

Design of Polyester-based Non-Porous Films and 3D Porous Scaffolds for Soft Tissue Engineering

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INTRODUCTION: The present study reports the design of poly(lactide-*co*-glycolide) (PLGA) non-porous films and porous 3D scaffolds for soft tissue engineering using the solvent casting technique and the emulsion processing route. Different parameters such as the concentration of PLGA or the amount of water were studied to assess their influence on the properties of the films or the porous scaffolds, respectively.

METHODS: The films were prepared by casting a solution of commercial PLGA (75:25, $M_w = 90,000$ - $126,000$ g.mol⁻¹, PDI = 2.8) and dichloromethane (DCM) on a microscope glass slide using the spin-coating method. The porous scaffolds were prepared by the emulsion freeze-drying technique. Briefly, the porous matrixes were prepared by mixing PLGA in DCM (17 wt/v %) and a surfactant (span 80) into a reactor equipped with a vertical steel stirrer and then adding water drop-wise. Thereafter, the emulsion was poured in a Teflon mould and placed in a freeze-dryer for 24 h.

RESULTS: The increase of PLGA concentration in the DCM solution leads to the increase of the thickness but the decrease of the film storage (E') and loss (E'') moduli (Table 1). After 7 days of incubation at 37 °C, thinner films exhibit a mass loss of 39 wt % while the mass loss of thicker films does not exceed 6 wt %. Environmental Scanning Electron Microscopy (ESEM) analysis revealed that no features were present on the film surface before or after degradation.

Table 1: Thickness and moduli of different PLGA films.

[PLGA] (wt/v %)	Thickness (μ m)	E' (MPa)	E'' (MPa)
10	25	5,400	480
20	50	650	210

Due to the stability of the emulsion or the fragility of the foam, the content of water in the emulsion can not be increased above 56 %, which leads to porous structures with pore diameters smaller than 100 μ m (Figure 1). After 14 days of incubation at 37 °C, the mass loss of foams does not exceed 13 wt %.

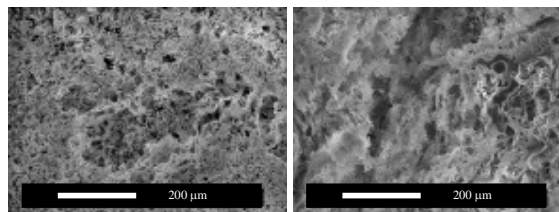


Fig. 1: ESEM micrographs of PLGA porous scaffolds obtained with a 40 % water-based emulsion: surface (left) and cross-section (right).

DISCUSSION & CONCLUSIONS: The increase in moduli with decreasing film thickness may be attributed to the increased importance of polymer microstructure [1]. The material's strength and stiffness are significant as they should ideally approach those of the tissue it is to replace [2]. At the beginning of the degradation process, the hydrolysis of thinner films is higher than the one of thicker films because thin films have a greater surface area to volume ratio and thus a greater extent of water uptake [3]. The absence of pores on the surface after degradation can be explained by the heterogeneous bulk degradation of PLGA films.

After freeze-drying, the molecular weight of the foams decreases and the polydispersity index increases up to 14.2 compared to raw PLGA, showing the degradation of the polyester during the foam process. The presence of pores at the surface of the 3D scaffold may allow the diffusion and the growth of the cells within the foams.

First results of bladder cell seeding onto the films or the 3D scaffolds show that the cells attach onto and survive on the non-porous films for at least one week. Moreover, cells were present on the surface and within the 3D scaffold structure after 7 days of incubation.

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