Impedance-Based Detection for Facing New Challenges in Biotechnology

Enhanced 3D Sensing, Conductometry and Electrode Functionalization

Canali, Chiara; Heiskanen, Arto; Larsen, Layla Bashir; Dufva, Martin; Wolff, Anders; Emnéus, Jenny

Publication date:
2014

Document Version
Peer reviewed version

IMPEDANCE-BASED DETECTION FOR FACING NEW CHALLENGES IN BIOTECHNOLOGY: ENHANCED 3D SENSING, CONDUCTOMETRY AND ELECTRODE FUNCTIONALIZATION

Chiara Canali[1], Arto R. Heiskanen[1], Haseena B. Muhammad[1], Martin Dufva[1], Anders Wolff[1], Jenny Emnéus[1]

[1]Department of Micro- and Nanotechnology, Technical University of Denmark, 2800 Kgs Lyngby, Denmark, E-mail: chca@nanotech.dtu.dk

The outstanding advances of the biotechnological research have raised increasing demand for solid analytical methods with a special focus on application within medical and pharmaceutical sciences, tissue engineering and health care.
We developed different impedance-based methods for real-time monitoring of 3D cell cultures and their metabolic activity. Planar vertical electrodes can be applied in different 2, 3 and 4 terminal configurations in a multiplexing-like approach to provide spatially distributed information on cell proliferation for *in vitro* tissue cultures (Figure 1A). The same setup can be used for estimating the influence of mammalian cell proliferation on medium conductivity (Figure 1B) and therefore characterizing the culture in terms of its biochemical activity. Moreover, this approach allows evaluating the overall 3D environment, even in terms of the scaffold architecture supporting cell organisation, proliferation and differentiation (Figure 1C). We are currently developing protocols for electrode functionalization to eliminate protein and cell adhesion to enhance detection reproducibility and electrode reusability using the same setup described above. For this purpose, chemical modifications performed in aqueous solvents are explored making them suitable for on-line modification of electrodes in polymeric perfusion-based cell culture systems.

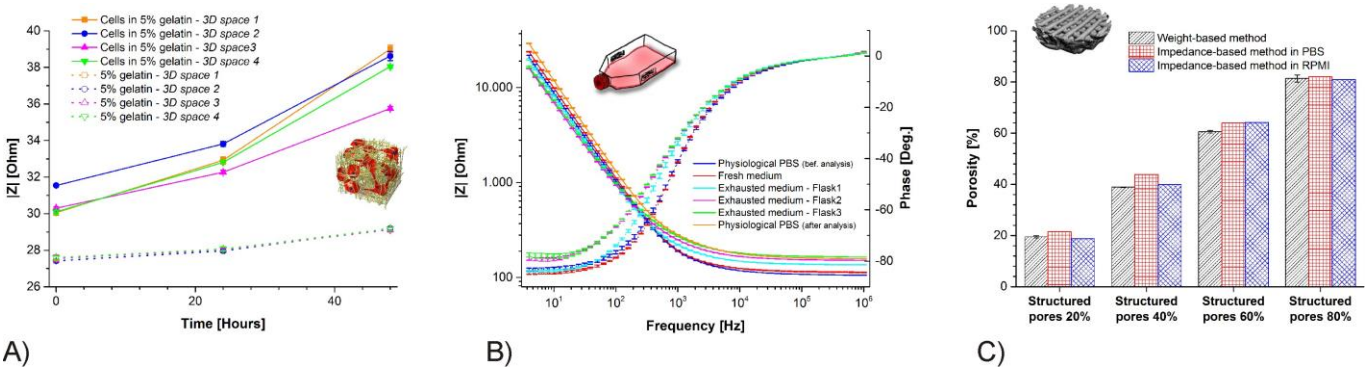

Figure 1. A) Spatial monitoring of cell growth for a 3D culture embedded in a 5% (w/v) gelatin scaffold (|Z| at 4 kHz over time). B) Influence of mammalian cell proliferation on medium conductivity. C) Evaluation of porosity for different 3D cell culture scaffolds.