Laser-assisted Impedance Cytometry in micro-fluidic chip: Detection of Cell Position by M-shaped Electrode

Div. Mat. Sci., NAIST[1], RIKEN BRD[2], Sch.Eng., Macquarie Uni.[3]

○Tao Tang[1], Xun Liu[1], Yigang Shen[2], Yo Tanaka[2], Ming Li[3], Yaxiaer Yalikun[1,2], Yochiroh Hosokawa[1]

The separation of special cells from a heterogenous cell group is an essential step in a variety of biomedical applications. We have developed a laser-assisted impedance cytometry to evaluate mechanical properties of single cells, in which the response of the cell to the femtosecond laser impulse is assessed as position shift in the channel.is assessed as position shift in the channel. For the real-time assessment, high-speed detection of the lateral positions of cells is required in the micro fluidic channel. For the purpose, we newly proposed a location-dependent impedance cytometry system integrated in the micro-chip, which allows to monitor the cell lateral distribution in the microchannel.

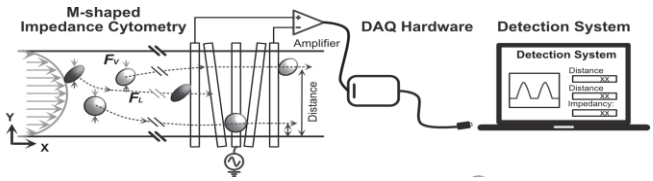

Fig 1. M-shaped impedance cytometry and the detection system.

As shown in Fig. 1, we have designed a new layout of electrodes, named as M-shaped electrodes, which has the capability to monitor the position of single cells. More specifically, electrodes with M-shaped layout (Fig. 2(b)) were patterned on glass wafers by lift-off process, and the microfluidic device was fabricated using standard photolithography and poly(dimethylsiloxane) (PDMS) soft photolithography processes. An AC signal of 5V and 0.5 MHz was applied to monitor single cells passing between electrodes, both outputs were collected and calculated differentially, and recorded data is illustrated in Fig. 2(b-c).

Theoretically, a cell (Fig. 2(a)) following different trajectories encounters an electric field of different strengths and intrigues different current signal. Based on the collected data, we conclude three metrics: (1) time duration between two peaks (Metric 1) is influenced by both the flow velocity and cell distance to channel wall. (2) the peak height (Metric 2) changes due to different cell locations. (3) the difference of two peaks stimulated by the same cell (Metric 3) indicates that the cell changes its lateral positions as it flows through the detection region.

All results indicated that the collected electrical signal is highly dependent on the cell location. In the future work, we will integrate the femtosecond laser into the detection system and analyze the cell's shift response to the femtosecond laser pulse via the proposed M-shaped impedance cytometry.

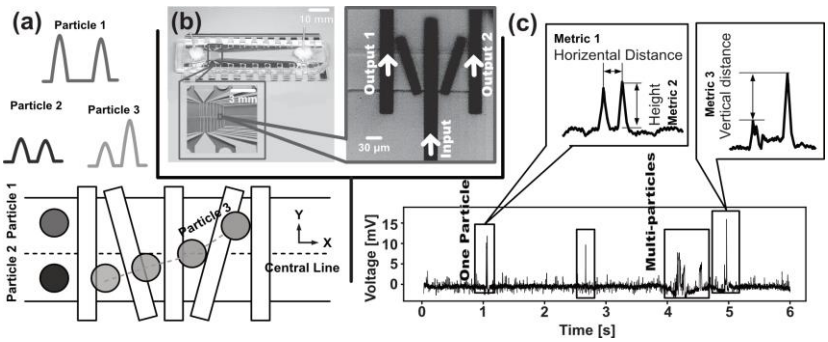

Fig 2. Data acquisition and analysis. (a) ideal response to single cells (b) measurement system. (c) recorded data and metric description