Expanding the information depth of impedance based assays by using piezoelectric growth substrates

S. Ruckdäschel[1]; J. Wegener[1,2]
[1]Universität Regensburg, Regensburg (Germany)
[2]Fraunhofer EMFT, Division Cell-Based Sensors, Regensburg (Germany)
Simone.Ruckdaeschel@chemie.uni-regensburg.de

Impedance measurements have been established as a versatile technique to monitor cell-based assays under label-free, non-invasive and time-resolved conditions. These approaches are capable of studying a huge variety of in vitro scenarios by observation and quantifying the behavior of adherent cell monolayers grown upon planar gold-film electrodes while they are exposed to different stimuli.
By using electric cell-substrate impedance sensing (ECIS) several fundamental processes in cell physiology such as cell adhesion, cell proliferation, cell migration, intracellular signal transduction or cell death have been successfully examined (Fig. 1A, [1]). In all cases the sensitivity of the measurement is either based on changes in cell coverage of the electrode or on changes in cell morphology. The technique does not provide information on the molecular level and is thus referred to as a *wholistic* readout. One strategy to get more specific information about the cells requires combining ECIS with other techniques. We have been exploring the quartz crystal microbalance (QCM) as an additional label-free and non-invasive transducer to monitor adherent cells (Fig. 1B, [2]). The core component of this technique is a piezoelectric quartz resonator with two evaporated gold-electrodes on each side. By applying an AC potential difference between the surface electrodes the shear-wave resonator is excited to perform mechanical oscillations close to its fundamental resonance frequency of about 5 MHz. This mechanical oscillation goes hand in hand with an electrical oscillation that can be probed by impedance analysis. If mass is deposited on the quartz surface, e.g. during cell adhesion, the resonant oscillation is affected by the mass loading and all mechanical changes within the cell bodies. So even though the readout parameter is the electrical impedance, the information content is different from ECIS and reports on changes in *cytomechanics* rather than *cell shape*. Both techniques are *wholistic* in nature but provide complementary information of the cells under study.
This abstract reports on experiments in which cells were monitored during attachment, spreading and polarization or treatment with Concanavalin A with both techniques. The individual parameters together provide a more comprehensive picture on what happens on a cellular level than any of the two techniques for itself.

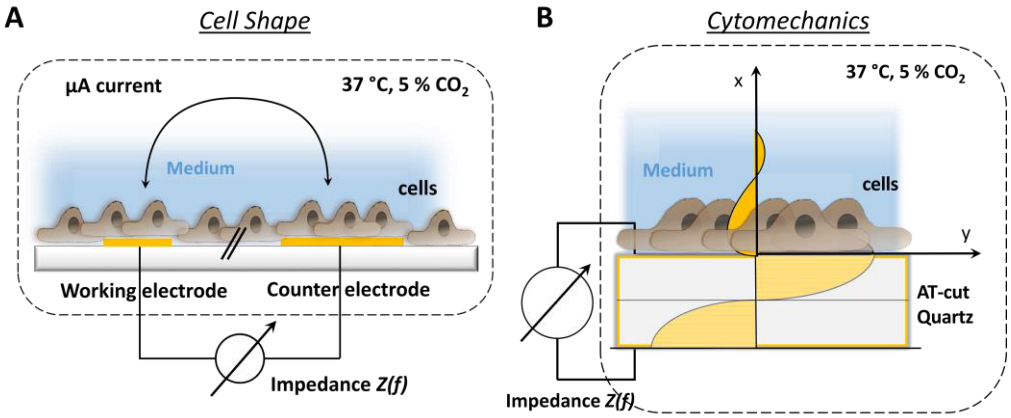

Fig. 1: The basic principles of two impedance-based cell monitoring approaches: electric cell-substrate impedance sensing (ECIS, A) and quartz crystal microbalance (QCM, B).

References:

[1] S. Lukic and J. Wegener, *eLS* (2015).
[2] M. Oberleitner, *Springer, Cham* (2018).