Microfluidic Cell Seperation

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ABSTRACT

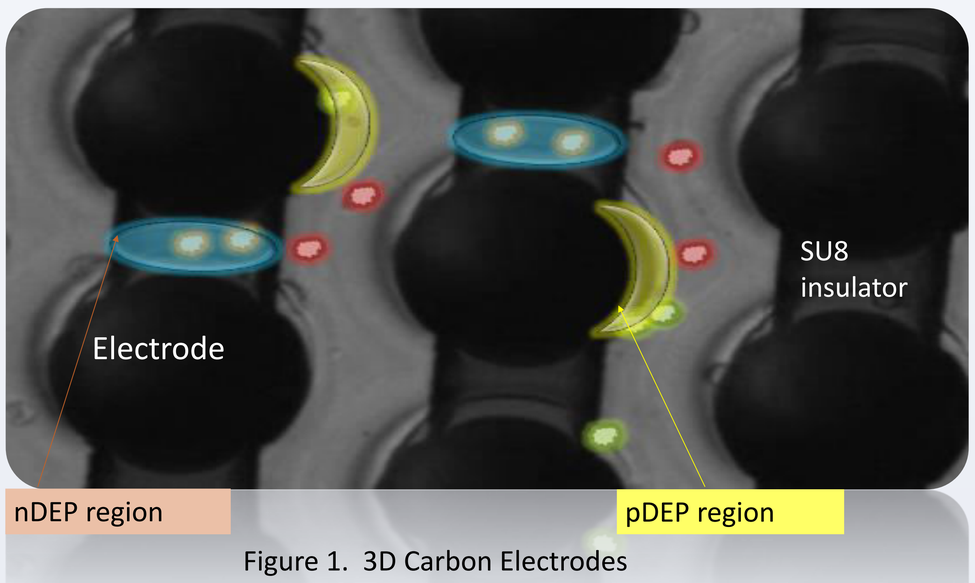

Figure 1. 3D Carbon Electrodes

For the diagnosis of diseases, blood is being used as reliable body fluid. Despite developments of lab-on-a-chip devices, the reliability is still problematic that makes the diagnosis more difficult. In that way, characterization of cells shows significance. In order to characterize the cells, we chose dielectrophoresis method that offers efficient, and qualitive solution. In this study, by using 3D carbon electrodes, the characterization of monocytes was observed.

Figure 2. DEP chip

DIELECTROPHORESIS METHOD (DEP)

Dielectrophoresis is the movement of a polarized particle in the non-uniform electric field. The most important feature that distinguishes the dielectrophoresis method from other techniques is that it does not change the genotypic and phenotypic characteristics of the cells. Also, DEP provides high-yield and low cost for the analysis of the cells.

$$F_{\mathrm{DEP}} = 2\pi a^3 \varepsilon_{\mathrm{L}} \,\mathrm{Re}\left(\frac{\varepsilon_{\mathrm{P}}^* - \varepsilon_{\mathrm{L}}^*}{\varepsilon_{\mathrm{P}}^* + 2\varepsilon_{\mathrm{L}}^*} \right) \nabla E^2,$$

Figure 3. DEP formula

PROJECT SETUP

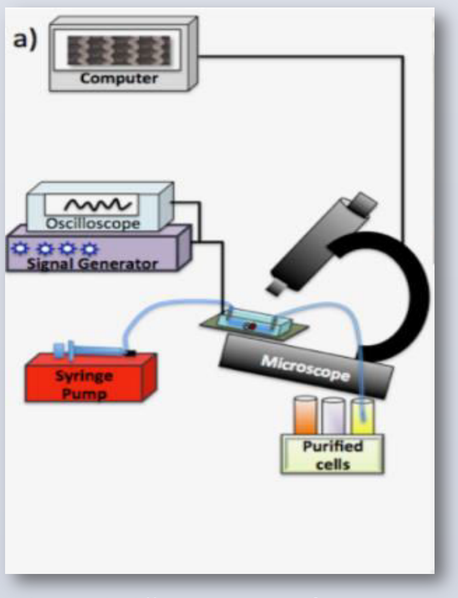

Figure 4. All processes of DEP

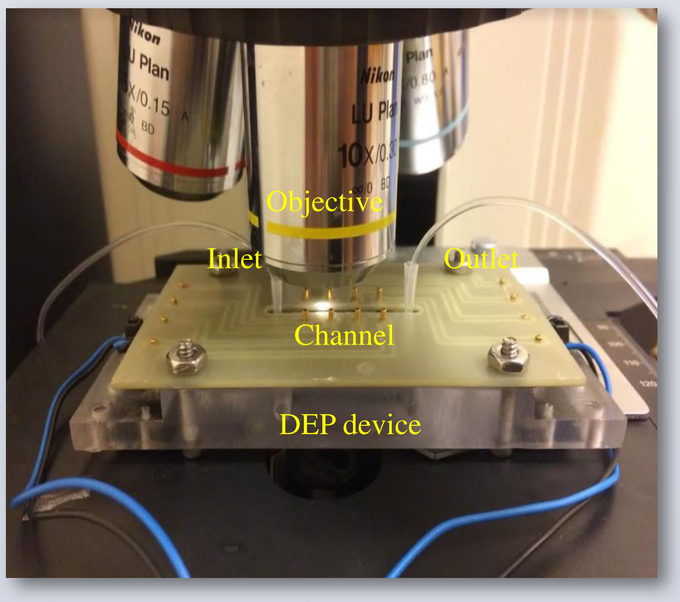

Figure 5. DEP Mechanism

In order to create the electric field was generated by a signal generator (Model: GFG-8216A, GW Instek, New Taipei City, Taiwan), an oscilloscope (Part Number: 54622D, Agilent Technologies, Santa Clara, CA, USA) to measure the frequency of the applied signal, upright microscope (Model: Nikon ME600 Eclipse, Nikon Instruments Inc., Melville, NY, USA) to monitor the cells, a computer to save the images to analyze the cells (Hewlett-Packard Company, Palo Alto, CA, USA), a syringe pump (Model: NE-1000, New Era Pump Systems Inc, Farmingdale, NY, USA) to flow the cells and clean our 3D carbon-DEP device by using ethanol, DI water, IPA, DEP buffer. Two 20–200 _L pipette tips (Manufacturer ID: 3120000917, Eppendorf, Hamburg, Germany) were used to create reservoirs of inlet and outlet . The tygon microbore tubing (Manufacturer ID: AAQ02103-CP S-54-HL, Cole-Parmer, Vernon Hills, IL, USA) was used to connect microchannels of the 3D carbon-DEP chip the syringe.

IMAGE ANALYSIS

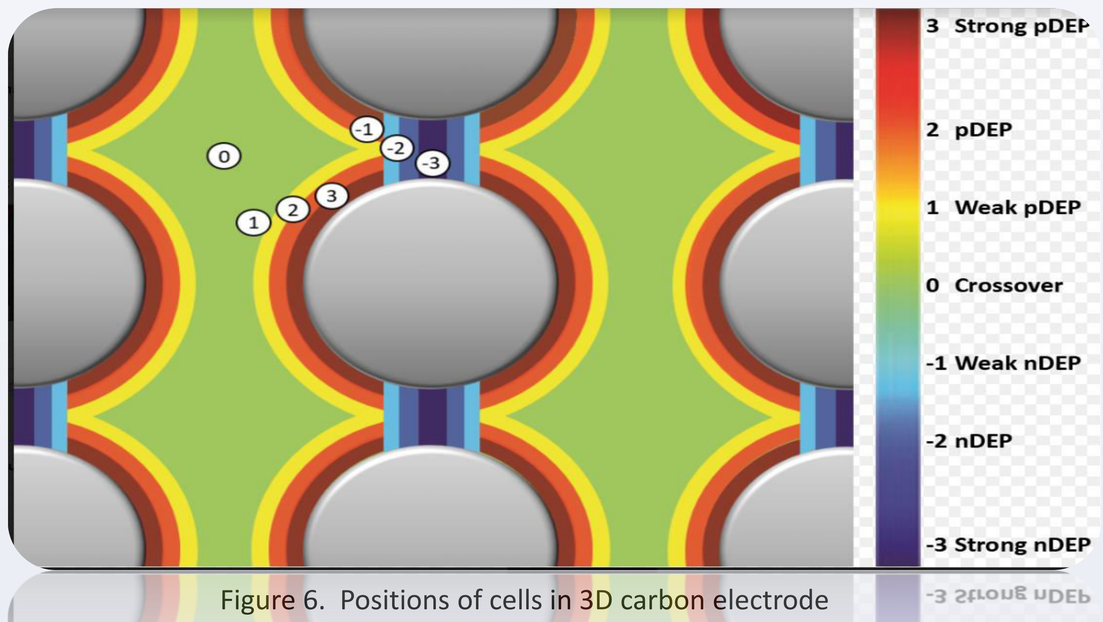

Figure 6. Positions of cells in 3D carbon electrode

Images were captured by using Nikon Eclipse upright optical microscope with 10x objective during the experiments. ImageJ program was used to integrate the image sequences.In that way, the behaviour of the cells with changing flow rates and frequencies, was studied. Various frequency values that change from 1 MHz to 20 MHz were applied to the cells can be easily manipulated in a fluidic channel. Standart deviations and mean values of their positions were calculated using the Prism software. In this interval, cells showed p-DEP response.

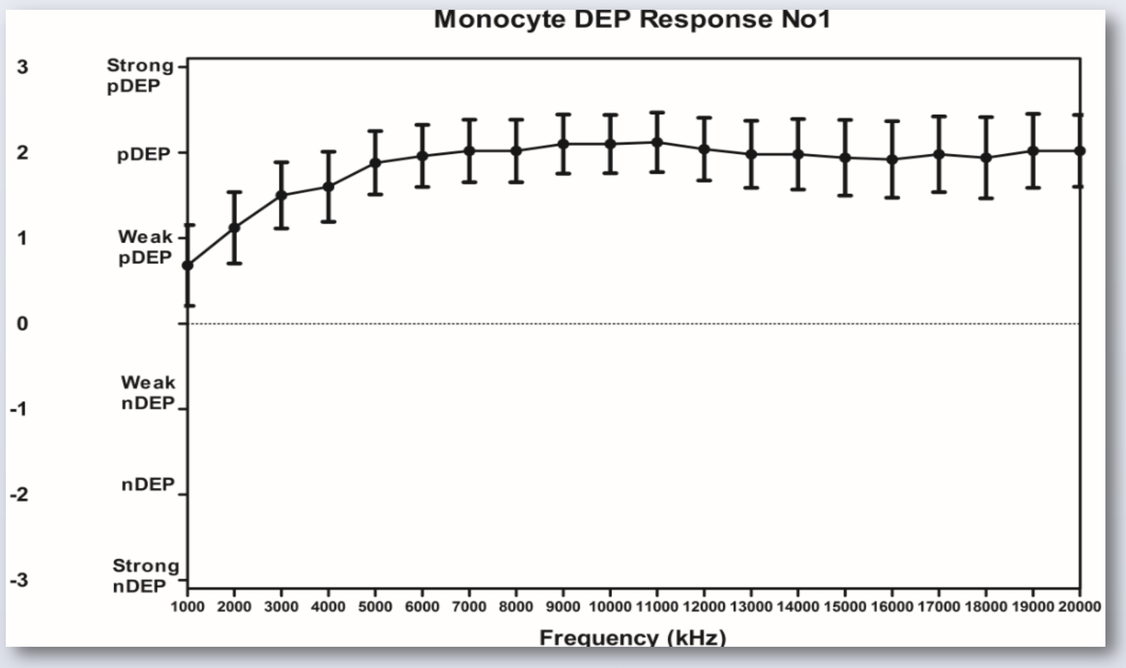

Figure 7. p-DEP analysis

CONCLUSION

This study demonstrates dielectrophoretic characteristics of monocyte cells (U937) by changing frequency values of 3D carbon electrodes. While changing the frequency, the position of monocytes changed because of characteristics of monocytes. By using dielectrophoretic characteristics of cells, the effiency of characterization was experimented. The frequency values that were applied in experiment showed in that values the cells show positive-DEP response while applying constant electric field.

REFERENCES

- Zhu, Hongwu, Xiaoguang Lin, Yong Su, Hua Dong, and Jianhua Wu. "Screen-printed Microfluidic Dielectrophoresis Chip for Cell Separation." *Biosensors and Bioelectronics* 63 (2015): 371-78.
- Das, Debanjan, Karabi Biswas, and Soumen Das. "A Microfluidic Device for Continuous Manipulation of Biological Cells Using Dielectrophoresis." *Medical Engineering & Physics* 36, no. 6 (2014): 726-31.
- Elvington, Elizabeth S., Alireza Salmanzadeh, Mark A. Stremler, and Rafael V. Davalos. "Label-free Isolation and Enrichment of Cells Through Contactless Dielectrophoresis."*Journal of Visualized Experiments*, no. 79 (2013).
- Yildizhan, Yagmur, Nurdan Erdem, Monsur Islam, Rodrigo Martinez-Duarte, and Meltem Elitas. "Dielectrophoretic Separation of Live and Dead Monocytes Using 3D Carbon-Electrodes." *Sensors*17, no. 11 (2017): 2691.
- Jubery, T Z, et al. “Dielectrophoretic Separation of Bioparticles in Microdevices: a Review.” *Advances in Pediatrics.*, U.S. National Library of Medicine, Mar. 2014, www.ncbi.nlm.nih.gov/pubmed/24338825.

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