Supplementary Material (ESI) for Lab on a Chip

An air-bubble-actuated micropump for on-chip blood transportation

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Video. The video shows the experimental demonstration for the pumping function of our air-bubble-actuated micropump by using human whole blood. The applied voltage for this blood-pumping demonstration is 2.2 V at 1 Hz. The whole prototype chip is made of the PDMS microchannel and the glass cover.

Anticoagulability process for the PDMS microchannel surface

The PDMS surface was first treated with O_2 plasma for 30 seconds at 0.15 Torr in a Harrick Plasma Cleaner to generate hydroxyl groups on the surfaces. The PDMS was then quickly immersed into a solution of 3-aminopropyltriethoxysilane (APTS, Fluka) for 2 hours to form the amine-terminated self-assembled monolayer (SAM) coating. The following steps take advantage of biochemical approaches[1] to immobilize functional macromolecules with high yields. The grafted amino group is reacted with bis(sulfosuccinimidyl)suberate (BS3, Pierce) to allow the subsequent attachment of an amino-terminated polyethylene glycol (PEG, Shearwater). Fig. 1 shows the illustration for the PEG anticoagulability which prevents the adhesion of the platelets to the microchannel surface.

Platelet adhesion tests were performed to evaluate the anticoagulability effects of the PEG layer. Micropump with the PEG layer drives the blood for thirty minutes. The blood flows through the main channel of the micropump chip smoothly without blocking. After thirty minutes, the blood was replaced with the PBS solution and the cells were washed for five minutes at a flow rate of 100 nl/min. Most suspension cells were washed out of the main channel. For comparison, the same setup with an untreated micropump chip was also adopted. Fig. 2(a) and (b) show the experimental comparison of platelet adhesion tests for both unmodified and PEG-modified PDMS surfaces of the micropump chips, respectively.

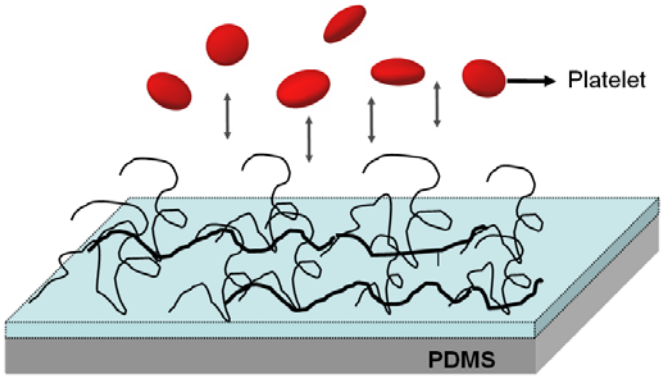
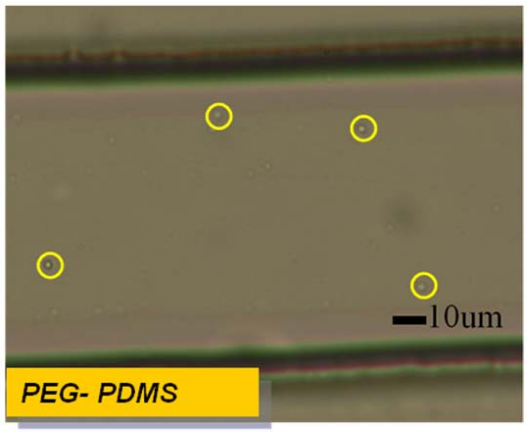
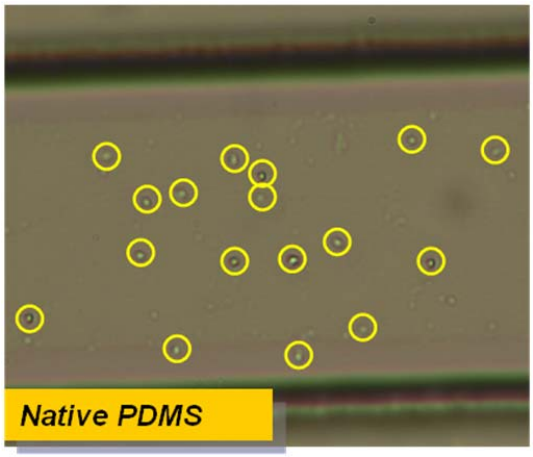


Fig. 1. PEG Protection for preventing the adhesion of the platelets to the microchannel surface



(a)



(b)

Fig. 2. Photographs for the platelet adhesion tests on of the substrate of main channel under the magnification of 500X. (a) PEG modified surface and (b) untreated surface.

References

1 S Knoller, S Shpungin, E Pick, “The membrane-associated component of the amphiphile-activated, cytosol-dependent superoxide-forming NADPH oxidase of macrophages is identical to cytochrome b559,” J Biol Chem. vol. 15;266(5), pp. 2795-2804, 1991.