DC Impedance-based Label-Free Cell Counter for Circulating Tumor Cell Detection

Hyoungseon Choi[1], Kwang Bok Kim[1], Taek Dong Chung[2] and Hee Chan Kim[3,4*]

[1] Interdisciplinary Program, Bioengineering Major, Graduate School, Seoul National University, Seoul 110-744, Korea, [2] Department of Chemistry, Seoul National University, Seoul 151-742, Korea, [3] Department of Biomedical Engineering, College of Medicine, Seoul National University, Seoul 110-744, Korea, [4] Institute of Medical & Biological Engineering, Medical Research Center, Seoul National University, Seoul 110-744, Korea

Abstract

Quantification of circulating tumor cells(CTC) in blood samples is believed to provide valuable informations about cancer progression and response to therapy in patients with metastatic cancer. Many microchip technologies mostly based on two principles of immunoassay and Coulter counting are being applied to detect these extremely rare cells. Alternating current (AC) impedance measurement with metal electrodes is a popular and inevitable method for particle counting in microfluidic chips to avoid the electrode-electrolyte junction capacitance as well as unwanted redox reactions at the metal surface. AC impedance of biological cells is, however, size-insensitive at high frequencies. A DC impedance-based cell counter using the proprietary polyelectroylytic gel electrodes(PGEs) is propsed for CTC counting. Linearity of DC impedance signal to the particle volume was evaluated using commercial polymer microspheres (Bangs Lab, USA) with known sizes of 8um(equivalent to RBC size), 10um(equivalent to WBC size), and 15um. Biological sample test was also performed using human ovarian cancer cells. A perfect linear response was obtained from the microbead test. Human ovarian cancer cells produced prominantly larger impedance signal than the all other microbead particles. The proposed system showed a good discrimination power in cell size flowing through microfluidic channels, which offers excellent potential for point-of-care test type cancer diagnosis and monitoring systems in the near future.

References

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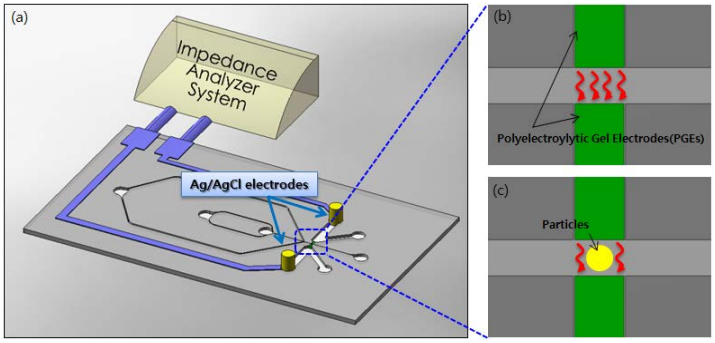

Figure 1. (a) Schematic illustration of the developed system for DC impedance-based flow cytometer. The impedance difference between (b) and (c) is detected by impedance analyzer system.

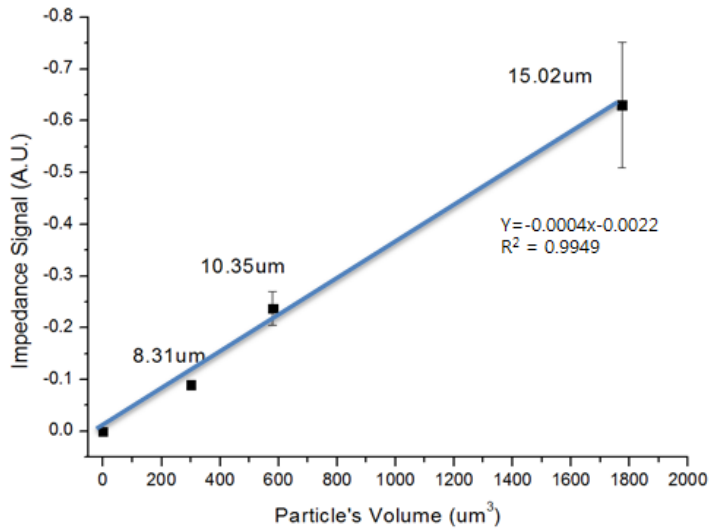

Figure 2. Calibration curve of the impedance signal using 8.31-, 10.35-, and 15.02-um-diameter particles. This curve shows that impedance signal is linear to the particle's volume.

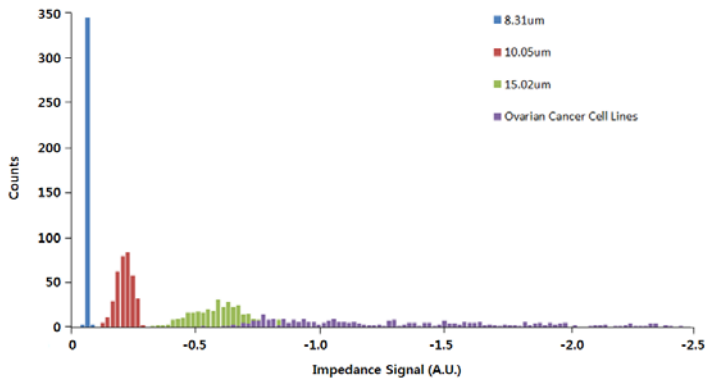

Figure 3. Histogram of the impedance signal obtained by various micro particles (8.31um, 10.35um, and 15.02um) and ovarian cancer cell lines. The impedance signals from ovarian cancer cell lines are bigger than blood cell size-like micro particles.