Model of an Interdigitated Electrodes System for Cell Counting Based on Impedance Spectroscopy

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Introduction: *Cell counting* is an essential procedure in biology and medicine for sample preparation and for diagnosis by detection of eg. cancer cells of white blood cells in case of HIV. *Impedance spectroscopy (IS)* is a powerful method for characterizing many of the electrical properties of materials and their interfaces [1]: it allows real-time detection, non-invasive sensing, label-free analyses and easiness of integration in a high-throughput screening.

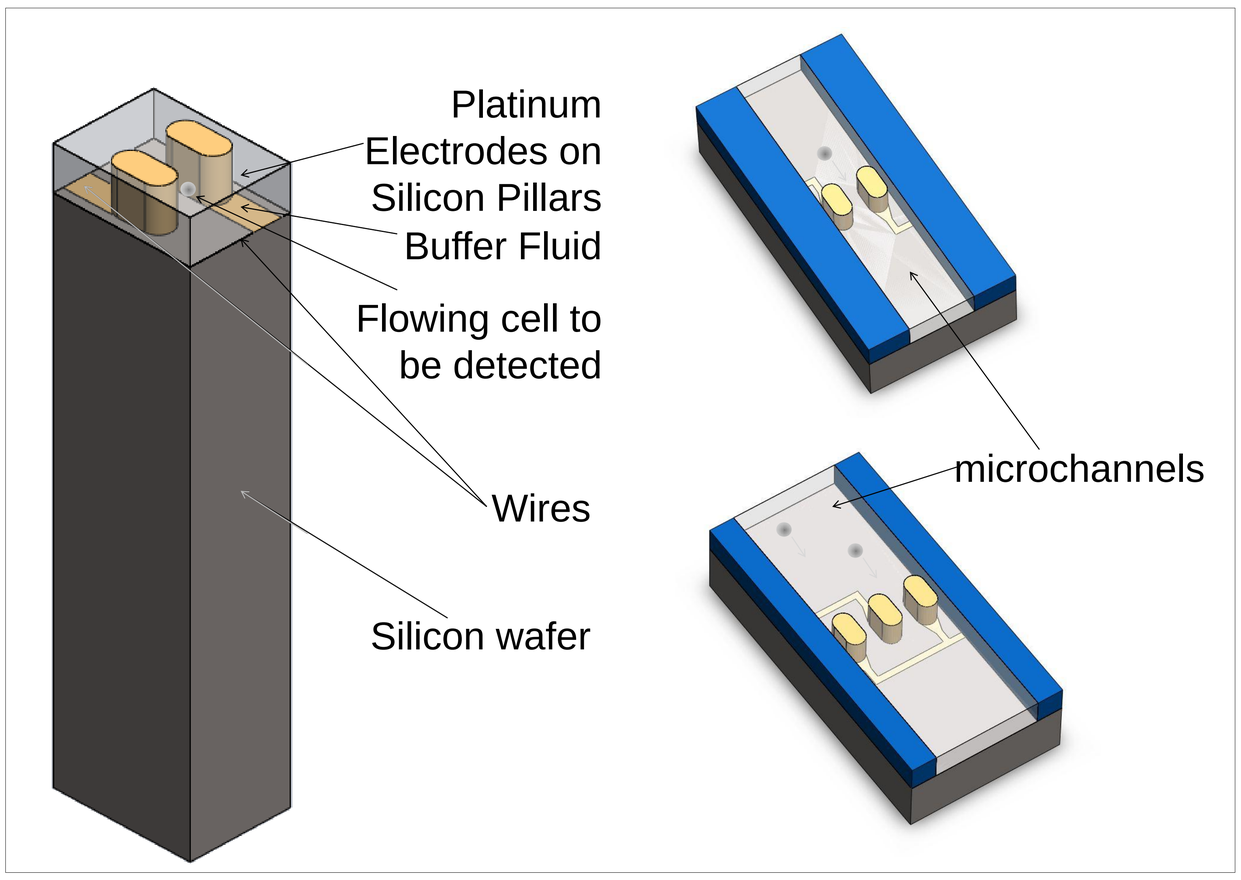

Figure 1. 3D sketch of the cell counter devices

Computational Methods: Impedance spectroscopy (IS) has been solved by the electric current module: the approach is to apply a known AC voltage, sweeping over a wide frequency range f =10^{-5} – 10^{9} [Hz] with a small-amplitude (50 mV) single-frequency signal. Resulting value of impedance Z [Ω] is calculated. The electric properties of the materials (silicon, platinum, buffer fluid, cell/bead core) have been assigned in terms of conductivity σ [S/m] and permittivity ε [-]. We introduced critical thin structures/layers or contact impedances, defined by conductivity σ [S/m], permittivity ε [-] and thickness d [m].

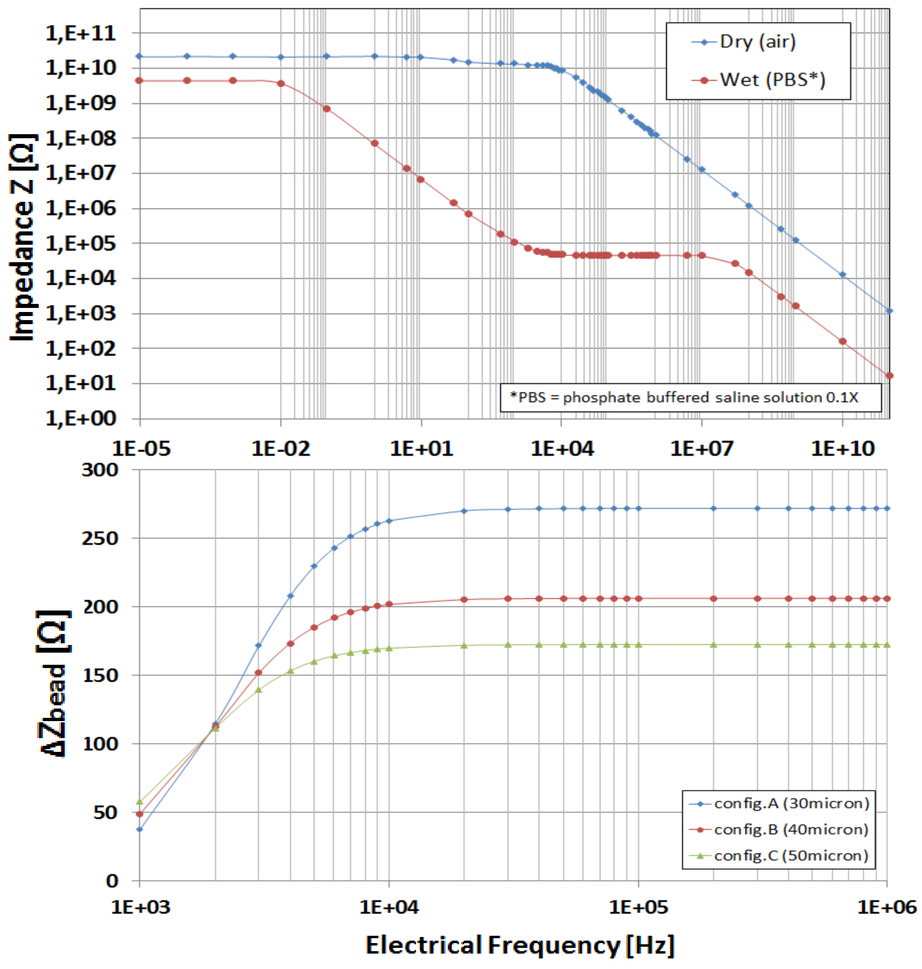

Figure 2 – Impedance characterization of the system (COMSOL)

Results/Conclusions: Dependence of the impedance spectrum Z(f) from the dimensions, number and configuration of the electrodes, buffer fluid conductivity has been studied and compared to IS experimental measurements to guide the experimental characterization of the system and to evaluate the efficiency of beads/cells detection.

References:

1. Cheung K. et al., Impedance spectro-scopy flow cytometry: On-chip label free cell differentiation, Cytometry Part A, 65A(2), 124-132 (2005)
2. Morgan H., Single cell dielectric spectro-scopy, Journal of Physics D: Applied Physics, 40(1), 61-70, (2007)