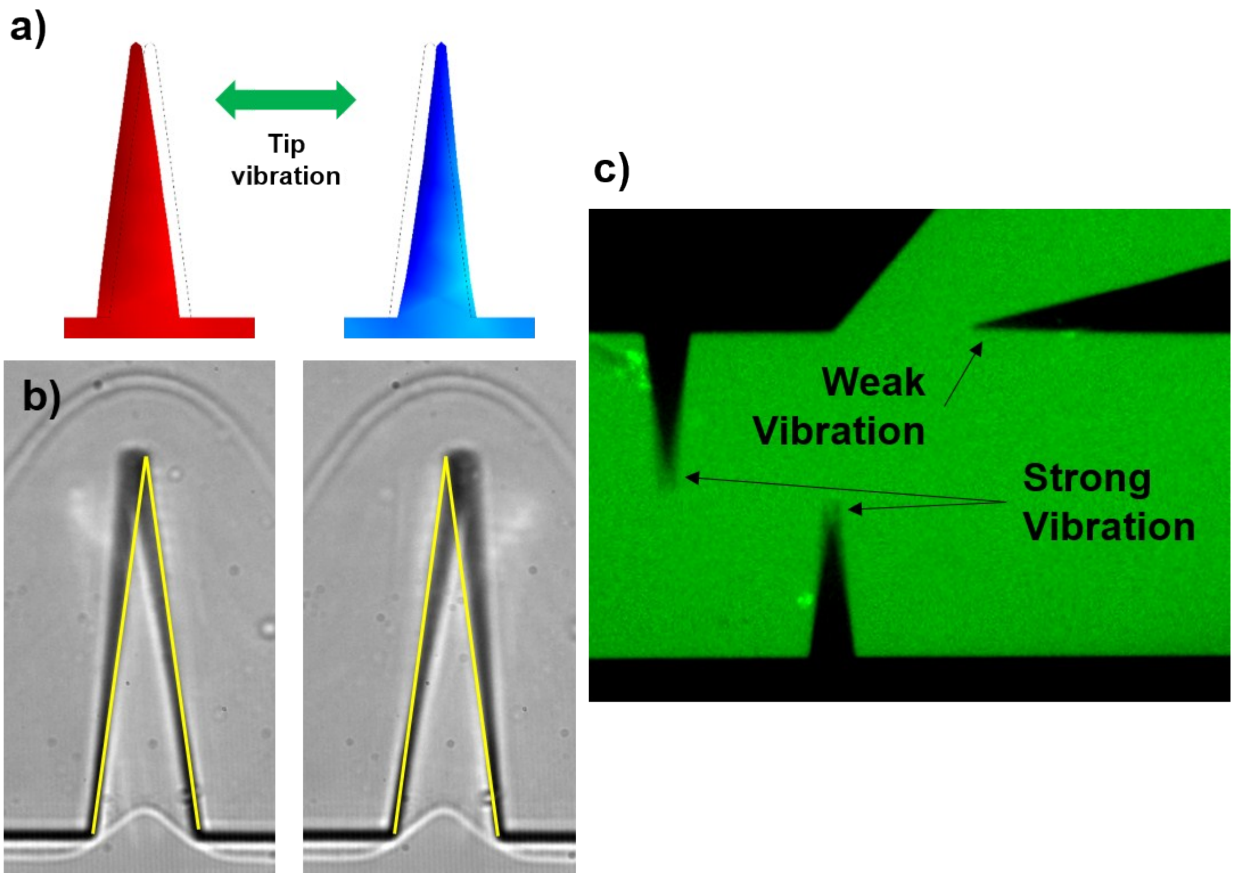

Fig. S3 a) Simulation results and b) microscope images for sharp-edge tip vibration generated by the propagating waves on the glass substrate. c) Experimental comparison of sharp-edge versus modified Tesla structure tip vibration.

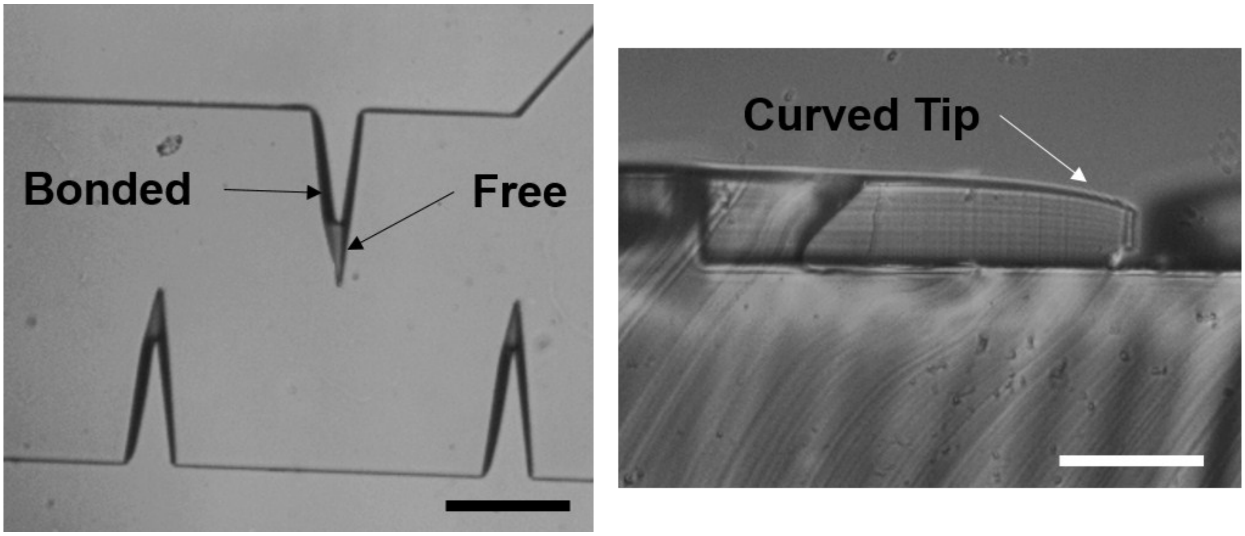

Fig. S4 (Left) Image of an unfilled mixing channel showing that the ends of the sharp-edges have come free from the glass substrate and are not pressed in contact with the surface. (Right) Side view of a sharp-edge tip showing the curved tip formed during DRIE. We hypothesize that these curved tips and strong acoustic vibrations encourage the sharp-edges to come free from the glass substrate and create larger vibration amplitudes. Scale bars: 200 µm.

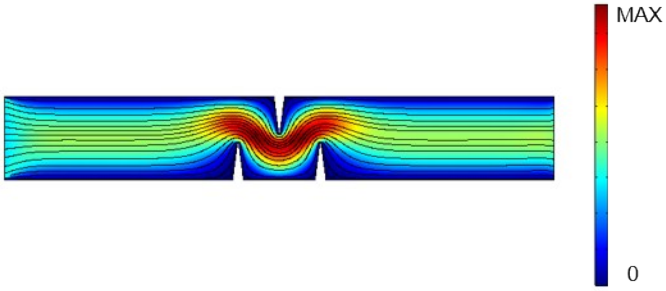

Fig. S5 Simulation result showing the relative flow profile utilized to explore the effectiveness of acoustic mixing at various flow rates. The zero order solution of the COMSOL model solved for the Stoke's flow, yielding velocity profiles that were nearly identical for the various flow rates. A representative plot for the velocity in the channel is provided here. The maximum velocity magnitudes (red areas) for the 20, 400, and 2,000 µL/min simulations were approximately 7.5e-3, 150e-3 and 750e-3 m/s, respectively.

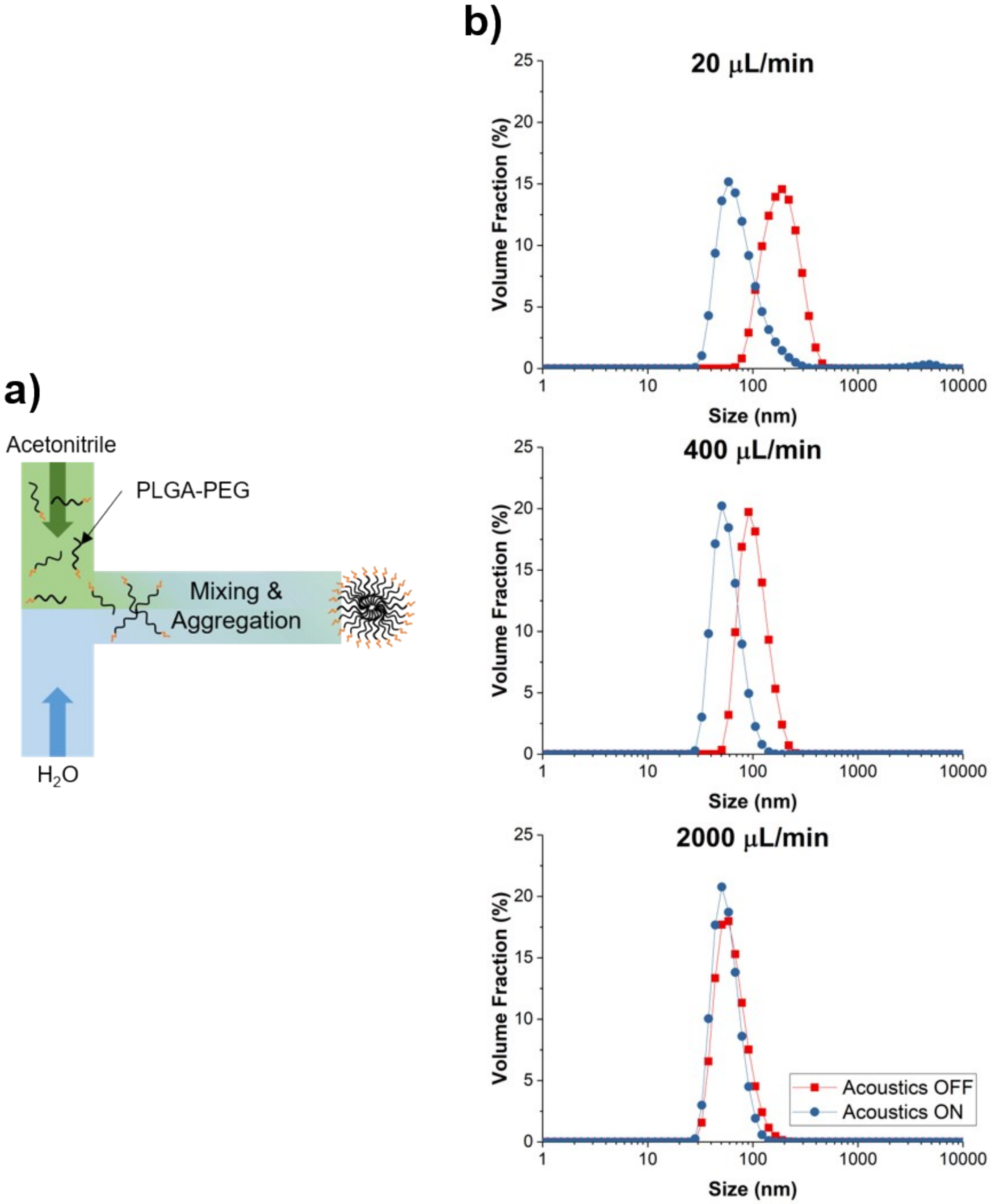

Fig. S6 a) Schematic detailing the mechanism for PLGA-PEG nanoparticle generation. b) Plots of the sizes of nanoparticles generated at various flow rates with the acoustics OFF and ON. Similar to the mixing performance, the size of the nanoparticles generated with/without acoustic mixing became closer as the flow rate increased and the hydrodynamic mixing effect became more prevalent.

Table S1. Summary of material properties used for analysis and simulation.

	ρ (kg/m^3)	E (GPa)	ν	Thickness (μm)
Glass	2230	63.0	0.2	150
Epoxy	1290	1.02	0.4	40
Brass	8490	106	.318	30
PDMS	970	750e-6	.49	3e3
PZT	7500	*	*	23

* Elasticity and coupling matrix taken from COMSOL and integrated into piezoelectric module

Video S1: Side by side video showing the vibrometer (left) and simulated (right) wave profile simultaneously.