**Figure S1.** Fabrication process flow. (a) Fabrication of the SU-8 mold on silicon wafers, (b) PDMS casting, alignment, and bonding for the formation of the microfluidic device. (c) Transparent mask layouts of the µFPA device.
Figure S2. Shear stress exerted on the cells under aspiration with maximum operation flow rate (0.75 µl/min) by numerical simulations.
Figure S3. Traditional micropipette aspiration. (a) Breast cancer cell (MDA-MB-231) under aspiration, pressure increment for 100Pa for every 10s interval, yellow line indicates the protrusion length (b) Young’s modulus of breast healthy (MCF-10A) versus cancer (MDA-MB-231) cell. (MCF-10A: 404.1 ± 18.4 Pa, n = 10 and MDA-MB-231: 225.5 ± 28.0 Pa, n = 14. Error bars represent standard error of the mean