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

Rheological properties of 500 ppm, 1000 ppm, 2000 ppm PEO solutions

The rheological properties of the fluids were measured in a rotational rheometer (Antonpaar MCR 301) that has a parallel plate configuration and a diameter of 20 mm. These experiments were performed at room temperature (24 ± 1°C). Figure S1 shows the viscosity of the PEO solutions as a function of the shear rate for polymer concentrations of 500 ppm, 1000 ppm, 2000 ppm. The shear viscosity of the viscoelastic fluids was measured in shear rates ranging from 200 s^{-1} to 10^3 s^{-1}. The PEO solutions slightly show shear thinning behaviors. The shear viscosity of the PEO solution increased rapidly with increments of PEO concentration because the higher the PEO concentration, the more couplings and entanglements are formed by the internal polymer chains; this action caused the viscosity to increase.

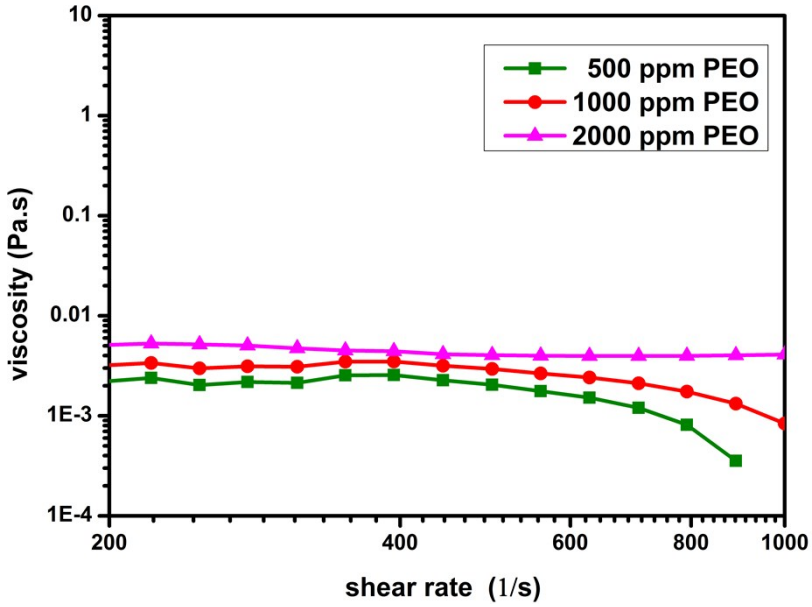

Figure S1 Viscosity of PEO solutions as a function of shear rate for polymer concentration of 500 ppm, 1000 ppm, 2000 ppm

Calculation for relaxation time:

The relaxation times for PEO solutions were estimated from the previous empirical relaxation times (λ) measured with CaBER [1]. The relaxation time depends on the polymer conformation, and can be defined by the polymer concentration c as:

$$\lambda = 18\lambda_z (c/c^*)^{0.65}$$

where λ_z is the Zimm relaxation time and c^* is the polymer overlap concentration (858 ppm [2]),

λ_z was calculated as 7.1 × 10^{-4} s from equation [2, 3]:

$$\lambda_z = f[\eta](M_w)\eta_s / RT$$

where f (=0.463) is the prefactor dependent upon solvent quality, $[\eta]$ (=0.916 m^3 kg^{-126}) is the intrinsic viscosity, η_s (=2.05×10^{-3} Pa·s) is the solvent viscosity, R (=8.314 J mol^{-1} K) is the gas constant, and T (=293K) is the absolute temperature.

However, the equation can only be applied when c/c* <= 1, so only 500 ppm PEO solution was calculated using the above equations. The empirical relaxation time for 500 ppm PEO solution is estimated to be 9.1ms. The relaxation time for 1000 ppm and 2000 ppm PEO solutions are refered from Xuan's work [4], which is 12.4 ms and 19.5 ms respectively.

Calculation results of R_c and W_i for 500 ppm, 1000 ppm, 2000 ppm PEO solutions from flow rate *Q*= 10 µl/min to *Q* = 80 µl/min

	500 ppm	**1000 ppm**	**2000 ppm**
***Q*= 10 µl/min**	R_c **=0.3** W_i **=7.64**	R_c **=0.2** W_i **=10.41**	R_c **=0.12** W_i **=16.22**
***Q*= 20 µl/min**	R_c **=0.6** W_i **=15.28**	R_c **=0.4** W_i **=20.82**	R_c **=0.24** W_i **=32.44**
***Q*= 30 µl/min**	R_c **=0.9** W_i **=22.92**	R_c **=0.6** W_i **=31.23**	R_c **=0.36** W_i **=48.66**
***Q*= 40 µl/min**	R_c **=1.2** W_i **=30.56**	R_c **=0.8** W_i **=41.64**	R_c **=0.48** W_i **=64.88**
***Q*= 50 µl/min**	R_c **=1.5** W_i **=38.2**	R_c **=1** W_i **=52.05**	R_c **=0.6** W_i **=81.8**
***Q*= 60 µl/min**	R_c **=1.8**	R_c **=1.2**	R_c **=0.72**

	W_i=45.84	W_i=62.46	W_i=97.35
Q= 80 µl/min	R_c=2.4 W_i=61.12	R_c=1.6 W_i=83.28	R_c=0.96 W_i=129.76

Effects of distance from inlet

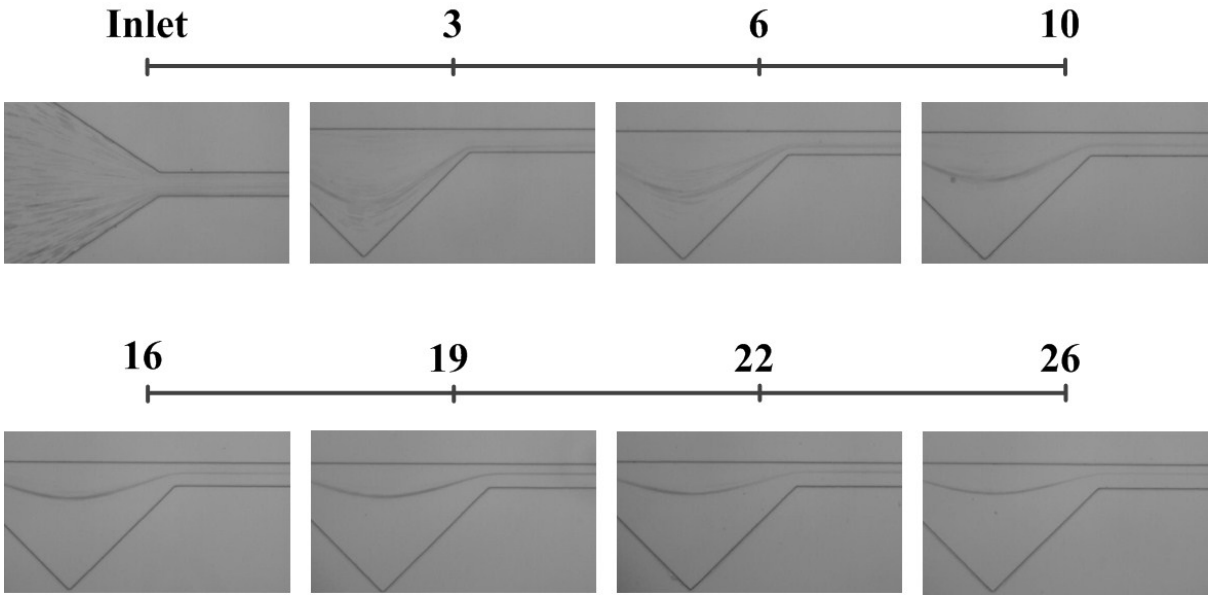

Figure S2 Effects of distance from inlet.

The red blood cells' focusing behaviour after every expansion–contraction cavity was investigated. Figure S2 shows the captured figure of focusing behaviour after certain number of the cavities. The number on the axis means the cavity order counted from inlet. It can be seen that at inlet, the red blood cells are randomly distributed, from the 3rd to the 6th cavity, the cells are gradually confined after the 10th cavity, most cells are focused, but not very well; until after the 16th cavity, all the cells are focused into a tight stream. The focusing after 16th cavity is as good as that of the cavity at further distance from inlet, as can be seen from the captured picture after the 19th, 22th, and the last cavity. Therefore, the length of our ECCA channel can be shortened to approximately 40mm while maintaining the good focusing performance.

Effects of blood hematocrit on focusing behavior

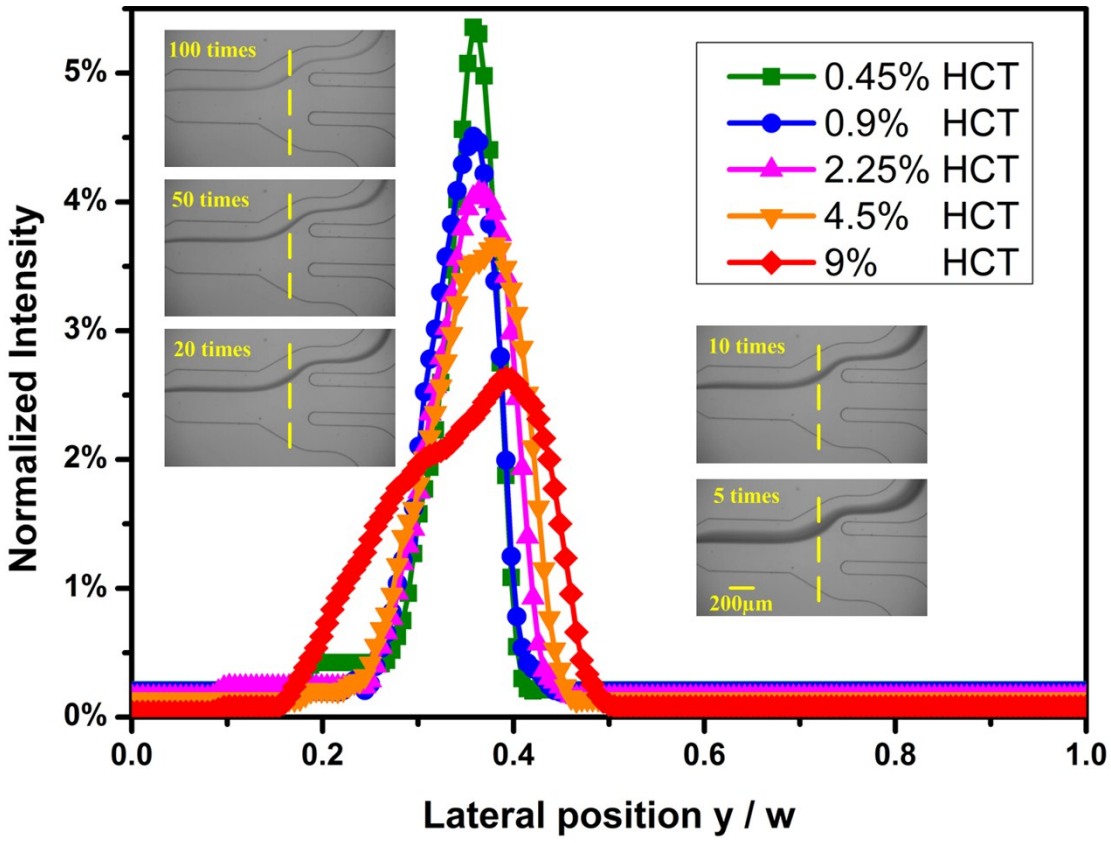

Figure S3 Effects of blood hematocrit on the focusing behavior

We've investigated the effects of blood hematocrit on the focusing behaviour by diluting whole blood 100 times (0.45% HCT), 50 times (0.9% HCT), 20 times (2.25% HCT), 10 times (4.5% HCT), and 5 times (9% HCT) respectively. It can be seen that as the blood hematocrit increases, the focusing width of blood cells in our ECCA channel becomes wider (Figure S3). This is because the higher the blood hematocrit, the more significant the interaction between blood cells. And strong interaction of blood cells deteriorates the focusing quality. Therefore, the blood hematocrit has an obvious effect on focusing behavior. The focusing width becomes tighter as the whole blood dilute more times.

References:

1 V. Tirtaatmadja, G. H. McKinley and J. J. Cooper-White, *Phys. Fluids*, 2006, **18**, 043101.

2 L. E. Rodd, T. P. Scott, D. V. Boger, J. J. Cooper-White and G. H. McKinley, *J Non-newtonian Fluid Mech*, 2005, **129**, 1-22.

3 L. Rodd, J. Cooper-White, D. Boger and G. McKinley, *J Non-newtonian Fluid Mech*, 2007, **143**, 170-191.

4 X. Lu and X. Xuan, *Anal. Chem.*, 2015, **87**, 6389-6396.