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

Supplementary Information

Continuous trapping, elasticity measuring and deterministic printing of single cells using arrayed microfluidic traps

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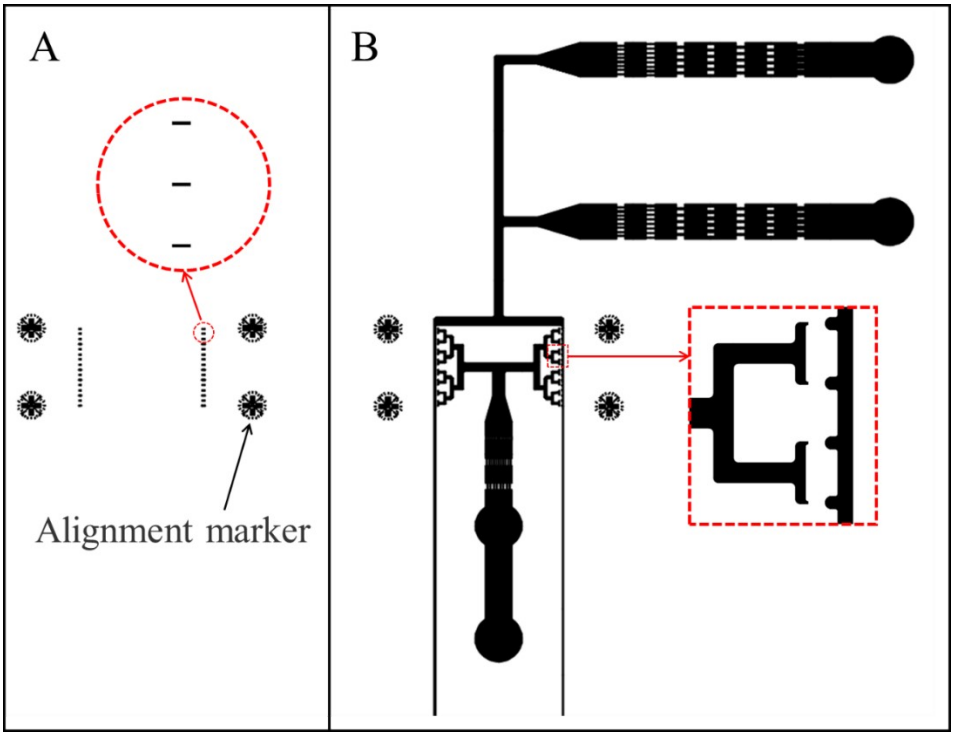

Fig. S1 The masks of the devices for double lithography. (A) Micropipette aspiration channels patterns during the first exposure. (B) The microchip patterns (for the second exposure) without the micropipette aspiration channels.

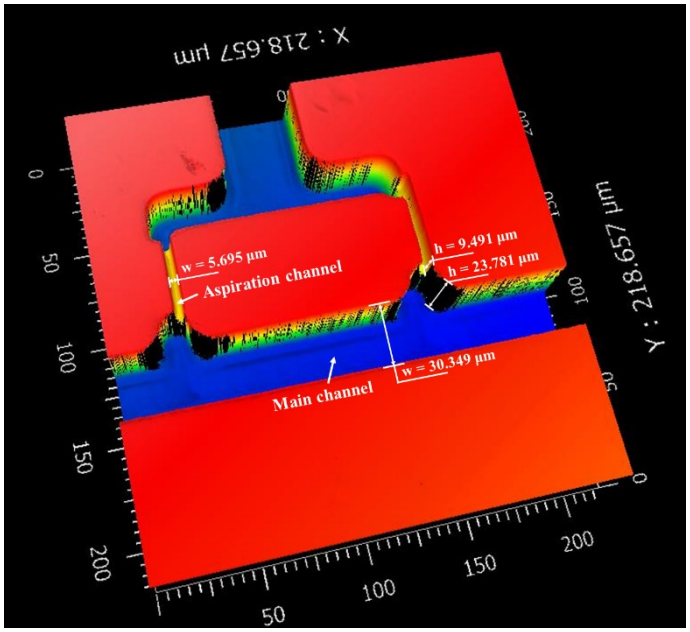

Fig. S2 The characterization of the microchannels using a 3D optical surface profiler (Zygo NewView^{TM} 9000, America). The width and height of main channel were 30.349 µm and 23.781 µm, respectively. And the width and height of aspiration channels were 5.695 µm and 9.491 µm, respectively. All the results were average of three measurements.

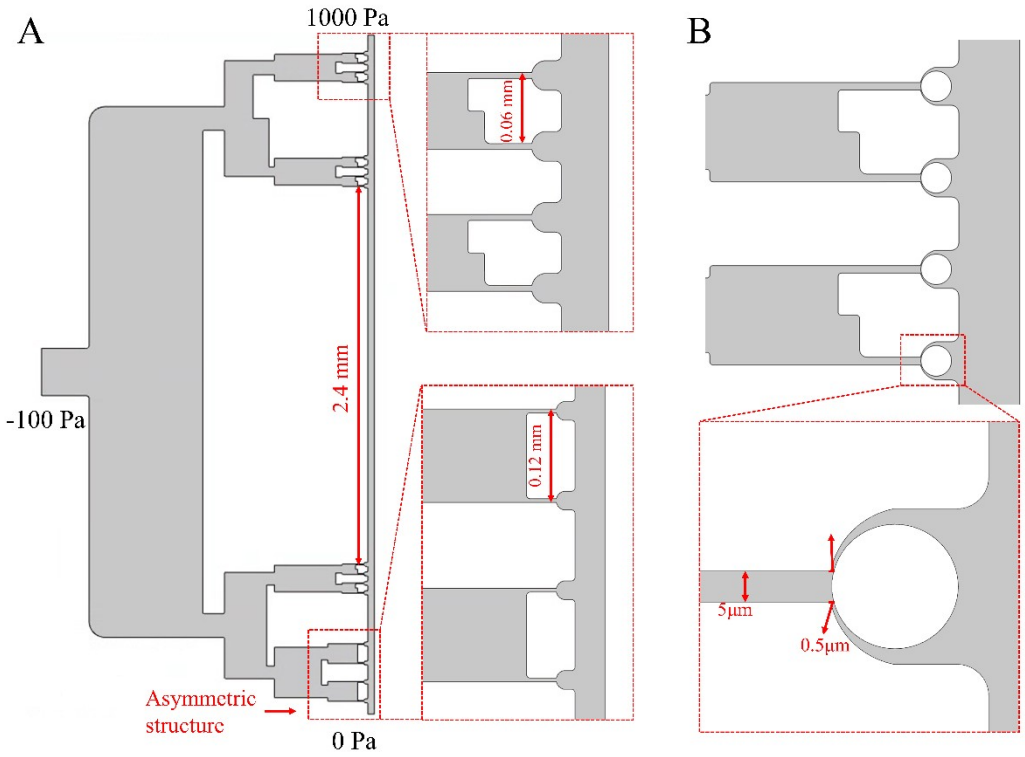

Fig. S3 The two-dimensional numerical model to simulate the hydrodynamics of the trapping process. (A) The model of the chip without beads. (B) The partial view of the model when beads were trapped.

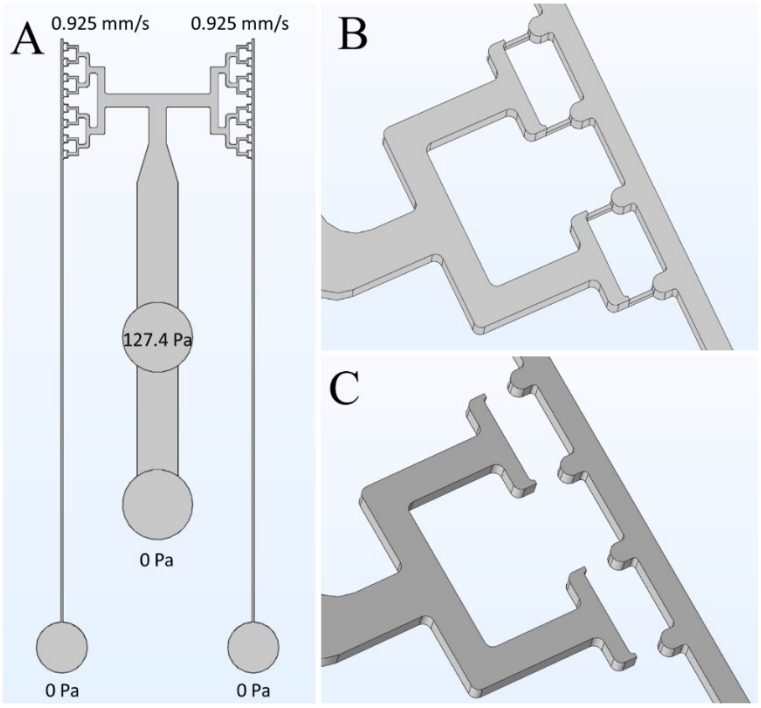

Fig. S4 The three-dimensional numerical model to simulate the hydrodynamics of the trapping process. (A) The three-dimensional model of the whole chip. (B) The partial view of the model when cells were not trapped. (C) The partial view of the model when the aspiration channels were blocked completely by the trapped cells.

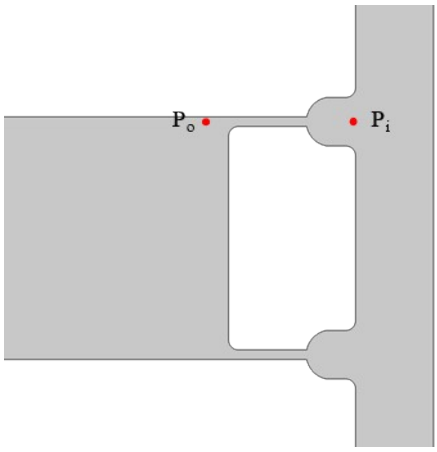

Fig. S5 The method to obtain pressure drop ΔP in simulation. P_i and P_o were determined by the point pressure at the entrance and exit of aspiration/shunt channel, respectively. And the pressure drop ΔP was the difference between them.

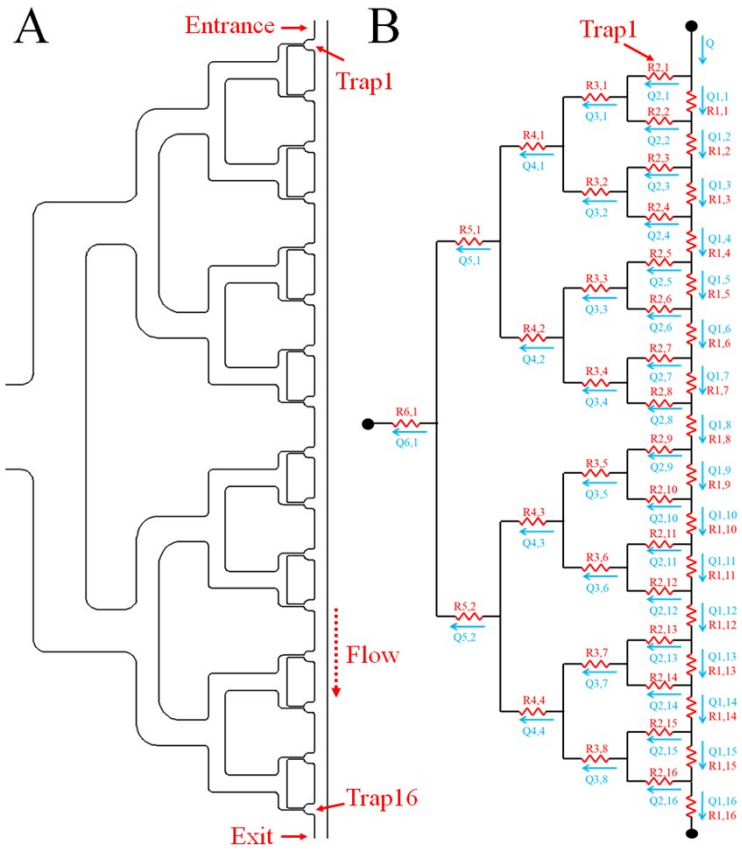

Fig. S6 The analytical analysis of the fluid flow in the microchannels. (A) The microfluidic network of one main channels with 16 U-shaped traps and the bifurcated channels for printing. (B)The equivalent hydraulic circuit of the left channels.

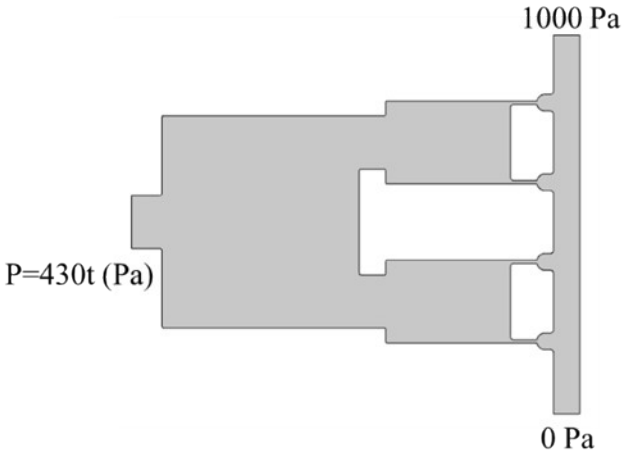

Fig. S7 The numerical model to simulate the pressure distribution in the process of microbead/cell printing. The pressure at the entrance was set at 1000 Pa, and the pressure at the exit was set at 0 Pa. The pressure at the printing side channel was a pressure that changed over time(P=430t Pa).

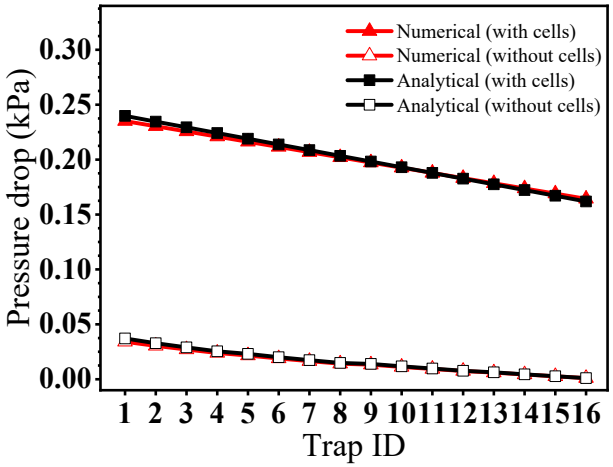

Fig. S8 Both numerical and analytical results of the pressure drop across either empty traps or traps retaining single cells when the flow rate of entrance was 0.08 μL/min.

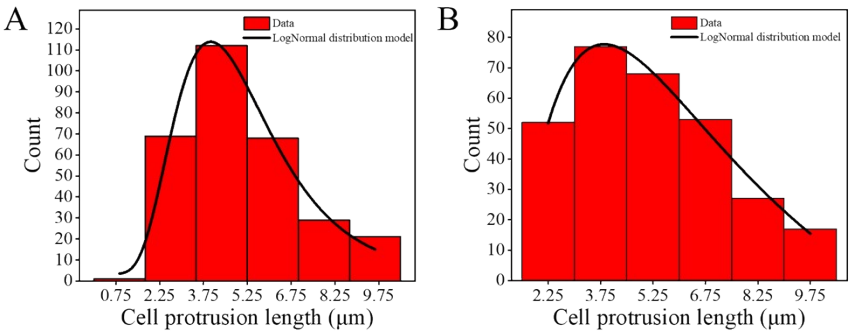

Fig. S9 The protrusion length of single K562 cells at (A) Passage 8 (N=300) and (B) Passage 46 cells (N=294) .The black curves represented the related logarithmic normal distribution model.

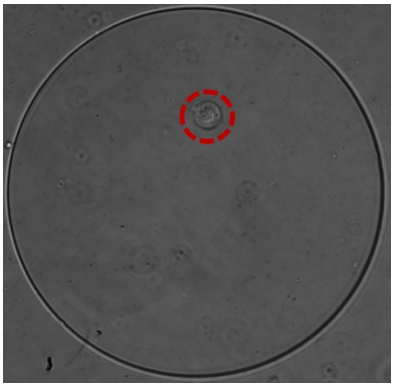

Fig. S10 The micro photo of the printed single cell in microwells with a diameter of 500 μm.

Table S1 Techniques for single cell printing

Single cell printing technique	Cell identification method	Single cell printing efficiency	Cell viability
Acoustic inkjet printing[1]	None	98.4%	89.8%
Inkjet printing[2]	Calculate cell's impedance signal	73%	
Air inkjet printing[3]	Label cell by fluorescent dyes	99.5%	
Piezoelectric inkjet printing[4]	Detect cell by optical image	87%	75%
Piezoelectric printing[5]	Detect cell by optical image	96.6%	90.3%
Single-cell pipette[6, 7]	Identify cell by microscope manually	~100%	

Video S1 Printing process of single microsphere (Trap 1-16) when the flushing inlet pressure was 200 mbar. The video was played at a speed of 2.5.

Video S2 Continuous printing process of single K562 cells (Trap 9-16) when the flushing inlet pressure was 100 mbar. The video was played at a speed of 1.7.

Video S3 Continuous and deterministic printing process of single K562 cells (Trap 1-16) when the flushing inlet pressure was 100 mbar.

Video S4 Continuous trapping and printing process of single K562 cells (Trap 1-16) when the sample inlet flow rate was 10 μL/min and the flushing inlet pressure was 100 mbar. The video was played at a speed of 2.

Supplementary References

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