Modelling and characterization of the degradation of bioabsorbable PLA yarns for textile-based tissue engineering applications

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Introduction. Although PLA is widely used for biomedical applications and the degradation rates are well studied, the behaviour of yarns or textiles is not well reported. In this work, the degradation behaviour of two morphologically different PLA yarns is assessed during accelerated *in vitro* degradation tests and compared with computational results in physiological conditions.

Materials and methods. A simplified reaction-diffusion model for semicrystalline polymer degradation [1] was implemented in COMSOL Multiphysics®. A parametric analysis was carried out to simulate hydrolysis at 37 °C of a single PLA filament with different cross sections. Monofilament (99 µm diameter) and multifilament (36 filaments, 15 µm diameter each) PLA yarn were degraded *in vitro* in PBS at 58 °C, pH 7.4 for 55 days adapting ISO 13781. Degraded samples were dried and tested via DSC and FTIR spectroscopy. Mechanical testing was carried out on wet degraded yarns following a variation of a tensile test based on ISO 2062.

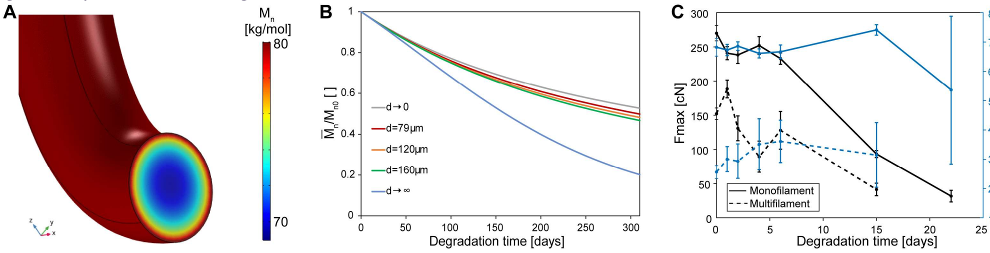

Fig. 1: (A) Autocatalysis captured by the computational model, (B) simulation of molecular weight (Mn) evolution for different yarn sizes, (C) yarns ultimate strength and Young's modulus during in vitro degradation.

Results. Simulations predicts that, even with autocatalysis taking place (Fig. 1A), little to no difference exists in the evolution of average molecular weight of PLA yarns with different diameters (Fig. 1B). Experimental data show that the two yarns feature comparable evolution of strength (with a drop of around 65% in 15 days) Young's modulus (Fig. 1C), elongation, and crystallinity during degradation, in line with simulation results since all properties directly depend on yarns molecular weight. These findings suggest that cross section size and geometry have a small impact on the degradation behaviour of PLA yarns, being diffusion favoured over autocatalysis at a typical yarn scale. These experimental and computational results can be combined to predict the degradation behaviour of complex textile structures, thus accelerating the development of absorbable biotextiles.

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