Chitosan scaffolds with hierarchical porosity

L Altomare[1], E Guglielmo[1], EM Varoni[2], L Rimondini[2], L De Nardo[1]

[1]*Dipartimento di Chimica, Materiali, Ing. Chimica 'G. Natta', Politecnico di Milano. Italy*
[2]*Dipartimento Scienze della Salute, Lab Odontostomatologia, Università del Piemonte Orientale, Italy* *lina.altomare@polimi.it*

INTRODUCTION: Chitosan (CH) is a versatile biopolymer whose morphological and chemico-physical properties can be modified for a variety of biomedical applications [1]. By exploiting the CH electrolytic nature, cathodic polarization allows its deposition on electrically conductive substrates [2], resulting in tunable thin porous structures [3]. Here we propose an easy method to obtain CH scaffolds with highly oriented microchannels for tissue engineering application via a simple control of the process parameters.

METHODS: Cathodic deposition on patterned metallic substrates has been performed in galvanostatic conditions (j =15-40 mA cm^{-2}) starting from CH solution [1g/L] in acetic acid (pH 3.5). Morphological and structural analysis of the coatings have been performed after rinsing in deionized water and drying overnight. Self-standing scaffolds have been detached from the cathode after freeze drying the coatings. Specimens have been weighted and observed by optical and Scanning Electron Microscopy

RESULTS: Obtained porous structures showed a morphology and weight dependence on apparent current density, time, and substrate patterns. A progressively increase in mass deposition have been observed (Fig 1) as a consequence of the total amount of the charge passed during the electrochemical process.

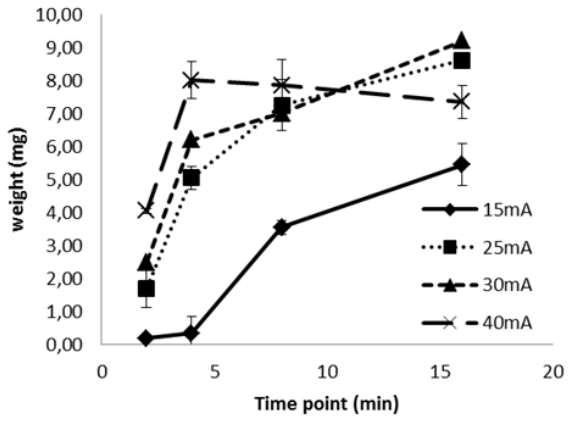

Fig. 1: Deposition on 500µm grid at different currents and time points.

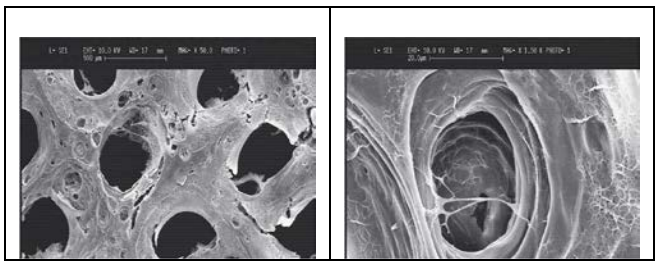

Fig. 2: SEM image of oriented pore structure. The electrodeposited CH net displays an oriented macro-porosity, (A), a random micro-porosity (B).

Figure 2 shows the typical morphology of the obtained structures. It is possible to notice macro-pores (micro-channels), due to the substrate patterning, and micro-pores, due to H_2 bubble evolution [2]. Both levels of porosity can be controlled in order to design scaffolds with a hierarchical organization. Dimensions of microchannels strongly depends on substrate patterns and total charge passed, decreasing in diameter by increasing the polarization time and currents.

DISCUSSION & CONCLUSIONS: Cathodic polarization is an easy technique to realize scaffold with different porosity and highly oriented microchannels. The oriented channels can improve cells and tissue orientation while the microporosity support nutrient diffusion and could promote vascularization; in vivo tests with promising results are under investigation. The properties of these scaffold such as porosity, channel dimensions, thickness and swelling ability, can be easily tuned and target depending on the tissue to be regenerated.

REFERENCES: [1] A. Francesko and T. Tzanov (2011) *Adv Biochem Eng Biotechnol* **125**:1-27 [2] J. Redepenning et al. (2003) *JBMR*; **66A**:411-6 [3] L. Altomare et al (2012) *Materials Letters* **78**, 18–21.

ACKNOWLEDGEMENTS: LA and LD thank MIUR - FIRB Futuro in ricerca (Surface-associated selective transfection - SAST, RBFR08XH0H) for the economic support.