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Bioimpedance based Lab-on-a-Chip (LOC) systems for tissue engineering

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Brief description of research area:

The goal of our research is to develop a new proof of concept Lab-on-a-chip (LOC) system with integrated bioimpedance detection for the purpose of *real time monitoring* of the growth and viability of a vascularized 3D bioartificial liver-on-a-chip system (BAL-on-a-Chip). This project will be executed in synergy with the newly approved EU project NanoBio4Trans, which forms a new research direction within Nanotech's LOC strategic field.

The ultimate goal of the NanoBio4Trans project is to develop, optimise and validate a highly vascularised *in vivo*-like BAL as an extracorporeal bioartificial liver (EBAL) ready to be perfused with human blood plasma, in order to be exploited in the medical technology of the 21th century.

What we know:

The use of *human induced pluripotent stem cells* (hiPSC) can be exploited as the starting material to enable the construction of personalized artificial organs from a patient's own cells. These cells can be grown and directed to differentiate into *in vivo*-like BALs by employing scalable and perfusable hybrid three dimensional scaffolds.

Integrated optical and electrical biosensing systems can be used to monitor the effects and changes that occur during tissue growth. This allows control and surveillance of the BAL formation, with envisaged feed-back control.

Different bioimpedance-based 3D tissue culture Lab-On-A-Chip (LOC) systems are designed and optimized in order to follow cellular dynamics under *in vitro* growth conditions mimicking the *in vivo* environment. Since important electrical characteristic of an electrode/tissue system are determined solely by geometrical configuration, simplified finite element models can be used to optimize electrodes number and orientation and the deriving sensitivity field distribution inside

the LOC. Different combinations of either current-carrying (CC) and pick-up (PU) electrodes or sensing configurations can be exploited. This approach can pave the way towards electrical impedance tomography (EIT) applications in order to image the changes in 3D cell culture environments.

Intra- and extracellular optical sensors will be also developed and applied for a multi-parametric imaging and bioanalysis of cells, tissues and organs (integrity of vasculature, viability, O_2, pH, liver function, differentiation markers, etc) working in close collaboration with *Luxcel Biosciences* (luxcel.com).

The perfusable hybrid scaffold and sensing systems will be integrated into the BAL support system enabling *real time monitoring* and *control* of the effects of various parameters during its growth.