유전영동 미세 유체장치의 혈구분리 효율 수치해석 연구

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Numerical study to improve the blood cells separation efficiency of a dielectrophoretic microfluidic device

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Abstract : A low-voltage based microfluidic device with dielectrophoresis was used to separate the blood cells based on their cell size. The microfluidic device comprises the injection section with blood and buffer inlets, the separation section with electrodes, and the collection section with outlets for platelets, red blood cells, and white blood cells. The study used the particle tracing methods to count the number of successfully separated blood cells by estimating their trajectories in the device. The separation efficiency of the device reduced with the use of higher buffer flow rates.

1. Introduction

Modern blood transfusion treatment commonly used only components of the blood (RBCs, WBCs, and PLTs). Several techniques were previously employed to separate different blood components from whole blood for their vast application in blood transfusion and other medical research [1,2]. However, the use of these techniques is limited because of the different blood cell sizes and low concentration of WBCs and PLTs compared with RBCs [3]. Therefore, the present study used the low-voltage based dielectrophoretic device to separate the blood cells based on their cell size. The blood cells separation efficiency was determined to examine the efficiency of the microfluidic device.

2. System and method

Fig. 1 shows a 2D dielectrophoretic device with a length of 870 μm and channel width of 40 μm. The left side of the device is called the injection section with blood and buffer inlets. The right side of the device is termed as the collection section with RBC, WBC, and PLT outlets. A voltage of 4V was used to generate electric field in the device. The blood and buffer are introduced in the device with the velcoity of 150 μm/s and 850 μm/s, respectively. The separation efficiency is the number of separated blood cells and the total number of inlet blood cells.

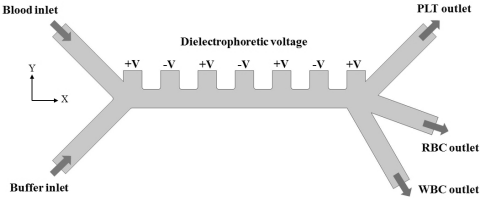

Fig. 1 Computational model of the microfluidic device.

3. Result and discussion

The effect of buffer flow rates on the separation efficiency for different blood cells is shown in Fig. 2. Increasing the buffer flow rates decreased the separation efficiency. The higher flow buffer flow rates forced the blood cells to move the collection section quickly. Therefore, the blood cells did not properly experienced the dielectrophoretic force and were not separated, consequently decreasing the separation efficiency of the device. A 2% decrease in

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the separation efficiency was observed for the RBCs and PLTs. The separation efficiency of the WBCs was dropped by about 3.5%. The results suggest that higher buffer flow rates are not suitable for this design of device.

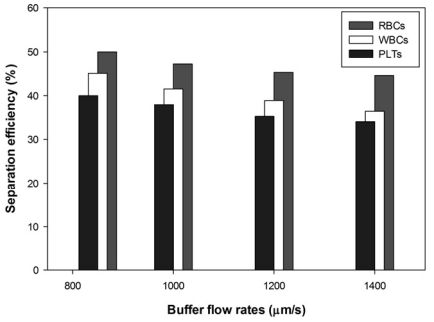

Fig. 2 Separation efficiency with the effect of buffer flow rates (μm/s)

후 기

This work was supported by the grant from the Priority Research Centers Program through the NRF, as funded by the MEST (No. 2010-0020089).

참고 문헌

(1) Lin, H. K., et. al., 2010, "Portable filter-based microdevice for detection and characterization of circulating tumor cells," Clin. Cancer Res., pp. 5011~5018.

(2) Slitcher, S. J. and Harker, L. A., 1976, "Preparation and storage of platelet concentrates. I. Factors influencing the harvest of viable platelets form whole blood," Br. J. Haematol., pp. 395~402.

(3) Piacentini, N. et. al., 2011, "Separation of platelets from other blood cells in continuos-flow by dielectrophoresis field-flow-fractionation," Biomicrofluidics, pp. 1~8.