Microfluidic device coupled with ATPS for cell separation

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1. Introduction

Cell separation technology being one of the most important techniques in biochemical and medical analysis and in few other fields. However, the complete separation of specific single cell group or single-cell from bulk cell suspension has been a difficult task, because of heterogeneous nature of cells and its shape. So far, Fluorescence-Activated Cell Sorting (FACS) and Magnetic-Activated Cell Sorting (MACS) have been intensely used for cell separation with high selectivity to the target. But use these methods; there is a possibility of change in the surface characteristics of due to use of antibodies. Aqueous Two-Phase System (ATPS), which is conventional technique, can separate cells easily and effectively without using antibodies. A two-phase interface can be prepared two different solutions - polyethylene glycol (PEG) and dextran (Dex).

In this study, we have developed a novel system for cell separation from blood cells using microfluidic device coupled with ATPS.

2. Experimental and Results

Microfluidic device for cell separation was made out of polydimethylsiloxane (PDMS) by soft-lithography technique. This device enables easy manipulation for operations, and its transparency provides better microscopic observation of cells. The microfluidic device has single reaction channel with 100-μm-height, 500-mm-width and 5-cm-lengths and three inlets, and three outlets for sample and two different phase solutions (Figure 1)

A two-phase interface between PEG and Dex solutions was prepared by the laminar flow of PEG and Dex in the reaction channel under pressure driven force of a micro syringe pump. The cell or particle sample solution was then applied on to the sample inlet, located between PEG and Dex solution inlets.

Two types polystyrene beads, carboxyl group conjugated and non-conjugated beads, as an example, were introduced on to the microfluidic chip, only carboxyl group conjugated beads were partitioned into Dex layer. On the other hand, non-conjugated beads stayed at the two-phase interface.

In the case of human blood as a sample, Red Blood Cell (RBC) and Jurkat cell as a mixture were applied to the microfluidic chip, it was observed that RBC was partitioned into Dex layer while Jurkat cells were partitioned into PEG layer (Figure 2).

The percentages of recovered cells after microfluidic ATPS cell separation were higher selectivity than conventional ATPS (Table 1).

3. Conclusion

In this study, we have developed a novel separation system, which was named a microfluidic ATPS, showed highly effective separation for different particles and cells. Especially, the blood cell samples, RBC and Jurkat, were easily and efficiently separated into two different layers in the microfluidic channel, using a syringe pressure without antibodies. Therefore, a rapid and effective cell separation was performed by the novel system microfluidic ATPS with easy handling as an alternation μ-TAS device.

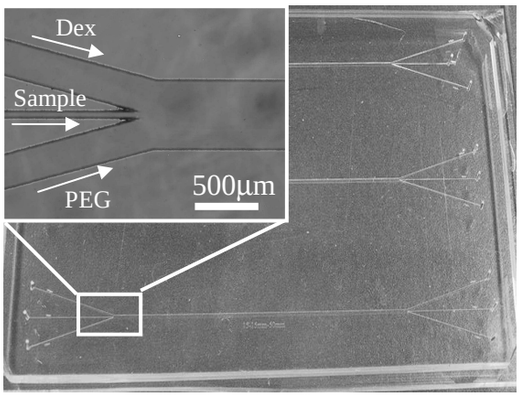

Figure 1. Miclofluidic device for cell separation using ATPS.

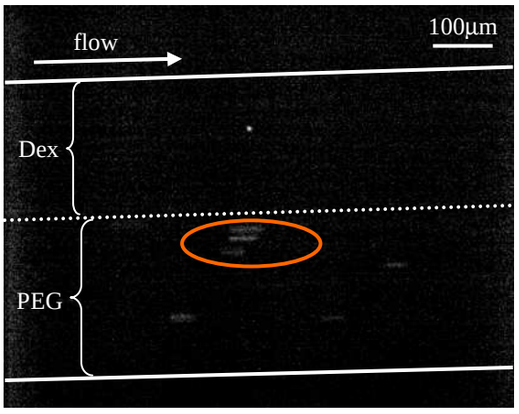

Figure 2. Fluorescence image of Jurkat cells movement in microfluidic ATPS.

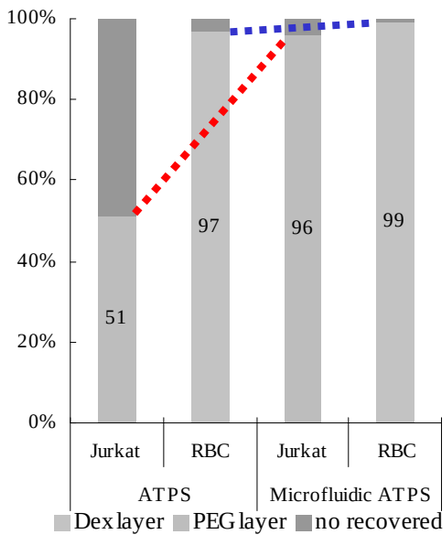

Table 1. Cell recoveries after blood cell (Red Blood Cell, Jurkat) separation using microfluidic ATPS and conventional ATPS.