Both Pneumatic and Magnetic Induction of Scattered Cells on Micro Channel Array for Cellular Analysis

Abstract

We present integration of magnetic induction to Micro Channel Array in addition to pneumatic induction. Electroplated structures into micro channels as magnetic paths can induce magnetic flux generated behind MCA substrate. Induced magnetic flux at individual micro channels can attract magnetically labeled cells so as to allocate and clamp scattered cells on MCA.

Both Pneumatic and Magnetic Induction

Motivation
- On-chip analysis of single cell or cellular network in a batch
  - Electrophysiological bio-sensing device
  - On-chip cell manipulation system
- Magnetic and Pneumatic Induction on MCA
  - Various approach to single cell by MCA with magnetic path
  - Ex. Magnetic force: Cell clamp
  - Pneumatic force: Chemical delivery
  - Application (Ex. Cell analysis, Tissue Engineering)

Pneumatic and Magnetic Induction

Preliminary Experiment

Experiments of magnetic induction of magnetic beads when 20 mA was applied
- Flow (40 nl/s)
  - Magnetic bead (1-2 μm)
  - Suction hole
  - Without electroplated magnetic path
  - With electroplated magnetic path

The magnetic path could generate localized magnetic force at micro channels.

Magnetic Induction

Experimental results of cell manipulation using magnetic induction
- The current with 70 mA was applied to the electromagnet.
- Cell labeled with MCLs (Φ10-20 μm)

The cells were electromagnetically clamped while the current was applied.

Transferring of a Single Cell

Cell labeled with MCLs

Flow (40 nl/s)

Magnetic path

Cell labeled with MCLs

Current

OFF

ON

Combination of pneumatic and magnetic induction makes it possible to control clamping and releasing of desired cells.

Toward Advanced MCA

Lucifer Yellow

Pressure

Gushing fluorescent Lucifer Yellow (LY) dye from micro channels to demonstrate of chemical delivery through micro channels of MCA

Summary

We presented Micro Channel Array equipped with functions of both pneumatic and magnetic induction of scattered cells. Magnetic induction of magnetically labeled cells (Mouse NIH/3T3 fibroblasts, Φ 10-20 μm) on developed MCA could be observed. MCA having both pneumatic and magnetic induction can be expected to contribute to study on cellular analysis.