In-vitro Degradation and Cell Viability Analysis of a Biodegradable Polyesterurethane

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Introduction: Development of elastomeric biodegradable materials has been a focus of several researchers [1,2]. Such materials could be used in the repair of anatomical defects or reconstructive surgery. However there is a lack of data characterising the behaviour of slowly degrading polyesterurethanes changes over time. The objective of this study was to synthesise and characterise a biodegradable polyesterurethane over 12 months. Specifically, change in mechanical properties, molecular weight and cell behaviour were characterised.

Methods: A biodegradable polyesterurethane polymer with telechelic poly(hydroxybutyrate)-diols for the hard segment and diglycolide and ε-caprolactone comprising the soft segment were used for this study. Infrared spectroscopy was used throughout the polymer synthesis phase to detect the completion of synthesis. The polymer was then purified and precipitated. Nuclear magnetic resonance (NMR) was utilised to validate the chemical structures of the amorphous diol post-synthesis. The thermal properties of the polymer were characterised using differential scanning calorimetry (DSC). The polymer was processed into two variants; non-porous films using the solvent-casting technique and a porous mesh by electrospinning. A degradation study to characterise the change in mechanical properties and molecular weight over 12 months was conducted. Dog-bone shaped samples were cut from the mesh and film and were immersed in PBS in a shaker bath at 37°C. The change in mechanical properties and molecular weight over time was determined by uniaxial tensile testing at 37°C and gel permeation chromatography (GPC) respectively. Concomitantly, any changes in the mesh or film morphologies throughout the degradation study were studied using scanning electron microscopy (SEM). Independently, fibroblasts were seeded onto sterilised mesh and film samples. Cell proliferation was quantified using WST-1 assay while SEM was used to examine cell morphology.

Results and Discussion: An elastomeric biodegradable polyesterurethane was synthesised when the Fourier transform infrared (FTIR) spectra no longer detected presence of the cross-linker. NMR spectra confirmed the presence of the different chemical structures in the amorphous diol. Thermal analysis revealed phase separation between the amorphous and crystalline segments around 37°C. Electrospinning of the synthesised polymer produced highly porous meshes, as illustrated in Fig. 1, while solvent casting produced non-porous films. The degradation study suggested a gradual decrease in the mechanical properties for both the film and mesh over a period of 12 months. Slow exponential decrease in the molecular weight as measured by GPC indicates a slow degrading polymer. SEM images of both variants revealed steady surface erosion. Cell proliferation on the mesh and film were similar to that of the control after 7 days, as in Fig. 2.

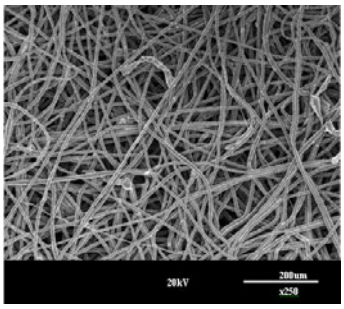

Fig. 1 – SEM image of high porosity electrospun mesh

Conclusions: By varying the ratio of the hard and soft segments it was possible to optimise the mechanical properties and degradation rate of the polymer. The phase separation evident in the DSC results highlighted that all characterisation should be performed at 37°C not room temperature, as otherwise the amorphous segment would be in a crystalline state. The degradation study showed a gradual decrease in the mechanical properties and the polymer degrades at a controlled rate. *In-vitro* assays revealed that cell proliferation was better than the control after 7 days, thus suggesting that this polymer and its degrading products are not cytotoxic.

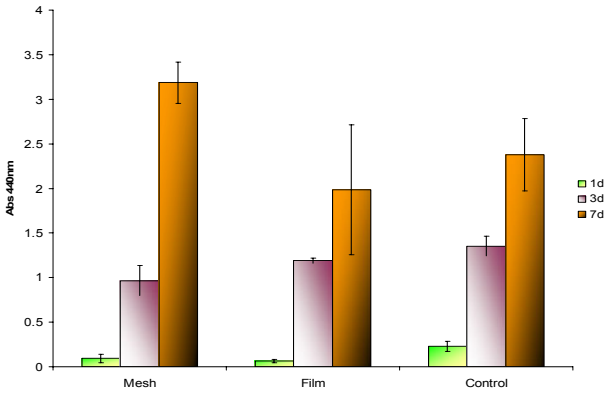

Fig. 2 – Cell proliferation measured by WST-1 assay of fibroblasts after 7-days on mesh, film and control, mean ± SD, n=3

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