Preparation and Characterization of Superlowfouling Electrospun Scaffolds of Zwitterionic Polysulfobetaine Methacrylate for Tissue Engineering Applications

Reza Lalani[1], Bo Zhang[2], Lingyun Liu[2]
[1]Integrated Bioscience Program, University of Akron, Akron, OH 44325, [2]Department of Chemical and Biomolecular Engineering, University of Akron, Akron, OH 44325

Statement of Purpose: As an alternative to organ transplant due to limited organ availability, tissue engineering (TE) offers fabrication and regeneration of tissue or organ due to organ failure in order to restore biological function lost in the host tissue. Basic principles of TE involve harvesting cells through biopsy or purchasing cells from an established cell line to be seeded onto a polymer scaffolding in order to be implanted into the target area in the body, where the scaffolding provides a three dimensional structure and a temporary extra cellular matrix (ECM) needed for cells growth and proliferatation. The scaffold architecture and the types of polymeric materials used in TE are two of the most important factors which determine cell-biomaterial interaction. As a promising fabrication method, Electrospinning (ES) has been shown to produce porous and continuous nanofiber scaffoldings, mimicking the natural ECM. ES is a simple and economical nanofiber scaffold fabrication method which is based on using electrostatic forces to produce fibers. Polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL) and their copolymers are among the materials most commonly used in TE for their biocompatible properties, however not being nonfouling in vivo has led researchers to look for other materials. Zwitterionic surfaces and hydrogels of sulfobetaines have been previously studied for their superlow biofouling characteristics. In an aqueous solution, zwitterionic polybetaines exhibit antipolyelectrolytic effect which contributes to its nonfauling properties due to formation of a water layer at the surface of biomaterial leading to reduced protein adsorption and bacterial adhesion, as recent studies have shown that pSBMA hydrogel surfaces are highly resistant to nonspecific protein adsorption. But in order to be useful in TE applications, porous scaffolds are needed and since no work has been done to produce fibers of pSBMA by ES or other means, here we report the preparation of pSBMA solution with different viscosities and fabrication of nanofiber electrospun scaffoldings.

Methods: In this study, polysulfobetaine methacrylate (pSBMA) was prepared by free radical polymerization of sulfobetaine methacrylate (SBMA) by dissolving the monomer in an aqueous salt solution and electrospun to afford a fibrous scaffold. Intrinsic viscosity of pSBMA was measured along with polymer weight percent conversion as well as dynamic viscosity of polymer solutions of pSBMA dissolved in different amounts of solvent. Morphology of the scaffolds was studied by scanning electron microscopy (SEM).

Results: Electrospinning was used as a method of scaffold fabrication to produce nanoscale continuous fibrous mats to be used as low-fouling and biocompatible TE constructs with different fiber diameters. The effect of viscosity on fiber diameter was a linear relationship with fiber diameters ranging from 475 to 1200 nm (Fig.1) indicating that fiber diameter can be controlled through modifications in solution viscosity. The SEM of the same solutions showed that at the lowest viscosity electrospun mats included beads and at highest viscosity the fiber diameters are in microscale range (Fig.2).

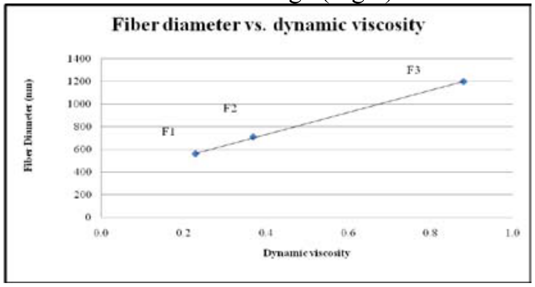

Figure 1. Correlation of diameter of electrospun pSBMA fibers and viscosity of samples F1: 39.7, F2: 52.9, F3: 79.3, (%w/v).

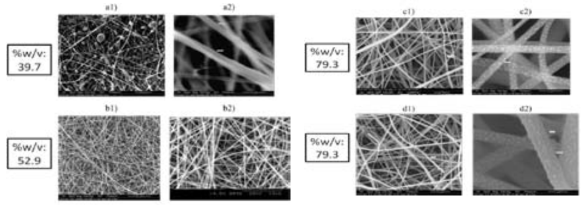

Figure 2. SEM of four electrospun samples F1: 39.7% a1-a2, F2: 52.9% a1-a2, F3: 79.3% a1-a2 (%w/v).

A linear relationship was observed between dynamic viscosity of pSBMA and solution concentration. Weight percent conversion of monomer to polymer showed that increasing initiator concentration in polymerization of pSBMA results in more monomer conversion and higher polymer weight. Intrinsic viscosity measurements indicate that intrinsic viscosity is about 0.21 for solutions using different initiator concentrations indicating that molecular weight of the samples are close together. Considering the results of monomer to polymer weight conversion and intrinsic viscosity in free radical polymerization of pSBMA, it can be deduced that branching increases as initiator concentration is increased.

Conclusions: In this work, pSBMA was electrospun to produce fibrous scaffoldings with different fiber diameters successfully. Fiber diameters in the range of 475 nm to 1200 nm was obtained. The effect of initiator concentrations on polymerization showed that monomer conversion to polymer can be controlled. The morphology of the pSBMA fibers can also be controlled as indicated by SEM of the scaffoldings.

References:

1. Barnes, C. P. *Adv. drug delivery rev.* **2007,** 59, (14), 1413-1433
2. Liang, D. *Adv. drug delivery rev.* **2007,** 59, (14), 1392-1412.
3. Li, W. J. *J. biomed. Mater. Res.* **2002,** 60, (4), 613-621.
4. Kudaibergenov, S. *Adv. Polym. Sci.* **2006,** 201, 157-224.
5. Smith, L. A.; *Colloids and Surfaces B: Biointerfaces* **2004,** 39, (3), 125-131.