Single Cell Preparation in a Centrifugal Microfluidic Chip System with Reflow Capability

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Preparing single cells has remained as one of the key strong points of microfluidics technology in the field of Life Sciences. However, typical microfluidic device, regardless of the flow control, end up wasting most of the cells perfused through the channels. This poses an issue when dealing with rare cells such as circulating tumor cells, stem cells, cell infected by virus or parasites, or to a suspension from a biopsy sample where all cells are desired to be analyzed. Conventionally, this problem is solved by channel design optimization resulting to several alteration of the design. Another approach, that has been proposed by our group, is to have a reflow system that allows the cell suspension to simply interact with the hydrodynamic traps several times which could provide a higher probability of trapping. The developed system uses centrifugal microfluidics which provides ease in parallelization and in operation due to its simplicity and familiarity of individuals to centrifugation. The reflow system has been realized by simply changing the direction of rotation of the main stage. Five microfluidic devices are placed 4 cm away from the center and are free to rotate. A stopper has been placed to limit the rotation of the chips to 180 degrees only. By virtue of conservation of momentum, the change of rotation result to a flipping motion of the microfluidic devices generating a back and forth flow. The previous report has been shown to have good trapping capability with 15 um bead and with THP-1 cells after 10 flips. A trapping efficiency of ~55% has been observed. However, it was found that there is a high variability of chip performance due to the difference in flipping motion of the chips; there were some chips that doesn't flip after some time. To solve this problem, bearings (1mm hole) were integrated to the system. This result to a uniform motion of the microfluidic device and significantly decreased the variability. With this, the reflow system has been improved and is expected to be useful in single cell preparation.

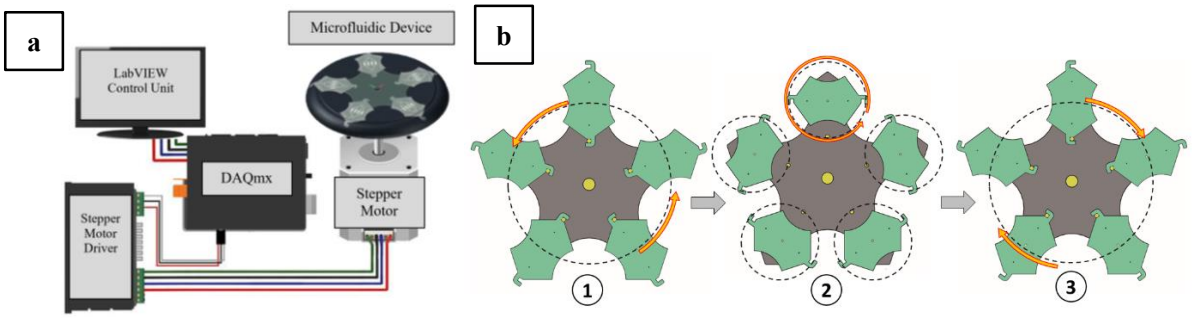

Fig. 1. Design and operation of the microfluidic device. (a) Schematic Diagram of the system. (b) Illustration of the rotating stage and microfluidic chips placed 4cm (from chip center) away from the center. Step 2 shows the instance where change of rotation was initiated.