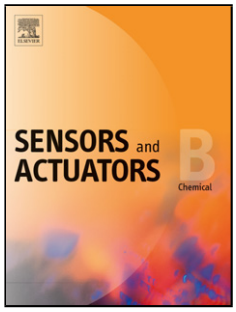


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# Investigation of geometry-dependent sensing characteristics of microfluidic electrical impedance spectroscopy through modeling and simulation

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## Abstract

Microfluidic electrical impedance spectroscopy (EIS) has been widely used for the identification of single cells based on the detection of cell size or morphology. However, the obtained impedance data are highly affected by the design of microfluidic setup and by the geometric parameter and orientation of samples. Here, we systematically investigated the geometry-dependent sensing characteristics of microfluidic EIS by using finite-element modeling. We considered two different detection units of microfluidic EIS: One is a sample-immobilization system where samples are immobilized at a narrow orifice and subsequently measured by using EIS; The other one is a flow-through system where samples are detected when flowing through the sensing unit. Spherical microparticles with different diameters and combinations were used as samples in the experiment and modeling. Linear regression calculation between the EIS data and the geometric parameters of samples revealed that EIS signal is highly sensitive to the height or the cross-sectional area of immobilized samples, while the flow-through setup enables the detection of sample volume. Simulation of non-spherical samples, i.e. budding yeast cells and erythrocytes, demonstrated that sample orientations have significant influence on the impedance measurements and thus may discredit the volume detection of non-spherical cells by using microfluidic impedance cytometry. The results could conduct the future design and application of microfluidic EIS systems for single-cell studies, especially the cell discrimination based on size or morphology.

Keywords: Electrical impedance spectroscopy; Microfluidic impedance cytometry; Cell trapping; Single-cell analysis; Cell size; Cell morphology