BIOLOGICAL CELL BEHAVIOR IN MICRO FLOW CHANNEL

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Introduction

An erythrocyte has flexibility and deforms in the shear flow [Hashimoto, 2005]. It also passes through micro-circulation, of which the dimension is smaller than its diameter. After circulation through the blood vessels for days, the erythrocyte is trapped in the micro-circulation systems. One of the systems, which trap erythrocytes, is a spleen. The spleen has special morphology in the blood flow path to sort injured erythrocytes. The photolithography technique enables manufacturing a micro-channel. Several micro-fabrication processes have been designed to simulate morphology of microcirculation. The technique also will be applied to handle cells in diagnostics *in vitro*. In the present study, a micro-channel has been designed to control behavior of biological cells *in vitro*. The fabrication technique has been investigated with the photolithography process.

Methods

The micro channel has been fabricated with the photolithography and etching processes. A borosilicate glass disk of 50 mm diameter and 1.1 mm thick was used for a mold. The photo-resist material was coated with a spin coater. The groove pattern was drawn on the disk with a laser drawing system. To control the width of the groove of the mold with the laser drawing system, variations were made in the parameters: the voltage, the velocity, the acceleration, and the focus. In the present study, the target minimum value of the width is one micrometer for the channel of cells. The disk was etched with the hydrofluoric acid. Variation was made on the time for etching. The disk, again, was dipped in TW to etch chrome. The dimension of the groove was measured with a laser microscope. The behaviour through the slit between micro columns of L929 was observed with a microscope when the suspension of L929 was pumped into the micro chamber.

Results

The experimental results show following relations between the width of the groove and the parameters of the drawing system: the width increases with the voltage, the width decreases with the velocity, and the width decreases with focus. To decrease the voltage of the single drawing, the each pattern was traced three times. The experimental results show that the too high velocity makes some patches along the narrow groove. The minimum width of 540 nm has been attained in laser drawing of three times at the voltage of 3.15 V, the velocity of 2 mm s^{-1}, acceleration of 0.5 mm s^{-2}, and the focus offset of 0.4 V. L929 can go through the micro slit of 0.003 mm.

Discussion

The fine architecture of the red pulp of the spleen has been investigated in the previous studies. The special morphology might relate to the function for sorting erythrocytes. A micro channel could simulate the microcirculation system. The microgroove governs the behavior of cells. Several factors govern the morphology of the groove at etching on glass. The wet etching process has been investigated on glass and applied to a monitoring system for a cell. When the width of the micro groove is narrow enough, the ratio of penetration of the hydrofluoric acid to the laminar direction increases. The isotropic etching produces round sidewalls. This process controls curvature of the micro groove on the mold. It enables making semi-cylindrical grooves. After etching process, the mold will be applied to polydimethylsiloxane to make a micro-channel for biological cells. The micro-channel devices may contribute to the development of biotechnology.

References

Hashimoto *et al*, J Systemics Cybernetics Informatics, 3:90-93, 2005.