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Alginate-based Microcapsules for Cell Therapy: A Combination of Techniques Designed to Characterize their Stiffness and Surface Properties

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Introduction

Cell encapsulation in porous hydrogel microspheres represents a potent tool in regenerative therapy. Microcapsules allow the diffusion of nutrients inside, and therapeutic products outside, while avoiding the immune system surveillance.

Microcapsule surface properties are of particular importance since most interactions with the host cells may occur on the surface.

Microcapsules are subjected to high shear stresses since implantation. Global stiffness characterization is needed to guarantee microcapsule stability.

Constriction assay

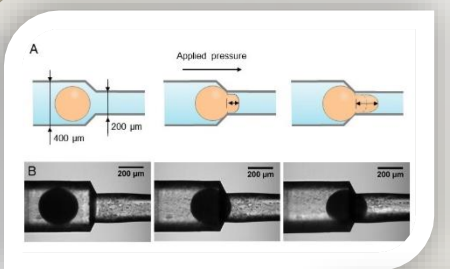
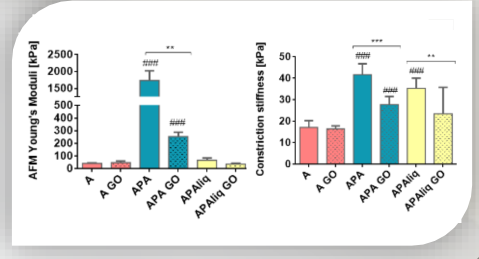


Fig. 4. Scheme and images of the custom-built constriction microdevice. Stiffness is calculated as the pressure/deformation ratio, where deformation is the penetration length.

Fig. 5. Since both stiffness measurements are based on different approaches, comparisons between them rely on comparing tendencies.



Surface characterization by AFM

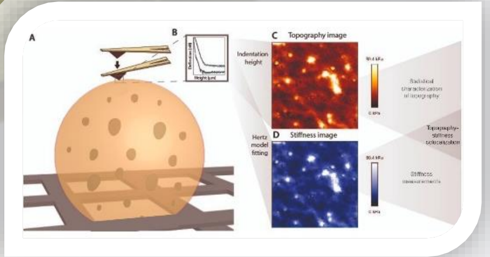


Fig. 1. Force spectroscopy-based grids were acquired and processed to obtain both a topography and a stiffness map of the same microcapsule surface area.

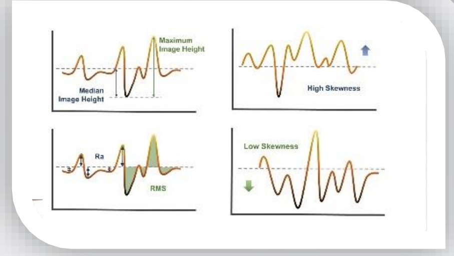


Fig. 2. Standard topographic parameters (MaxIH, MedIH, Ra, RMS, Skewness) were calculated from topography maps.

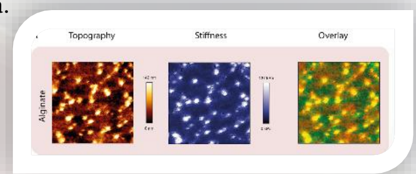


Fig. 3. Topography-stiffness colocalization study.

Results and conclusions

This workflow allowed us to determine the effects of Graphene Oxide (GO) on the conformation of the microcapsule alginate network, which becomes more apparent with subsequent surface coatings.

The methodology also demonstrated that long periods of cryopreservation did not translate into problematic alterations of microcapsules mechanical properties.

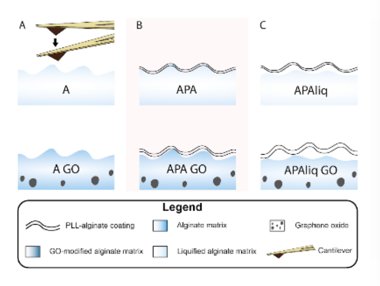


Fig. 6. Proposed model of the surfaces of microcapsules before and after GO supplementation.

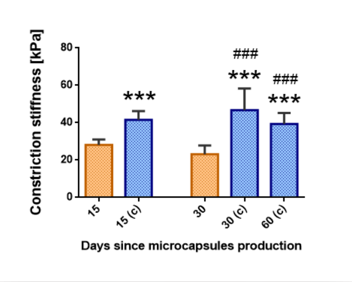


Fig. 7. Global stiffness of microcapsules cryopreserved (blue) or cultured at 37ºC (orange).

Our methodology represents an interesting tool for rational design of microcapsules.

This workflow could accelerate microencapsulation research and its clinical translation.