Single Particle Compartmentalization in the Designed Microfluidic Chip

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Microfluidics, a multidisciplinary field, has been successfully exploited into vast applications in past years due to its innate nature of having the ability to conduct experiments with low volumes – and thus reduced cost. One of the major trends in microfluidics is single particle trapping. However, for cell applications, solely trapping the cell in ideal sites is not enough to claim that the behavior that we can observe is based on a single cell alone. Effects of neighboring cells or chemical reactants in the flowing media could stimulate such behavior which may lead to false interpretation of the data. Thus, isolation of single cells in desired trap sites is much more ideal. This report; therefore, presents the design and operation of the designed microfluidic chip for trapping particles or pairs of particles and isolating them into compartments. Success of this study could aid in developing devices for high-throughput analysis and related studies.

Fig. 1 presents the simplified microfluidic chip for demonstrating single particle compartmentalization. The device is consisted of two layers of PDMS that are separately cured which then plasma treated for permanent bonding. Alignment is done under a microscope using a 4x magnification lens. A total volume of 350 µL of particle suspension (3 x10^5/mL) is placed in the inlet and flow through the channels where hydrodynamic trapping of particle is expected (Fig. 1b). After trapping the particles, the valve layer (Fig. 1c) is activated using an air pump. As a result, a cylindrical compartment for each trap site is produced. Even after activation of the valve layer, flow from the inlet to the outlet is still possible but the fluid will not interact with the entrapped particles anymore. Fig. 1d shows the image of a trapped microbead (15 µm in diameter). With this set-up, single particle isolation is expected which can be utilized for; but not limited to, single cell growth observation, screening of fluorescence emission, and drug screening. This could also be further extended to particle-particle interaction in a confined volume.

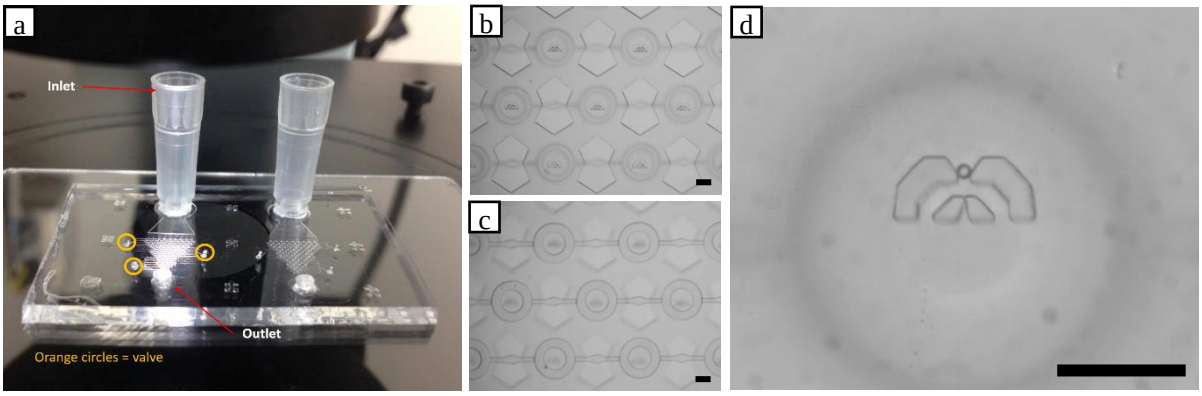

Fig. 1. Device design and features. (a) Complete microfluidic device with identified inlet, outlet, and valve ports. (b) Bright field image of PDMS flow channel layer. (c) Bright field image of PDMS valve channel layer. (d) Trapped microbeads in a trap site. Scale bar = 50 µm