On-chip cell manipulation systems
-Part6: On-chip Droplet Dispensing by Magnetically Driven Microtool-

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バイオチップ内でドロップレットのサイズ調整を高速に行うには？

Abstract:

We have investigated an actively size controlled droplet generation system by using magnetically driven microtool (MMT). With this method cell-enclosed droplet can be produced on demand to fit the size of each enclosed cell, and which is difficult to be carried out by fluid dynamic force. For the current study, the system has been evaluated in terms of the frequency of MMT actuation and the size of droplets produced and which contribute to the effective transportation of cells in microchannel

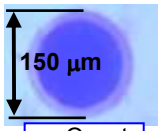
Background:

Cell Manipulation

Actuator

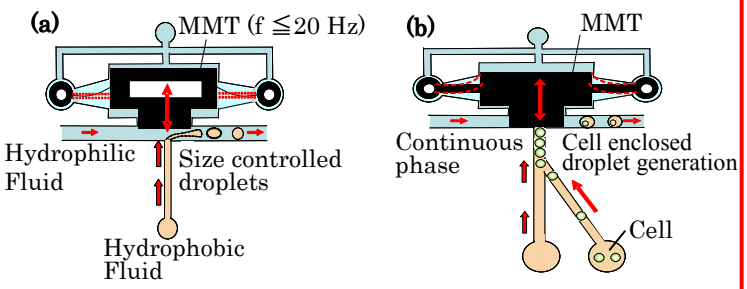
1. 非接触駆動可能
2. 柔軟(ヤング率 5 MPa)
3. 生体試料に無害
4. ディスポーザブル

PROBLEMS



細胞を液滴に内包する
⇩
移動の効率化

Concepts -液滴生成のマイクロチップ-

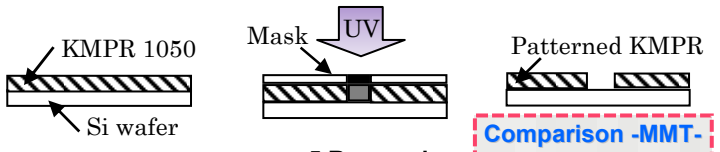


(a)液滴生成とMMTによるサイズ制御　(b)細胞バルブ機能をもつMMT

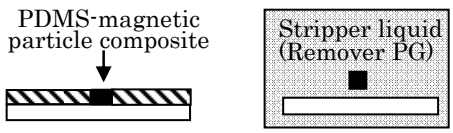
Fabrications :

Process -磁気マイクロツール-

1.Spincoat photoresist　2.Exposure　3. Development



4.Filling in the composition　5.Removal

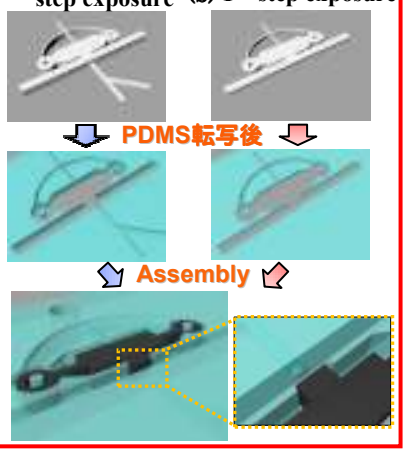


Comparison -MMT-

Process -マイクロチップ-

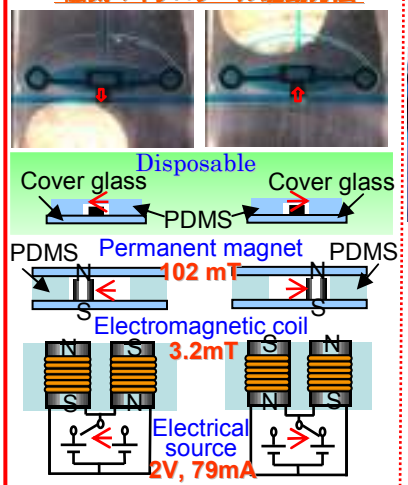
1. Molding
(a) 1st and 2nd step exposure
Patterned SU-8
2nd layer　1st layer
PDMS
Si wafer
(b) 1st step exposure
Patterned SU-8
2. Assembly
MMT
Plasma
Micro-channel

(a)1st and 2nd step exposure　(b) 1st step exposure



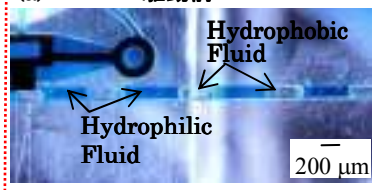
Experiments:

Experimental Setup -磁気マイクロツール駆動方法-



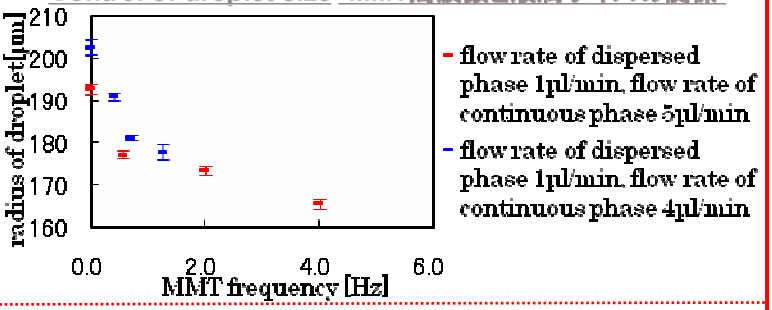
Operation of MMT -磁気マイクロツール駆動-

(a) MMT 駆動前



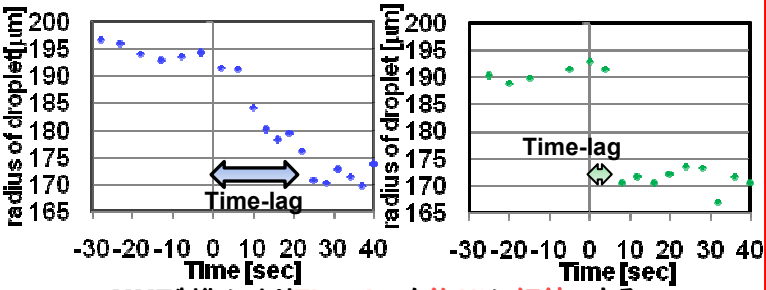
(b) MMT 駆動時
(MMT frequency = 0.6 Hz)

Control of droplet size -MMT周波数と液滴サイズの関係-



Operating Time Characteristic -流量制御とMMT制御の違い-

(a)流量制御
(流量を変化させた時間を0とする.)
(b) MMT制御(f=0.4Hz)
(MMTが駆動開始時間を0とする.)



MMT制御によりTime-lagを約1/3に短縮できる.

Conclusions:

・マイクロチャネル内でMMTを用い，液滴を能動的にサイズ制御して輸送するシステム開発のための基礎実験に成功した.
・将来的にはオンチップ細胞操作の自動化を行い，バイオ産業やドラッグデリバリー等の分野に大きく貢献することができる.

References:

Y. Yamanishi, Y. Kihara, S. Sakuma, F. Arai, "On-chip cell manipulation systems -Part6: On-chip Droplet Dispensing by Magnetically Driven Microtool-", Proc. 2008 JEMS Conf. on Robotics and Mechatronics (ROBOMECH2008), 2P1-D13, Nagano, 2008