Stretching and fixing DNA molecules on air-plasma-treated surface by using an air/water interface in a microchannel

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1. INTRODUCTION

Stretching and immobilizing DNA molecules have been used for DNA analyses. In a previous study, these were achieved on a glass surface treated with silane coupling agents such as APTES using the movement of an air/liquid interface in a microchannel[1]. However, the surface modification increases the number of fixed DNA molecules and often causes the overlapping of DNA molecules, which interrupts the analysis of a single DNA molecule. In this study, we tried to stretch and fix DNA molecules on an air-plasma-treated glass surface without the silane coupling agents in a microchannel. We improved the number of DNAs stretched and immobilized by setting the depth of channel small. Additionally, we investigated the dependence of stretching rate and number of DNAs on the velocity of air/water interface movement.

2. EXPERIMENTS

We fabricated a chip device with a straight microchannel by transferring Si mold created by photolithography to PDMS. The length and width of the microchannel were 40 mm and 50 μm, respectively. The depths were set to be 16 μm and 2 μm. DNA sample was 48.5 kbp-DNA combined with YOYO-1 (Maximum length l_{max} =22 μm). The concentration was 25 ng/μl. DNA samples were introduced into the channel from the reservoir by applied pressure. The air/liquid interface was moved by introducing air from the reservoir by applied pressure. The values were set to be 50 mbar in 16 μm-deep channel and 50 mbar, 200 mbar, and 400 mbar in 2 μm-deep channel. The velocities of air/liquid interface were 2000 μm/s in 16 μm-deep channel and 16, 125, and 650 μm/s in 2 μm-deep channel, respectively.

3. RESULTS AND DISCUSSIONS

We succeeded in stretching and fixing DNAs on the air-plasma-treated glass surface in the microchannels of both 16 μm and 2 μm depth. We measured the stretching length l and obtained the stretching ratio $S = l/l_{max}$. In the 16 μm-deep channel, only four DNAs could be stretched and immobilized on the surface. In the 2 μm-deep channel, 100-400 DNAs could be stretched and immobilized, that indicated that we succeeded in improving the number of DNAs. As the results using 2 μm-deep channel, we succeeded in increasing the stretching rate S using higher velocity of the air/liquid interface. The total number of DNAs decreased with the increase of the velocity. We consider that it is necessary to optimize the velocity of the interface to improve the stretching ratio.

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[1] C. A. P. Petit and J. D. Carbeck, Nano Letters 3, 1141 (2003).