Combinatorial Method for Screening the Effect of Nanofiber Scaffold Composition on Cell Response

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Statement of Purpose: We are developing combinatorial methods for screening cell-material interactions. Although previous approaches for rapid screening have used material libraries in the form of two-dimensional surfaces or films (2D), biomaterials are commonly used in a three-dimensional scaffold format (3D) and cells behave more physiologically when cultured in a 3D environment. Electrospun nanofibers have shown promise as tissue scaffolds [1] because they mimic the nanotopology of native extracellular matrix (ECM) [2]. Therefore, we are developing a combinatorial platform for screening the effect of nanofiber scaffold composition on cell response.

Methods: A new 2-spinneret approach has been developed for fabricating nanofiber scaffold libraries containing a gradient in composition. The two spinnerets simultaneously deposit two different polymer solutions into a non-woven mat composed of a mix of two nanofiber types. The new method was characterized by fabricating gradients of Sudan IV red dye and measuring dye absorbance to determine composition. Poly(ε-caprolactone) (mass averaged relative molecular mass 80 000) (PCL) was used to fabricate scaffold libraries using 10% mass per volume solutions in 3:1 chloroform:methanol. One spinneret spun pure PCL fibers while the second spinneret spun PCL fibers with Sudan IV. The scaffold libraries were cut into sections, dissolved in solvent and dye absorbance was determined with a platereader. Nanofiber scaffolds prepared from pure PCL or pure PCL with dye were analyzed as controls. Composite nanofibers containing hydroxyapatite nanoparticles (nHA) (Berkeley Advance Biomaterials) were also fabricated and imaged by scanning electron microscopy (SEM).

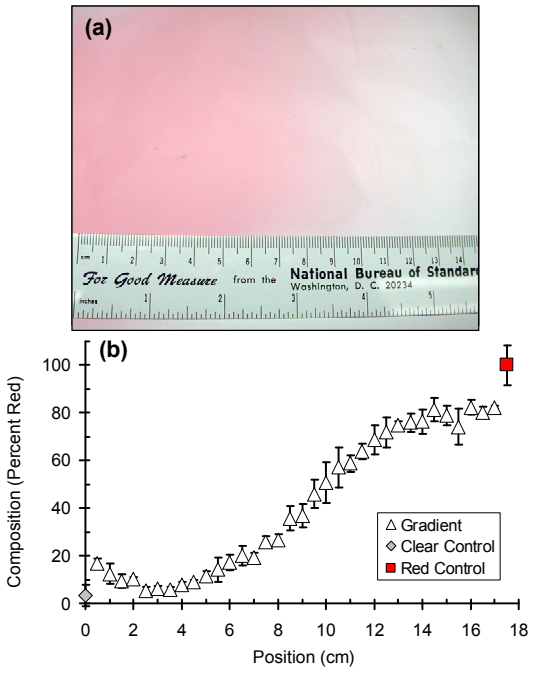

Fig. 1. (a) Photograph of a nanofiber scaffold library. Red dye was used to visualize the gradient. (b) Plot of red dye composition versus library position (n = 5, error bars are standard deviation).

Results: A nanofiber library with a gradient in red dye is shown in Fig. 1a. Dye absorbance measurements showed that a linear gradient in nanofiber composition can be attained with the 2-spinneret approach (Fig. 2b). Red dye gradients are useful for characterizing fabrication, but gradients in hydroxyapatite nanoparticle composition are being fabricated for screening cell response. Images of control nanofiber scaffolds containing nHA are shown in Fig. 2. Nanofiber libraries containing gradients in nHA are being fabricated by the 2-spinneret approach and characterized by thermogravimetric analysis. Osteoblasts are being cultured on the nHA nanofiber scaffold libraries to determine the optimum scaffold composition for inducing osteoblast differentiation and osteogenesis.

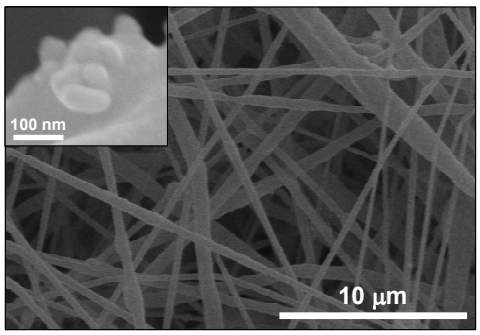

Fig. 2. SEM of electrospun nanofibers containing 30% by mass nHA. Inset shows a close-up of nHA on the surface of a nanofiber.

Conclusions: A novel approach has been developed for fabricating nanofiber scaffold composition gradients. The gradients can be used as "libraries" for screening the effect of nanofiber properties on cell response.

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