Electronic Supplementary Material (ESI) for Lab on a Chip.

Supporting Information

A Simplified Sheathless Cell Separation Approach Using Combined Gravitational Sedimentation Based Prefocusing and Dielectrophoretic Separation

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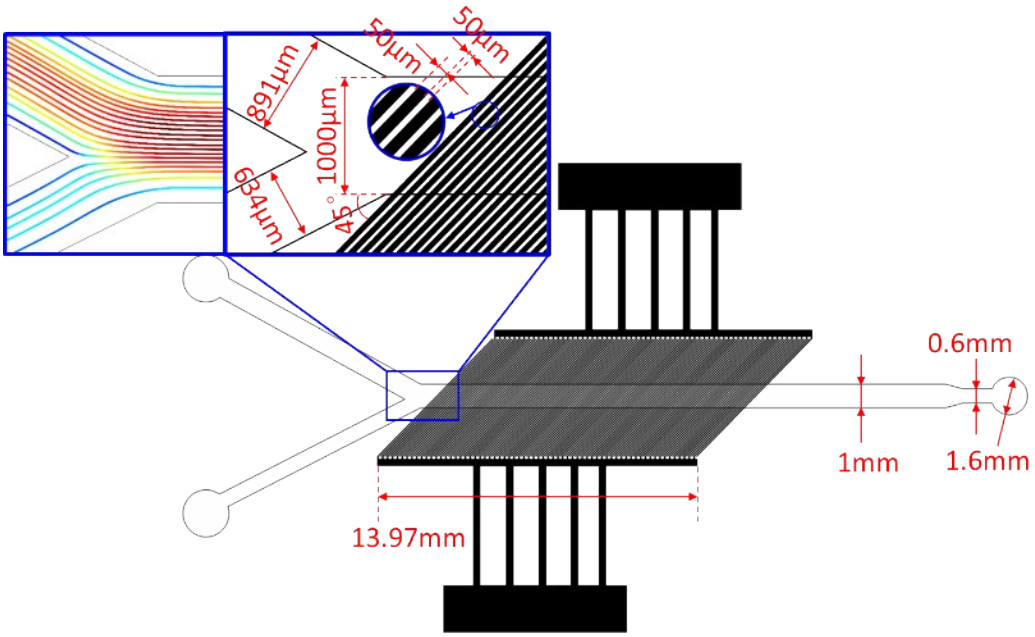

Fig. S1 Layout of the chip and simulated streamlines of the laminar flow in the down-stream of the chip.

Table S1 Densities of few cells and liquid.

Cells and liquid		Density (g/ml)
Cells	Red blood cells[1]	1.10-1.12
	Monocytes[2]	1.067-1.077
	Lymphocytes[2]	1.073-1.077
	Platelets[3]	1.065-1.080
	Yeast cells[4]	1.10-1.12
Liquid	10XPBS[5]	1.063-1.072
	1XPBS[6]	1.00-1.01
	Cell culture media[7]	1.007
	Blood plasma[8]	1.025
	DEP buffer (8.5% (w/v) sucrose and 0.3% (w/v) dextrose)	1.016 (Measured)
	DI water	1.0

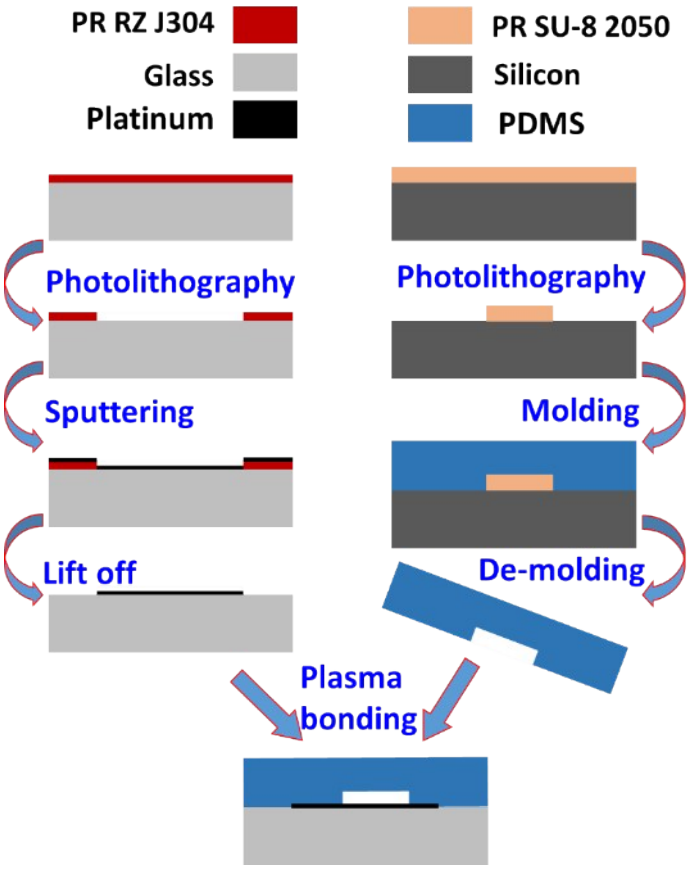

Fig. S2 Schematic of the chip fabrication process.

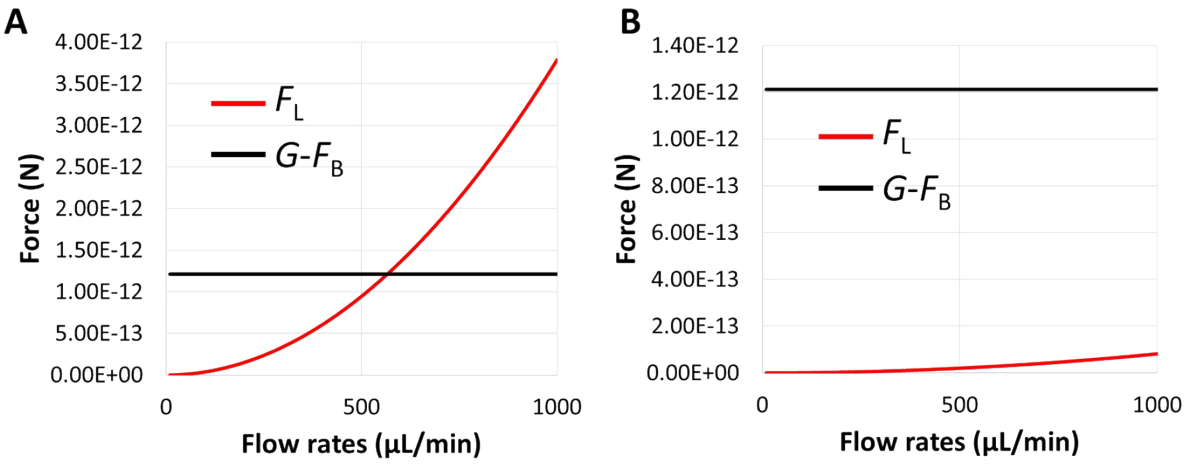

Fig. S3 Comparison between net inertial lift force F_L and gravitational sedimentation force $G\text{-}F_B$ at different flow rates. The net inertial lift force F_L can be simplified as FL = $f_L\rho_f U^2 d^4/D^2$, where D is the diameter of the circular cross section of the tubing, d is the diameter of the cell, ρ_f is the density of the fluid, U is the average fluid velocity, and f_L is the lift coefficient, and can be approximated averagely as 0.5[9]. (A) Tubing diameter is set to 0.38 mm. (B) Tubing diameter is set to 0.72 mm.

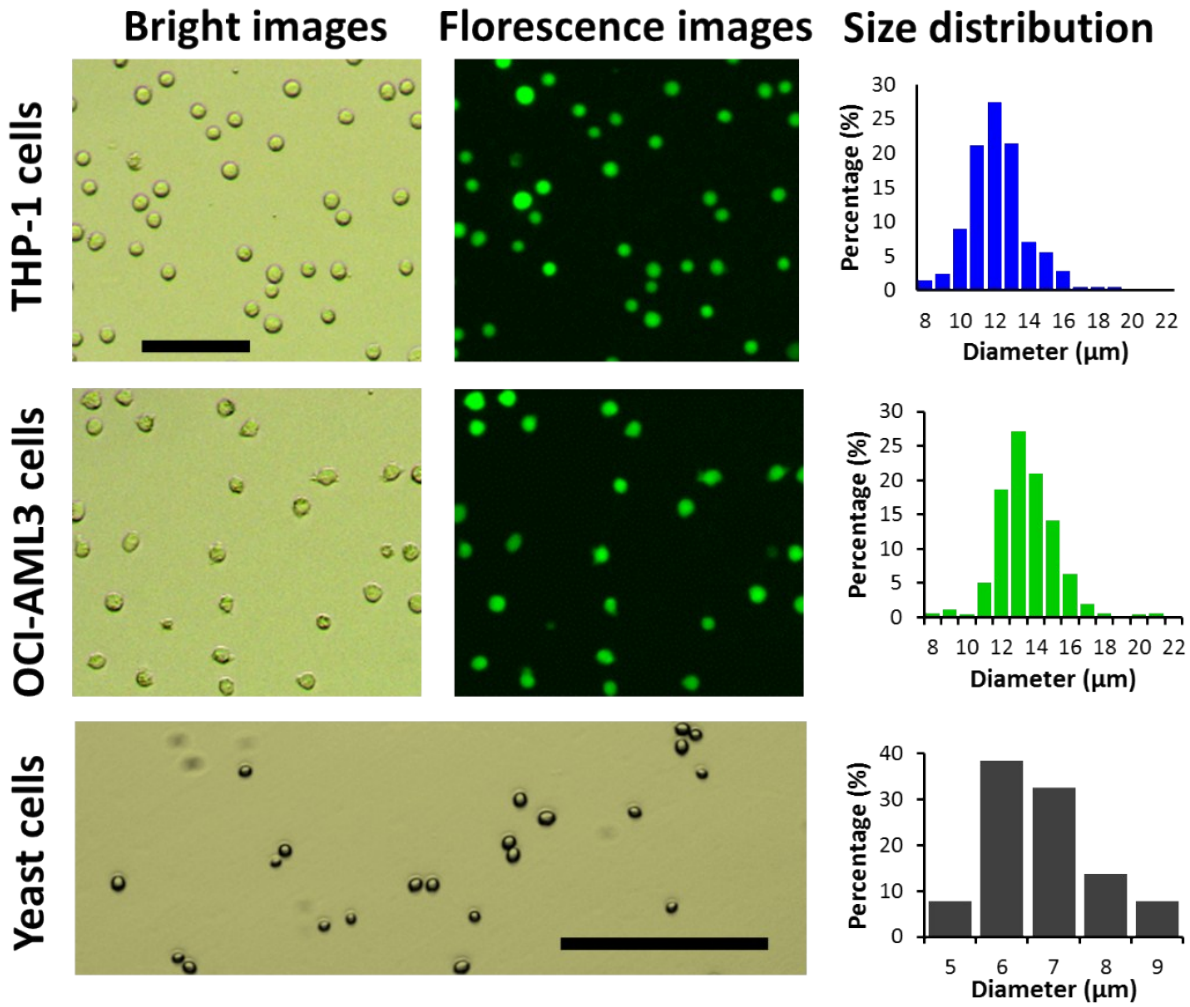

Fig. S4 Measured size distribution of the cells used in this paper. Scale bar=100 μm.

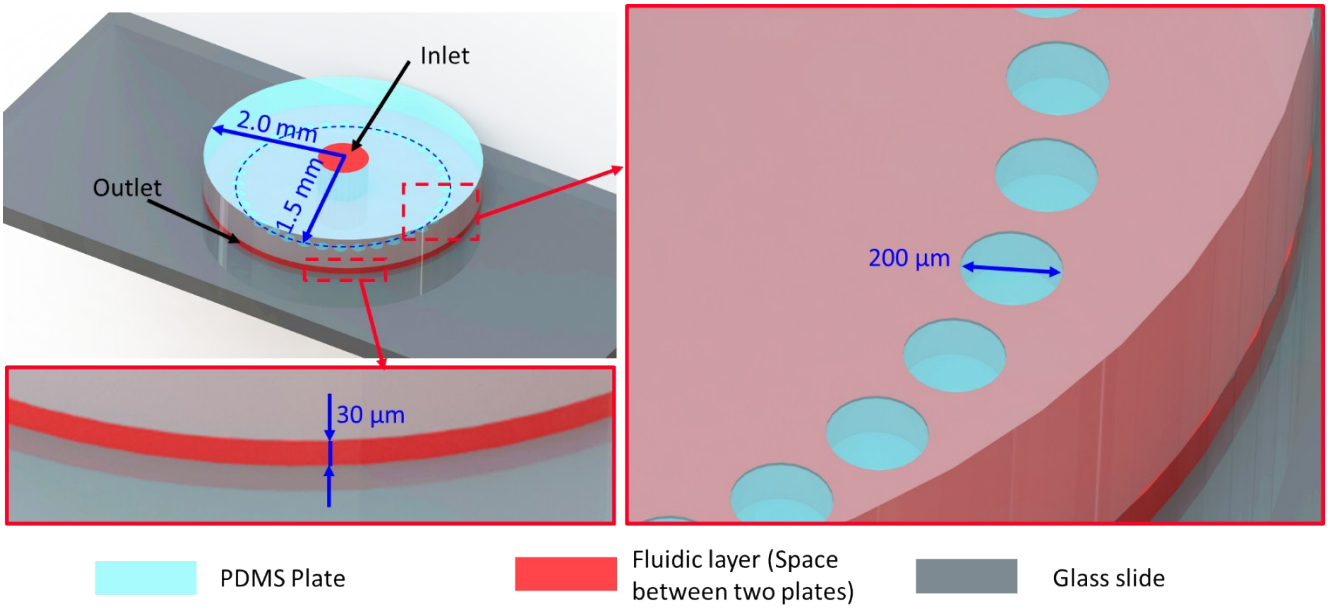

Fig. S5 Schematics of the designed microfluidic chip with an inlet and a 360°-opened outlet for study gravitational sedimentation of cells in the tubing (Fig. 3). The outlet is a circular space sandwiched by two plates. The upper plate is a PDMS plate with pillars which have the diameter of 200-μm and the bottom plate is a glass slide. They are bonded together by the treatment of oxygen plasma. The pillars of the upper PDMS plate are the supports between two plates.

Table S2 The size and dielectric parameters that were used to calculate the CM factor of THP-1, OCI-AML3 and yeast cells. The value of these parameters are obtained from literatures[10–12].

Parameters	Cell Types		
	THP-1	OCI-AML3	Yeast
Radius of the cell r_1 (μm)	——	——	3
Permittivity of the cell wall ε_1 (ε_0)	——	——	60
Conductivity of the cell wall σ_1 (μS/cm)	——	——	140
Inner radius of the cell wall r_2 (μm)	6.5	6.5	2.78
Permittivity of the cell membrane ε_2 (ε_0)	6	6	6
Conductivity of the cell membrane σ_2 (μS/cm)	0.0025	0.0025	0.0025
Inner radius of the cell membrane r_3 (μm)	6.496	6.496	2.772
Permittivity of the cytoplasm ε_3 (ε_0)	162	162	50
Conductivity of the cytoplasm σ_3 (μS/cm)	6600	2900	2000
$\varepsilon_0 = 8.85 \times 10^{-12}(F/m)$ is the permittivity of free space			

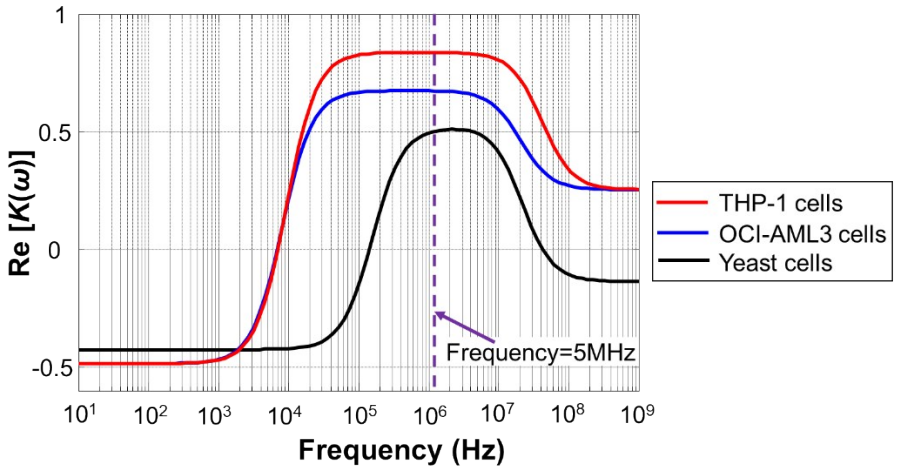

Fig. S6 Real part of the CM factor of THP-1, OCI-AML3 and yeast cells. For those three types of cells, Re [K(ω)]>0 at the working frequency of 5MHz, which means that all those cells experienced positive DEP force.

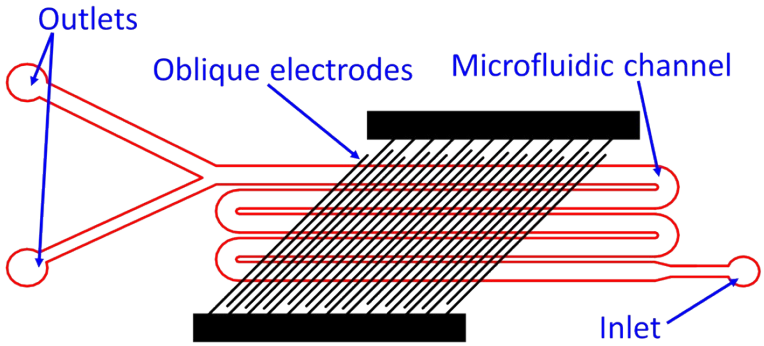

Fig. S7 Schematic of the chip design for increasing the throughput of DEP separation through extending the flow path in the DEP region.

Reference

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