DYNAMIC MECHANICAL STIMULATION OF A 3D GRAPHENE OXIDE-COLLAGEN SCAFFOLD FOR TISSUE ENGINEERING APPLICATIONS

André F. Girão (1), Gil Gonçalves (1), Paula A.A.P. Marques (1), António Completo (1)

1. TEMA, Department of Mechanical Engineering, University of Aveiro, Portugal

Introduction

During the past few years, graphene oxide (GO) has emerged as a front runner nanomaterial for tissue engineering (TE) applications due to its remarkable biochemical and physical properties, including an oxygen rich surface capable of guarantee excellent aqueous processability and amphiphilicity, together with the ability to establish either non-covalent or covalent bonds with several proteins and polymers.[1] Thus, in this work, we pioneerly developed a self-assembled porous GO-collagen (GO-Col) scaffold, which biological and mechanical properties were able to potentiate a suitable cellular microenvironment, as it was confirmed by preliminary biocompatibility tests using Rat Schwann cells. Our expectation is that, in addition to the enhanced cell-material interactions showed, the GO-Col scaffold can be also able to respond to mechanical stimulation (provided via a customized bioreactor[2]) and consequently modulate the cell response.

Methods

The negatively charged GO sheets and the positively charged Col particles were self-assembled via electrostatic interactions using several pH mediums and GO/Col ratios in order to construct a wide range of GO-Col scaffolds. After a lyophilization process, the best candidate for TE applications was selected via compression and swelling tests and then subjected to a biocompatibility assay using a Rat Schwann cell line. Finally, the GO-Col scaffold was exposed to several degrees of deformation (1%, 3% and 7%) in a controlled environment inside the bioreactor chamber with the purpose of studying its compression-recovery properties.

Results

The microporous architecture of the GO-Col scaffold and its ability to simulate an appropriate cell microenvironment are shown in Figures 1a and 1b, respectively. Figures 1c and 1d show a scheme of the dynamic compression-recovery assays performed inside the bioreactor. It was concluded that the structural integrity of the GO-Col scaffold was not compromised during deformations of 1%, 3% and 7%.

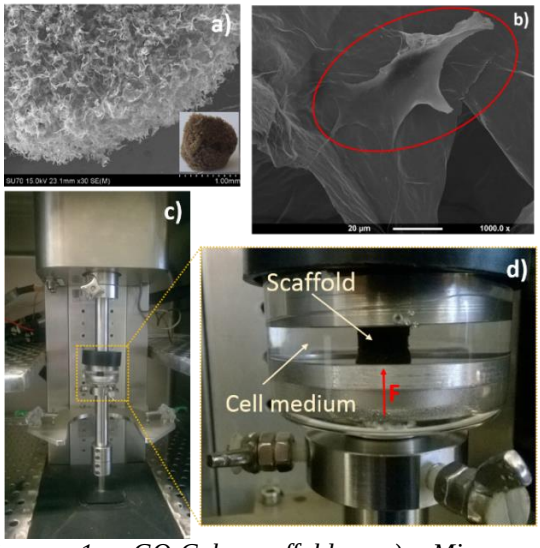

Figure 1: GO-Col scaffolds. a) Microporous architecture; b) Cell-material interactions (red circle is showing a Rat Schwann cell); c-d) Mechanical stimulation using the bioreactor apparatus.

Discussion

As it was previously reported,[3] the replication of different natural cell niches *in vitro* should include specific mechanical stimuli capable of induce precise cellular activity patterns. In this regard, we developed a 3D GO-Col scaffold able to combine excellent biocompatibility levels with a microporous architecture that guarantees the structural integrity of the composite system during several dynamic mechanical stimulation assays. We believe that the scaffold-bioreactor interactions described could be ultimately used to guide the differentiation process of stem cells into specific cell lineages, depending on the stimuli applied.

References

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