NANOSTRUCTURED BIOMATERIALS FOR PERIPHERAL NERVE REGENERATION

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ABSTRACT

Nowadays, peripheral nerve injuries constitute a major challenge for reconstructive surgeries. Peripheral nerve injury is a critical problem that affects more than 1 million people worldwide each year [1] and is particularly difficult to treat from the surgical perspective. The insertion of a nerve conduit in the lesion site is used as an alternative to autologous nerve grafting, for short gaps (<3 cm) between the proximal and the distal part of the injured nerve.

The aim of this study is to develop scaffolds for peripheral nerve regeneration, made of innovative biodegradable materials and enhanced with topography modifications.

AN INNOVATIVE MATERIAL: CHITOSAN

Chitosan is the second most abundant polymer in nature (after cellulose).

It is a copolymer of β(1-4)-linked N-acetyl-D-glucosamine and D-glucosamine subunits, obtained from the controlled deacetyation of chitin, a natural omopolymer of N-acetyl-D-glucosamine widely found in the exoskeletons of arthropods and insects, in crustacean shells and in fungi cell wall.

Chitosan is now approved by FDA for its use in biomedical devices and it represents an interesting polymer for its properties of biocompatibility and biodegradability [2].

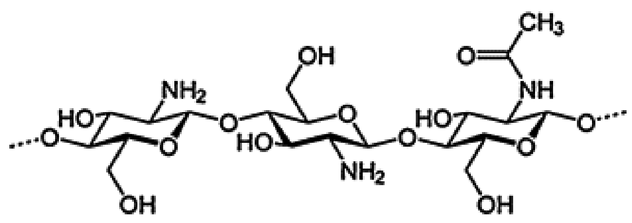


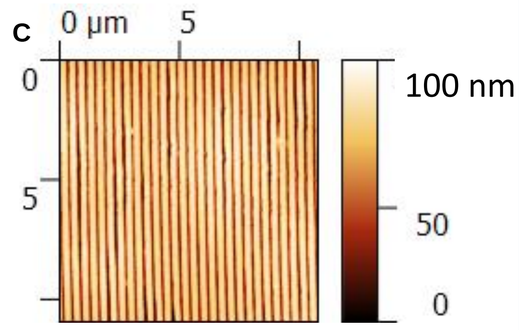
Figure from L.A.M. van den Broek et al. / Carbohydrate Polymers 116 (2015)

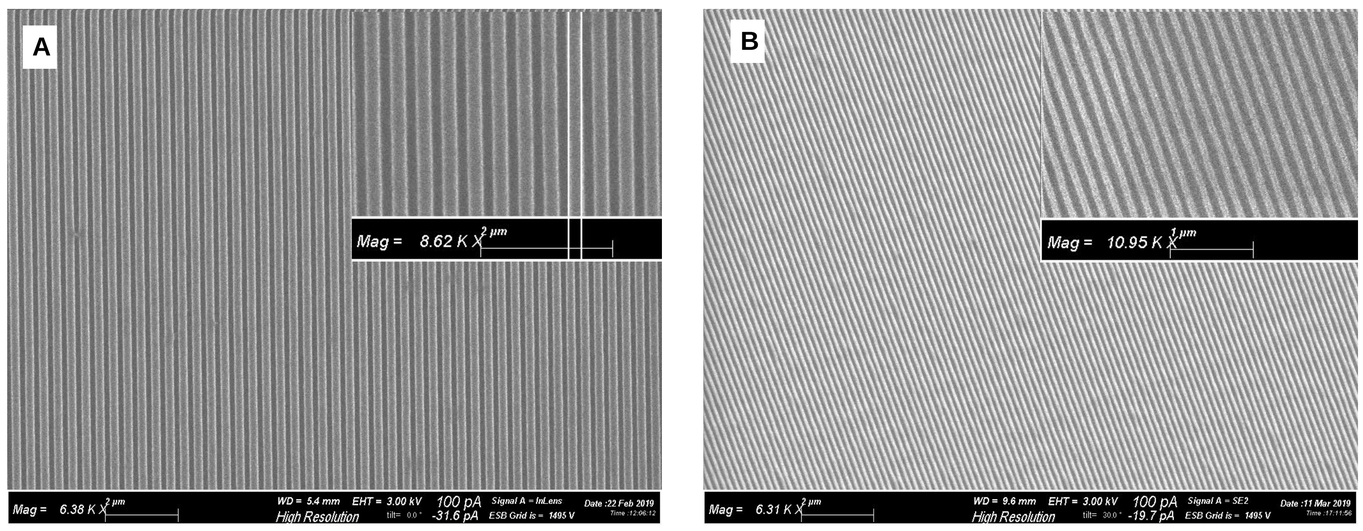
WHAT IS THE RESOLUTION LIMIT OF CHITOSAN IN SOFT LITHOGRAPHY?

The method that we developed for chitosan nanopatterning is based on soft lithography.

Patterned films are fabricated by solvent casting on a mold, that can be made of PET, COC or PDMS.

We successfully created grating topographies with a period of 400 nm (T400) and 200 nm (T200).

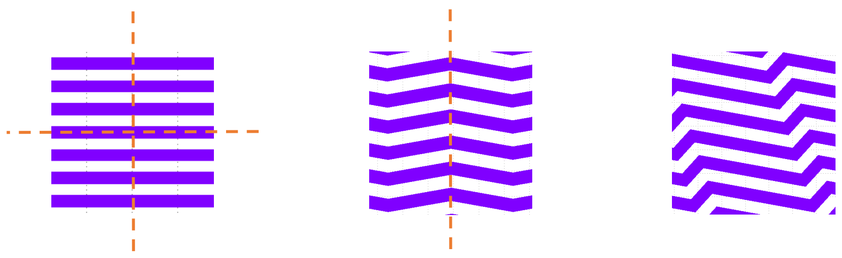




SEM images of T400 (A) and T200 (B) on chitosan films. (C) AFM measurement of T400.

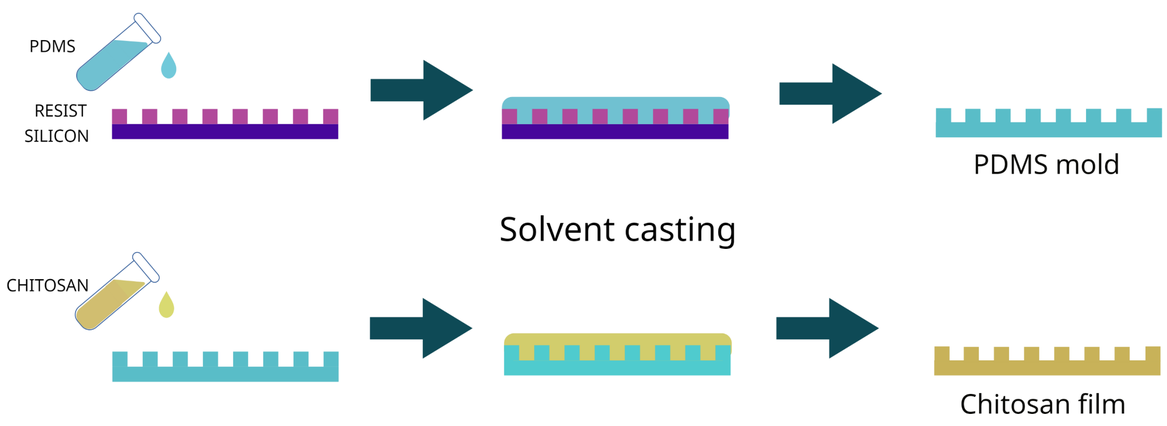
ENGINEERED SURFACE TO GUIDE CELL MIGRATION

Neural cells polarization and migration are influenced by the surface topography [3]. The direction and speed of migration can be modified by the geometry and the symmetry level of the pattern [4].



We generated 3 geometries with different levels of axial symmetry, to assess if it is possible to enhance cells unidirectional movement.
All the geometries have a 10 µm period (T10).

We fabricated initial Si molds by UV-photolithography, using a Laser Writer machine.



Secondary molds in PDMS were created by solvent casting.
Then, microstructured chitosan films were produced using the PDMS molds.

Schwann and DRG cells will be cultured on this scaffolds, in order to study cell migration and tissue repair.

REFERENCES:
[1] Daly W *et al*. J R Soc Interface 2012;9:202–221.
[2] Wang W *et al*. Journal of Biomedical Materials Research Part A 2006
[3] Cecchini M *et al.* Journal of Physics: Conference Series 100. 2008
[4] Tang QY *et al*. Journal of Biomedical Materials Research Part A 2015