Supplementary information

Finite element simulations were conducted in COMSOL 4.3. The purpose of the simulation is to qualitatively confirm that the current changes in this setup are reflective of RBC deformation. Table 1 summarizes simulation parameters. Halpern et al. [1] simulated RBCs inside channels comparable to our channel sizes. They approximated the deformed RBC profile to a cylindrical region with a hemispherical head and inverse hemispherical tail. In our simulation, a deformed RBC of this geometry with a fixed volume is situated in the channel, and electrical current within the channel is simulated for varied deformation lengths (see SI Fig. 1 (a)(b)). Volume is also varied to understand size-dependent current signals. At a low frequency (10 kHz) voltage, the deformed RBC behaves as an insulator, and only the liquid within the gaps between cell membrane and the channel walls conducts current [2-4]. The curves allow for a qualitative correlation between cell volume, deformation and current change (see SI Fig.1 (c)). The RBC's shape used here is a simplified model, wherein the volume of the RBCs can be readily controlled using analytical equations. The results qualitatively prove that the current change is in association with both RBCs' volume and deformability.

Table 1

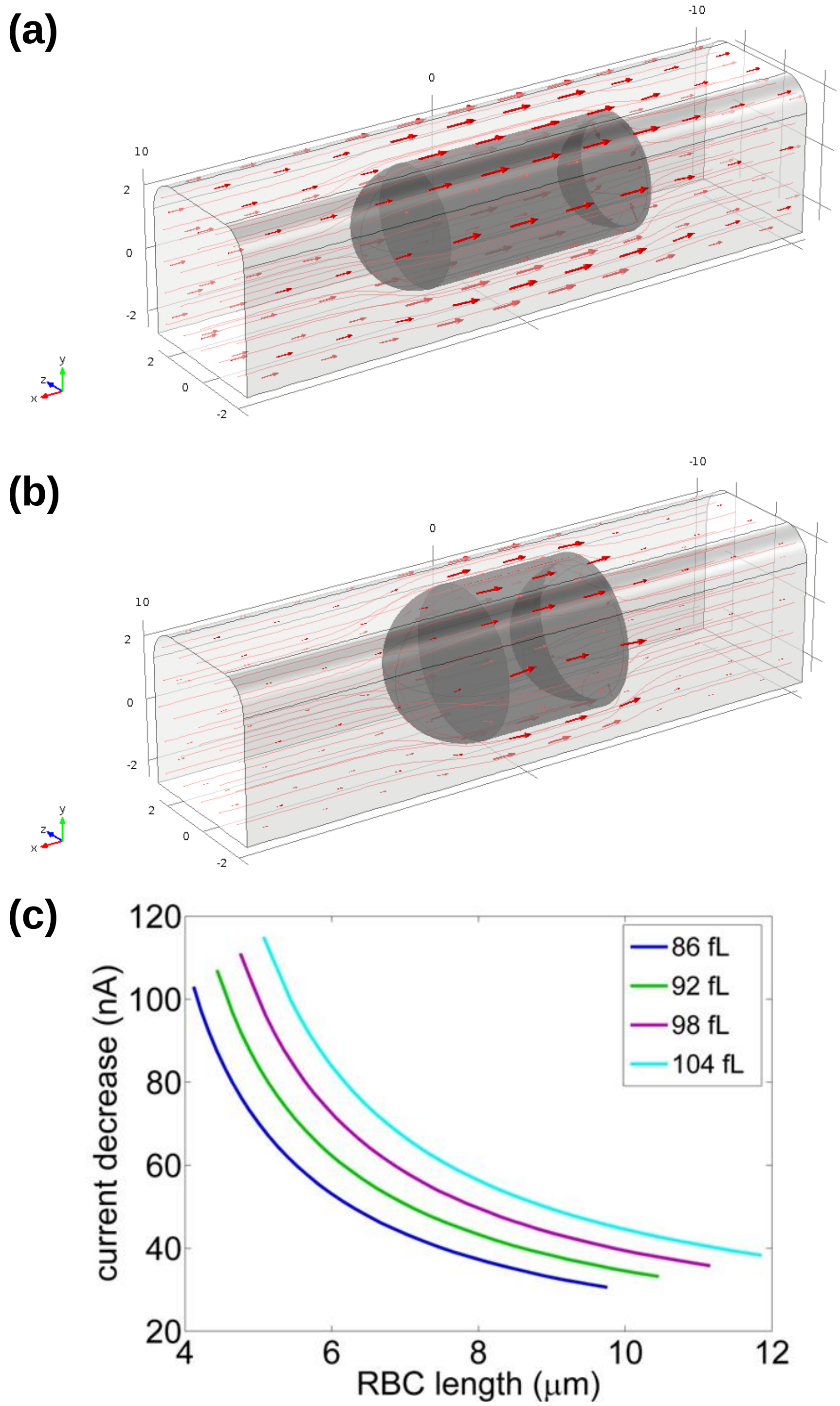
Parameter	Value
Channel length	20 μm
Channel cross-sectional area	5 μm ×5 μm
Effective cell conductivity	0 S/m
Effective cell relative permittivity	80
PBS conductivity	1 S/m
PBS relative permittivity	80
Cell volume	86-104 fL
Voltage applied	10 kHz@0.5 V_{pp}

[1] D. Halpern and T.W. Secomb, "The squeezing of red blood cells through capillaries with near-minimal diameters", *J. Fluid Mech.* vol. 203, pp. 381-400, 1989.

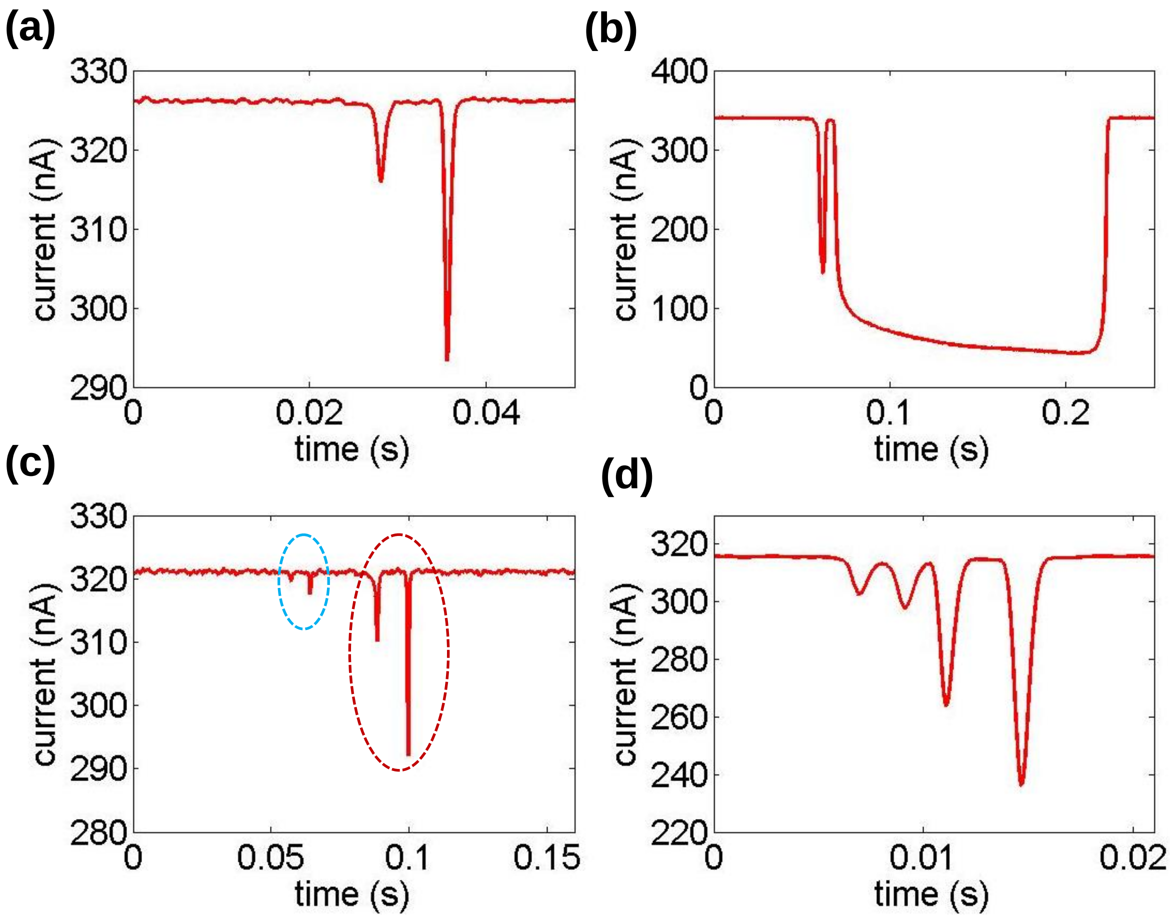
[2] Y. Katsumoto, K. Tatsumi, T. Doi, and K. Nakabe, "Electrical classification of single red blood cell deformability in high-shear microchannel flows," International Journal of Heat and Fluid Flow, vol. 31, pp. 985-995, 2010.

[3] A. Adamo, A. Sharei, L. Adamo, B. Lee, S. Mao, and K. F. Jensen, "Microfluidics-based assessment of cell deformability," Analytical Chemistry, vol. 84, pp. 6438-6443, 2012.

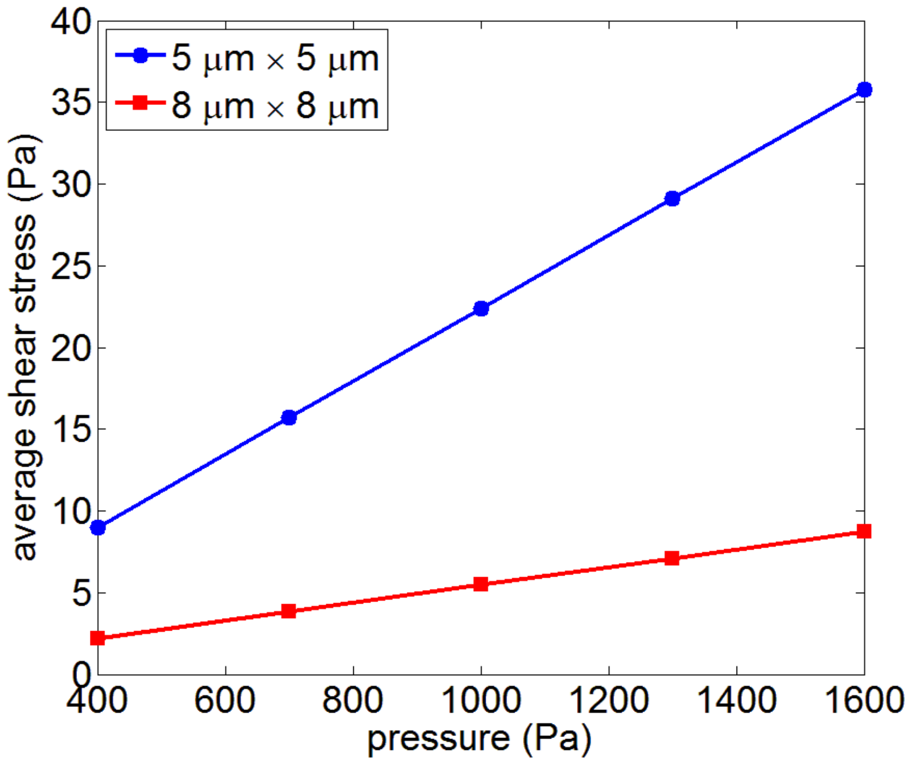
[4] P. R. C. Gascoyne, X. B. Wang, Y. Huang, and F. F. Becker, "Dielectrophoretic separation of cancer cells from blood," Ieee Transactions on Industry Applications, vol. 33, pp. 670-678, May-Jun 1997.



Supplementary Figure S.1: Simulation results of current conduction and field lines for a deformed RBC of 86 fL volume and a deformation length of 10 µm (a) and 6 µm (b). The length of the arrows represents electrical current magnitude. For two RBCs having the same volume, the more deformable RBC causes a less current decrease due to larger gaps between the cell membrane and channel walls. (c) The current decrease within the channel, when RBCs with different volumes and deformation length are present.



Supplementary Figure S.2: Representative experimental data from (a) a single RBC (two peaks from two measurement units), (b) a single white blood cell (WBC), (c) a single platelet (circled in blue) and a single RBC (circled in red), and (d) two RBCs within the measurement areas at the same time. The signals generated by platelets and WBCs have significant difference in signal magnitude; and the overlap events (two RBCs within the measurement area at the same time) have multiple consecutive larger valleys.



Supplementary Figure S.3: Average shear stress of the cross-sectional area within the 5 μm ×5 μm channel and the 8 μm ×8 μm channel under different driving pressures. Parameters for shear stress simulation are summarized in Table 2. The average shear is obtained by dividing the integrated shear stress over the cross-sectional area by the cross-sectional area ($\int_0^A \tau \,/A$, A: cross-sectional area; τ: shear stress).

Table 2

Parameter	Value
5 μm ×5 μm channel length	20 μm
8 μm × 8 μm channel length	20 μm
50 μm × 20 μm transit channel length	30 μm
Driving pressure	400-1600 Pa
Viscosity	1 mPa·s
Boundary condition	no-slip