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

SUPPLEMENTARY INFORMATION

Circulating tumor cell detection using a parallel flow micro-aperture chip system

Chun-Li Chang,[ab] Wanfeng Huang,[ab] Shadia I. Jalal,[d] Bin-Da Chan,[ab] Aamer Mahmood,[b] Safi Shahda,[d] Bert H. O'Neil, Daniela E. [d] Matei[d] and Cagri A. Savran*[abc]

[a] School of Mechanical Engineering, Purdue University, West Lafayette, IN, 47907, USA.
[b] Birck Nanotechnology Center, Purdue University, West Lafayette, IN, 47907, USA.
[c] Weldon School of Biomedical Engineering, Purdue University, West Lafayette, IN, 47907, USA.
[d] Department of Medicine, Indiana University School of Medicine, Indianapolis, IN, 46202, USA.
[*] Corresponding Author (Email: savran@purdue.edu)

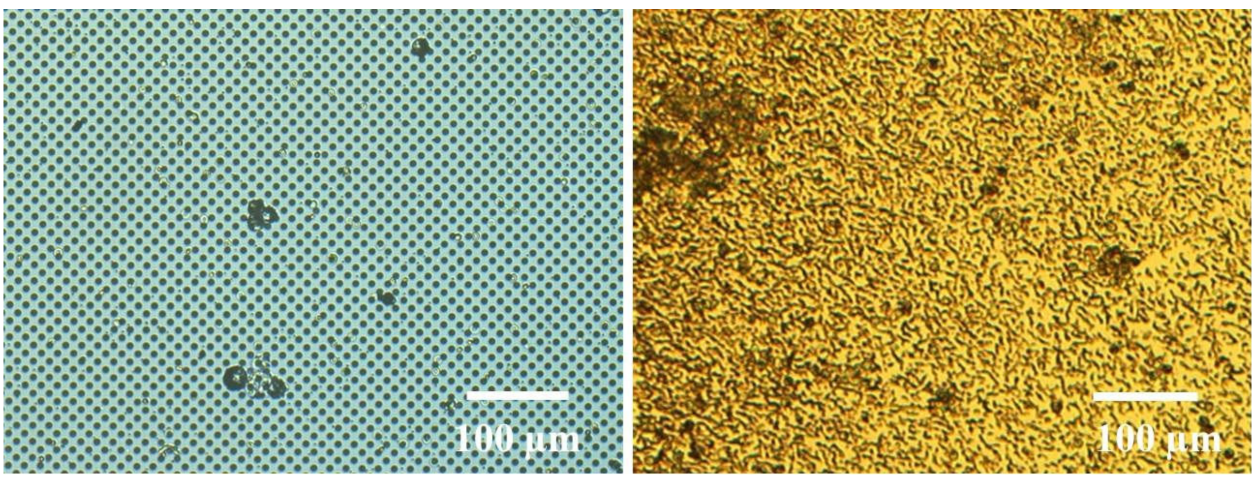

Figure S1: Detection of MCF-7 cells spiked in blood using a micro-aperture chip and a glass slide (without any apertures). The aperture chip effectively clears most of the free beads.

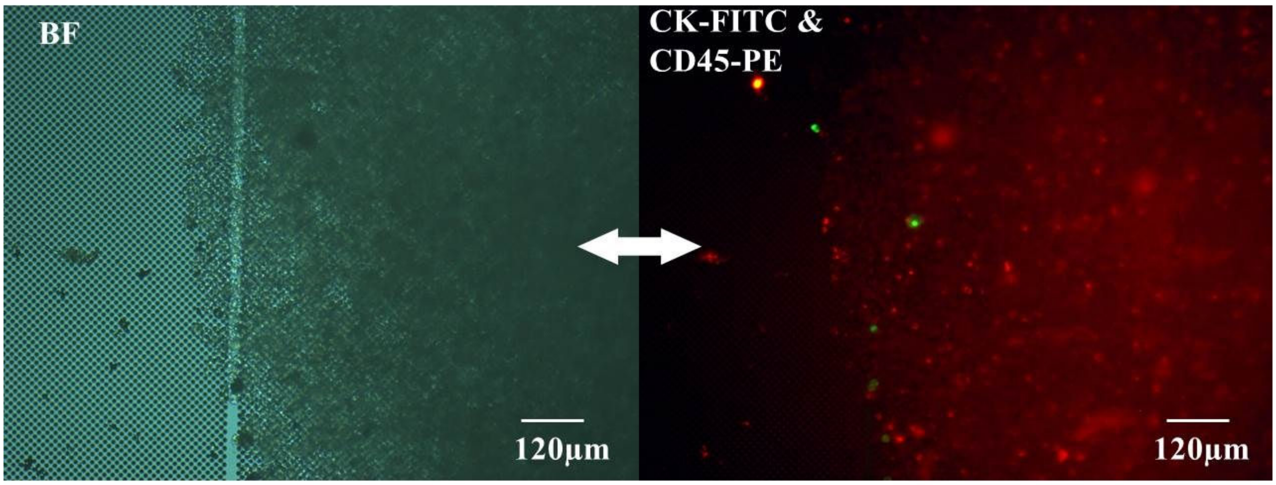

Figure S2: Detection of MCF-7 cells spiked in blood at a flow rate of 0.5 mL/min. At this flow rate the magnetic force greatly overwhelms the fluidic force, and hence the beads (which are many) aggregate and pile up on the chip, burying the target cells underneath, instead of spreading them over the chip surface.

Shear rate

The shear rate of the flow ($\dot{r}_a$) for a rectangular channel can be estimated using:[1]

$$\dot{r}_a = \left(\frac{6Q}{WH^2}\right)\left(1+\frac{H}{W}\right)f^*\left(\frac{H}{W}\right)$$

where W and H are the width (3.8 mm) and height (2 mm) of the channel, and $f^*\left(\frac{H}{W}\right)$ is a function of the aspect ratio (H/W) and can be expressed by: [1]

$$f^*(x) = \left[\left(1+\frac{1}{x}\right)^2\left(1-\frac{192}{\pi^5 x}\sum_{i=1,3,5}^{\infty}\frac{\tanh\left(\frac{\pi}{2}ix\right)}{i^5}\right)\right]^{-1}$$

$f^*\left(\frac{H}{W}\right)$ is calculated to be around 0.64 for the chamber in our system, and the resulting shear rate at the optimal flow rate (2 mL / min) is 12.85 s^{-1} which is less than the reported shear rates in human blood vessels (over 1250 s^{-1} in arterioles and capillaries).[2]

References

1. Y. Son, "Determination of shear viscosity and shear rate from pressure drop and flow rate relationship in a rectangular channel," *Polymer*, vol. 48, pp. 632-637, 2007.
2. T. G. Papaioannou and G. Stefanadis, "Vascular Wall Shear Stress: Basic Principles and Methods," *Hellenic J Cardiol*, vol. 46, pp. 9-15, 2005.