Optimising the acceleration of cell proliferation in a bioreactor for scaffold-based tissue engineering

One of the most exciting areas in recent years has been regenerative medicine in which failed or damaged body parts are grown from the patients own cells loaded into a porous scaffold. The scaffold is placed in a bioreactor to accelerate the proliferation of the cells and when the tissue is partly formed it is implanted into the patient. It is fair to say that apart from isolated cases the promise has not been transformed into reality as a consequence of the limited proliferation rates. In this work we explore the use of computer modelling to optimize the stimulation processes used in the bioreactor to deliver enhanced rates of proliferation.

Currently, mechanical stimuli are used in most of the studies allowing to accelerate the growth of cells placed on the scaffold inside the bioreactor. Some in-vitro studies have shown promising results when mechanical, electrical and magnetic stimulation are used either isolated or combined. Therefore, it is important to understand the gain of using these three type of stimulation. In this talk we will present the work that has been done at the Center for Rapid and Sustainable Product Development, regarding new biomaterials and the development of 3D biofabrication equipment to produce and host these scaffolds. The main focus is on computer modelling. We introduce a finite element analysis approach used to optimise the design of a new bioreactor allowing mechanical stimulation. We present the numerical results of the application of electrical stimulation in a biocompatible scaffold. We have performed the optimisation of the application of electrical stimulation when different electrode montages are used.

The results have allowed us to gain a valuable insight on the influence of the different stimulation parameters involved. This work is supported by the Fundação para a Ciência e a Tecnologia (FCT) through the Project references: UID/Multi/04044/2013; PAMI - ROTEIRO/0328/2013 (Nº 022158) and MATIS (CENTRO-01-0145-FEDER-000014 - 3362).

Figure 1 Examples of highly porous scaffolds produced by direct digital manufacturing for use in tissue engineering [5].

Recent Publications


Biography
Nuno Alves is the Director of the Centre for Rapid and Sustainable Product Development (CDRSP), which is dedicated to the transformation of the manufacturing industry through the development and implementation of novel Additive Manufacturing (AM)/three/four-dimensional (3D/4D) printing technology. He is an Associate Professor on Computer Modelling and Simulation at the Polytechnic Institute of Leiria (PIL). His research interests are based on the development and exploitation of novel direct digital manufacturing systems, contributing for the new paradigm of the industry 4.0 (as recently named new industrial and societal revolution), mainly based on additive manufacturing/printing techniques, including computer-aided modelling and fabrication of complex multi-material 3D and 4D structures (with spatio-temporal varying properties) for both industrial and biomedical applications; Computer vision and photogrammetry; Biomimetics and bioinspiration (learn from nature); Tissue engineering; Mould design and polymer injection moulding; Rapid product development; and Circular economy.

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