Topic 8. Sensing for Health, Safety and Security

A microfluidic cell counting device based on impedance sensing

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■ Summary

In our research, a planar electrode pair is designed and implemented to detect cell properties, such as cell size. Compared with previous research works, the proposed device is not only capable of cell counting but also diagnosis of cell properties in the fabricated microfluidic channel. Based on experimental results, in addition, the designed planar-electrode device is proved to have capabilities of detection of bead size and bead position of beads in the micro-channel. As a consequence, this work shows the proposed impedance-analysis device not improves potentials of integration but also enhances the sensing characteristics of the beads differentiations. In following works, the device sensing performance will be verified with cells to demonstrate the feasibility the proposed device.

Key words : impedance-analysis device, microfluidic, planar electrodes, cell counting, diagnosis of cell properties

■ Experiment

➢ Setup

A set of sensing electrodes is made on glass substrate and is bound with PDMS micro-channel by oxygen plasma surface treatment. The voltage signal applied on the electrodes is generated by lock-in amplifier (HF2LI, Zurich Instrument), and the electrical signal between electrode pairs are also measured by the same lock-in amplifier. In addition, a micro scope is used to observe the objects to be sensed.

➢ Device Fabrication

The planar electrodes are made by photolithography and e-gun evaporator. Photolithography is used to define the electrode pattern on glass substrate. On the other hand, e-gun evaporator is used for electrode material (Chromium and Gold) to be deposited (Fig.1). The microfluidics channel is made of PDMS and the channel pattern is defined through a mode with channel pattern on it. The mode is made on silicon wafer and the SU8 series photoresist on the silicon wafer form the channel pattern. The channel pattern is also defined by photolithography (Fig 2).

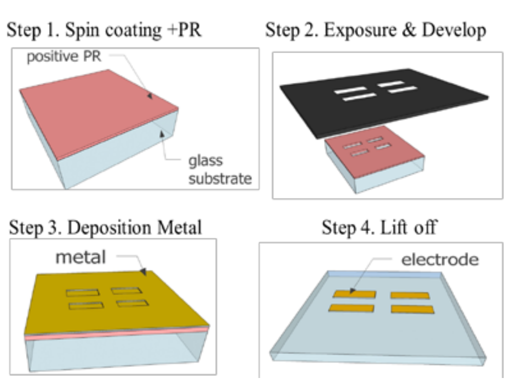

Fig.1 the fabrication process of electrode

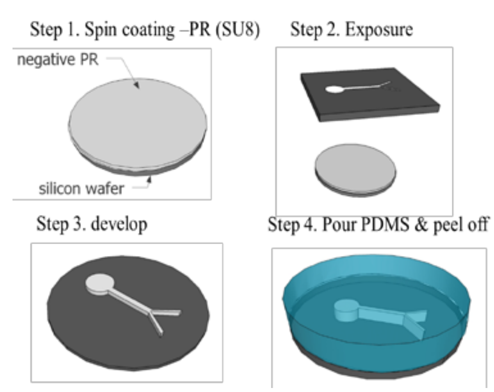

Fig.2 the fabrication process of micro channel

- Method and data analysis

As shown in Fig.3, Fluorescent beads which are made of polystyrene are injected into micro-channel by a syringe. Beads with two size,10um and 6um, are used to demonstrate the sensing ability of our planar electrodes. By analyzing the electrical signal change when beads pass through the electrodes, we can get the information such as size of beads and the height of the beads in the microchannel. Image analysis tool, Image J, is used to evaluate the flow speed of beads.

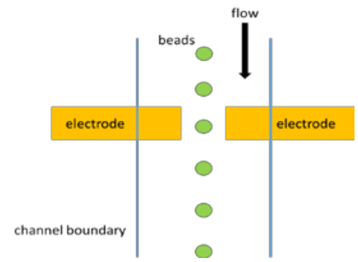

Fig.3 the schematic of impedance sensing

- Results

Fig.4 shows the electrical signal change under different flow velocity, which means different height of beads in the micro-channel. From the experiment results, we can know that the higher position the bead is, the smaller the electrical signal change is. By observing the signal changes, we can derive the relative position of beads in the micro-channel.

Fig.5 shows the performance of signal change of two different bead size. We can see from the experiment results that the larger one, 10um in diameter, has bigger signal response. In other word, we can distinguish the bead size by the magnitude of signal response.

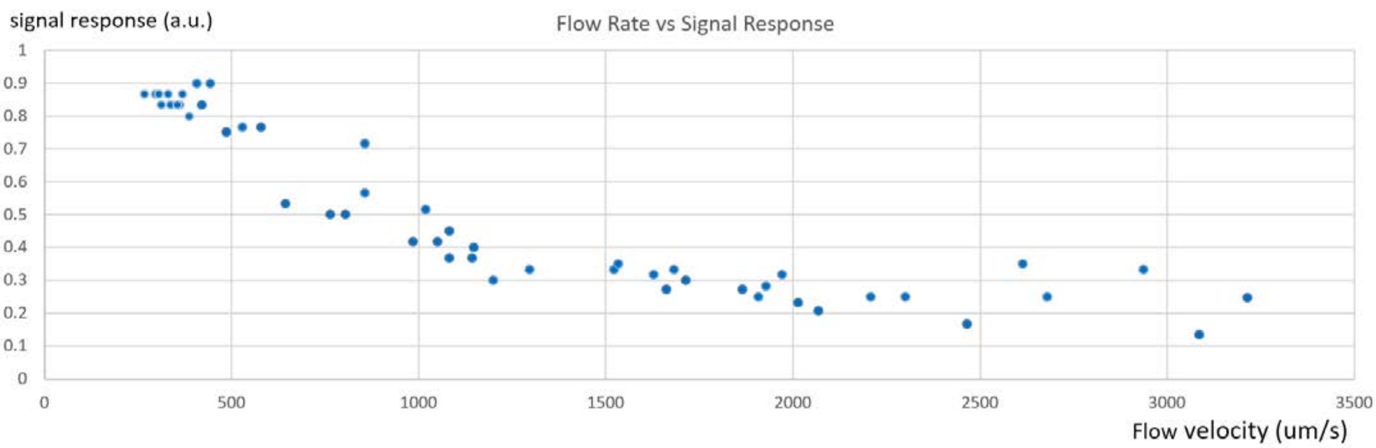

Fig.4 Signal responses under different flow velocities.

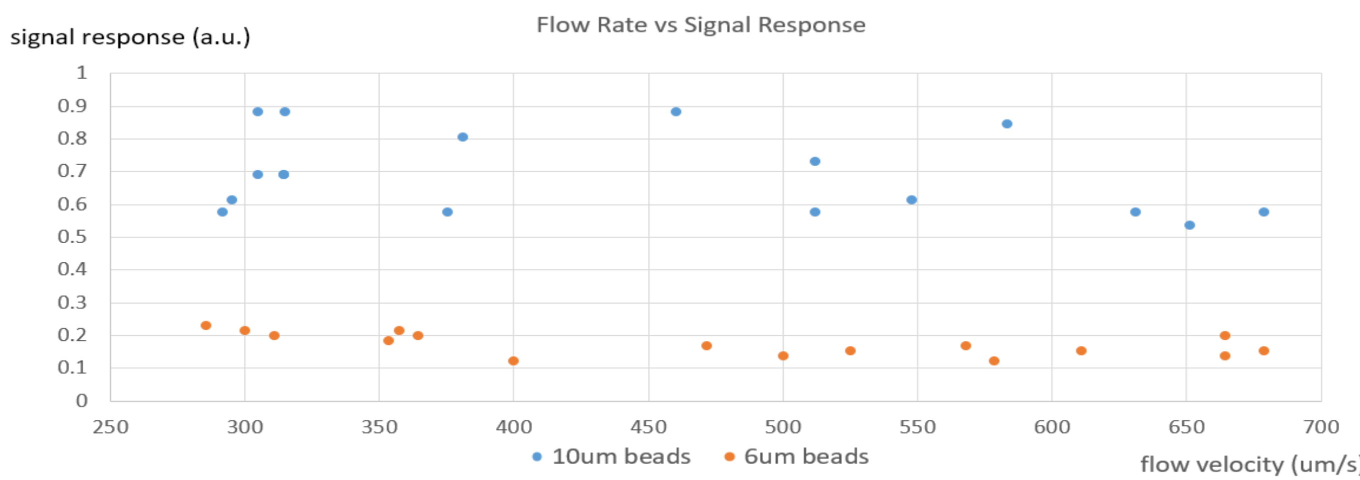

Fig.5 The performance of signal change of two different bead sizes.