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A SELF-ASSEMBLED 3D GO-COL COMPOSITE SCAFFOLD FOR TISSUE ENGINEERING APPLICATIONS.

André F. Girão^{1(*)}, Gil Gonçalves¹, António Completo¹, Paula A.A.P. Marques¹,

¹Department of Mechanical Engineering, University of Aveiro, Portugal

^(*)*Email:* andrefirao@ua.pt

ABSTRACT

A portfolio of Graphene Oxide-Collagen (GO-Col) composite scaffolds was prepared and submitted to mechanical and swelling tests in order to select the most suitable candidate for tissue engineering applications. The optimal GO-Col scaffold composition and its reduced contra-part were then tested as promising materials for cell culture assays.

Keywords: graphene oxide, nanocomposite scaffolds, tissue engineering.

INTRODUCTION

The potential of GO in the regenerative medicine field has received much interest in the past few years, mostly due to its excellent aqueous processability, amphiphilicity and surface functionalization approaches (Goncalves et al. 2010). Indeed, the heavily oxygenated surface of GO sheets can be successfully combined with both biomolecules and polymers (Bai et al. 2011) in order to work as building blocks of more complex composite structures such as films, electrospun fibres and hydrogels.

There are a large number of proteins (Zhang et al. 2013) that are currently used to create GO composite hydrogels (e.g. chitosan and gelatin), however, and from our knowledge, the potential of Col as physical crosslinker for GO sheets has not been explored yet. Col is the principal component of the extracellular matrix and the most relevant biomaterial used in scaffolding approaches since it can form a hydrogel at physiological pH or be combined with other materials to enhance their compatibility and biodegradability (Abou Neel et al. 2013). In fact, the potential of a Col scaffold coated with either GO or reduced GO (rGO) was already reported by Kanayama et al. (Kanayama et al. 2014), improving the biological and mechanical properties of the original Col structures. Similarly, other group has recently improved the osteogenic differentiation of human mesenchymal stem cells (hMSCs) by investigating the covalent binding between a collagen sponge and GO flakes via a carbodiimide crosslinker (Kang et al. 2015).

Although these results are very promising, there are many topics that were not been addressed yet. For example, the possibility of varying the structural network of the 3D scaffold by changing the pH of the medium or the Col/GO percentage ratio. Taking all this into account, 3D GO-Col composite scaffolds should be able to match good biological and mechanical features together with a great design flexibility and reproducibility under controlled conditions.

RESULTS AND CONCLUSIONS

In this work we hypothesize that Col can be successfully used as physical crosslinker for GO sheets to form a self-assembled composite hydrogel, which structural network can be adapted by changing the pH of the medium and the Col/GO ratio in the system. In fact, we verified that by varying those variables and consequently changing the network of repulsion and bonding forces among the negatively charged GO sheets and the positively charged Col particles, it was possible to fabricate a wide range of GO-Col composite hydrogels that were characterized after drying by lyophilization.

Finally, the most viable candidate, in terms of mechanical integrity, for tissue engineering applications was selected after mechanical and swelling tests. We propose that, similarly to other works (Chen et al. 2012; Lee et al. 2011), this new optimal GO-Col scaffold and its reduced contra-part (rGO-Col) could open promising possibilities for cell-material interaction approaches towards tissue engineering.

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