Adsorption phenomena of nanoliposomes on PDMS microchannel's surface

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1. Introduction

Poly(dimethylsiloxane) (PDMS) based microchannel of a microcapillary chip is attractive for characterization of polymer nanoparticles (NPs) [1]. Due to the structural conformation, the surface potential of PDMS is negative in nature, and in presence of charged-based nanoparticles, there exist an electrostatic interaction between the nanoparticles and microchannel surface. In this study, the adsorption phenomena of nanoliposomes in the microchannel was investigated by using a microfluidic chip designed for autonomous compensation of hydrostatic pressure flow.

2. Experimental method

For observing adsorption phenomena of nanoliposomes, a microfluidic chip with a bypass channel was used (Fig. 1a). This microfluidic chip was designed for autonomous compensation of hydrostatic pressure flow [2], thus, counting of individual nanoliposomes can be achieved. Nanoliposomes were prepared by thin film evaporation method. Neutral and cationic nanoliposomes were prepared for studying adsorption phenomena on negatively charged PDMS microchannel's surface. The neutral liposome was prepared with 1,2-dilauroyl-sn-glycero-3-phosphocholine (DLPC) (Avanti Polar Lipids) and cholesterol (Sigma Aldrich) at 4:1 molar ratio, whereas the cationic liposome was prepared with 1,2-di-O-octadecenyl-3-trimethylammonium propane (chloride salt) (DOTMA) (Avanti Polar Lipids) and cholesterol in 1:1 molar ratio. Size of the nanoliposomes was tailored to 100 nm using a mini-extruder. Adsorption of nanoliposomes were evaluated by counting the number of liposomes in microchannels. The individual nanoliposomes were visualized by dark field image of Rayleigh light scattering. The number of the liposomes in region of interest (ROI) counted using the vesicle analyzer software, as shown in Fig. 1b.

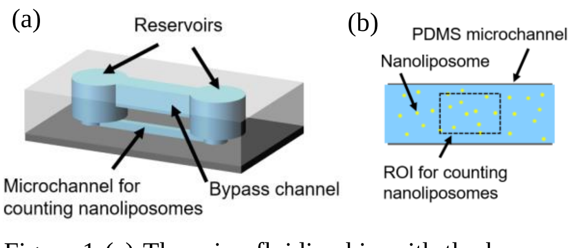

Figure 1 (a) The microfluidic chip with the bypass channel. (b) Schematics of counting nanoliposomes in the PDMS microchannel (200 μm in width and 200 μm in height).

3. Results and discussion

First, the zeta-potential of the neutral and cationic nanoliposomes were measured by using a zeta potential analyzer (Zetasizer Nano ZS, Malvern Instruments). The average value of the zeta-potential was -1.0 mV and 46.7 mV for the neutral and cationic nanoliposomes, respectively. Then, nanoliposomes in the PDMS microchannel were observed. Due to the compensation of the hydrodynamic flow by the bypass channel, Brownian motion of nanoliposomes in ROI were stably observed without any fluid flow. Figure 2 shows time course of the particle numbers in the ROI in the PDMS microchannels. Adsorption phenomena was observed as decreases of the numbers of nanoliposomes, for both DLPC and DOTMA nanoliposomes. The adsorption of the neutral DLPC liposomes was considered to be arisen from hydrophobic interaction, whereas the cationic DOTMA liposomes from electrostatic interaction.

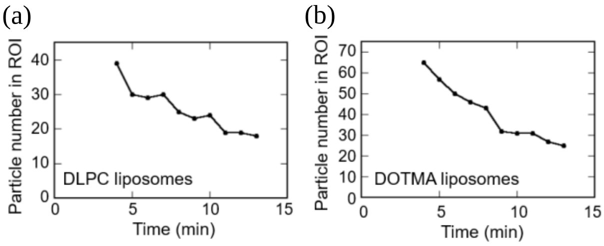

Figure 2 Time course of the particle numbers in the microchannels. (a) Neutral nanoliposomes of DLPC. (b) Cationic nanoliposomes of DOTMA.

4. Conclusion

The microfluidic chip for autonomous compensation of hydrostatic pressure flow enabled to observe adsorption phenomena of nanoliposomes arisen from hydrophobic interaction and electrostatic interaction.

Reference

[1] T. Akagi, *et al.*, J. Photopolymer Sci. Technol. **5**, 727–730 (2015).

[2] V. Majarikar, *et al.*, Microfluidics and Nanofluidics, **22**, 110 (2018).