PLGA/Collagen/HA Nanofibrous Scaffolds with Tunable Mechanical and Degradation Characteristics

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Statement of Purpose: Electrospinning technique offers an ideal route to synthesize nanofibrous scaffolds for tissue engineering because the scaffolds thus prepared have a highly interconnected porous structure (80-90% porosity) and nanoscale features which resemble the natural extra cellular matrix (ECM) [1] . Type I collagen is the most abundant in the body and hence has a major role in bone tissue engineering [2]. The drawback of using collagen alone as a scaffold material is its faster degradation rate and lower mechanical properties [3]. In order to improve the properties of collagen, blends or nanocomposites have to be synthesized [4]. In this study, nanofibrous scaffolds based on blends of Collagen type I and PLGA (85/15) were prepared and further nanohydroxyapatite (nanoHA) was incorporated to the blend system to synthesize nanocomposite nanofibrous scaffolds by electrospinning process. Apart form improving mechanical strength by blending with PLGA and adding nanoHA, the overall degradation stability of the scaffold is expected to improve due to the presence of PLGA. The degradation kinetics of tissue scaffolds should be engineered in such a way that the degradation rate of the synthetic scaffold should coincide with the creation of the new tissue.

Methods: Type I collagen (Elastin Products Co., Inc, Owensville, Missouri) and PLGA with PLA: PGA ratio of 85/15 (Absorbable Polymers, Pelham, AL) were dissolved in 1,1,1,3,3,3-hexafluor-2-propanol (HFP), from Fluka®, Sigma-Aldrich, USA, to achieve 15-wt% polymer solution. To make nanocomposite fibers of PLGA/Collagen blend with nanoHA, nanoHA powder (~100 nm particle size and 15 m^2/g surface area, Nanocerox Inc., Ann Arbor, MI) of desired amount (wt %) was dispersed in the solvent system by ultrasonication for 30 min. Then, PLGA/Collagen was dissolved in it. The morphology of the fiber structure was characterized using Scanning Electron Microscopy (SEM). The fibrous scaffolds were cut into rectangular strips of 40 × 6 mm and tested on a Dynamic Mechanical Analyzer (DMA, TA Instruments Inc., DE) in tensile mode. In-vitro degradation studies of the nanofibrous scaffolds (50 × 10 mm) sheets were carried out by immersing in 15mL of 0.1M phosphate buffer solution (pH = 7.4) at 37^0 C with constant shaking for different periods (up to 8 weeks). The weight loss of the specimen (n=3) with different duration were obtained and compared. Apart from mass loss the specimen obtained at different periods was characterized using SEM, Fourier transform Infrared spectroscopy (FT-IR) and Differential Scanning Calorimetry (DSC).

Results/Discussion: Different ratios (80/20, 50/50, 20/80) of PLGA/Collagen blends were synthesized. Scaffolds exhibited a random oriented non-woven fibrous morphology. The individual fibers on the scaffolds had cylindrical morphology and no fiber bundles, indicating the tip-to-collector distance was adequate for proper evaporation of the solvent. The diameters of the fibers obtained were within the range of 100 nm - 1.5 μm. Also there was complete absence of bead-on a string morphology suggesting the concentration and the viscosity obtained is optimum. More than two fold increase in tensile strength was observed with increasing PLGA content. The effect of nanoHA on the mechanical properties as well as biodegradation studies of the scaffolds are underway and will be presented.

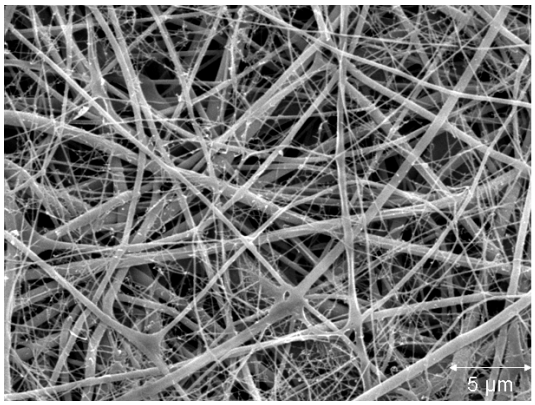

Figure 1. SEM image of PLGA/Collagen blend (80/20)

Conclusions: Porous nanofibrous nanocomposite scaffolds based on PLGA/Collagen/nanoHA were synthesized using electrospinning technique. SEM micrographs suggested the scaffolds had a bead free structure. Tensile testing of specimen showed increase in mechanical properties with increasing concentration of PLGA content. The mechanical properties of nanocomposite scaffold based on nanoHA as well as degradation stability studies are still undergoing.

References:

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