Microfluidic Cell Trapping Methods for Single Cell Analysis for Lab-on-a-chip Applications

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Context Manipulation of the individual cells on a microfluidic device has revolutionized the traditional population based cell culture experiments removing the negative aspects of statistical data averaging [1]. Moreover, simultaneous observation of the cells on addressable array locations opened the paths for the investigation of unknown cell expressions and intercellular communication mechanisms. For example, using the proposed devices single-cell analysis of Heat Shock Response (HSR) in eukaryotic cells (particular protein expression of cells to prevent the damage triggered by the stressors) can lead to the crucial development of HSR inhibitors in cancer research.

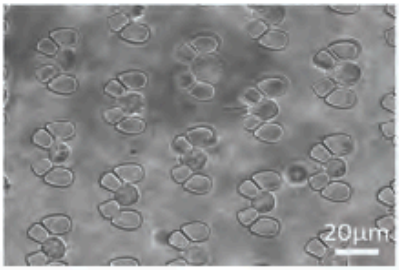

Fig.1. Optical image of the arrayed hydrodynamic cell trap stations. More than 95% trapping efficiency is achieved repeatedly on an array of 500 cell trap stations.

Objectives This work includes the investigation of microfluidic cell trapping methods optimized for various cell-types and experiments. Single-cell isolating microfluidic devices are designed, fabricated using standard micro-fabrication methods and tested using live cells. As a biological application, Heat Shock Response (HSR) of a genetically modified cell line (NIH/3T3) is used to first immobilize cells individually on the micro-structured cell trap stations located in a microfluidic channel where the cells are cultured and examined.

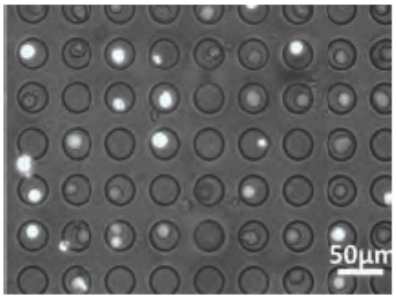

Fig. 2. HSR expression of the micro-well trapped NIH/3T3 cells.

Results Cell isolation on the hydrodynamic array trapping devices is shown successfully using the fluorescent dyed U-937 lymphomas. Fig. 1 shows an image of the hydrodynamic cell-trap array. With this method 95 % loading efficiency is achieved on average. The heat shock response on the individually isolated NIH/3T3 cells using micro-well trapping is also successfully demonstrated. Fig. 2 shows the superposition of fluorescent and optical images of a sample array on the fifth hour after heat stressing the cells.

References and Publications

[1] S. H. Kim, et al., Single-Cell Analysis, Humana Press, 2012.
[2] P. Ginet, et al., Lab. Chip, vol. 11, no. 8, pp. 1513–1520, 2011.