Nanofiber 3-dimensional fabric for scaffold via electrospinning method

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Statement of Purpose: Nanofibers, polymer fibers ranging from submicron to several nanometers, are used in a wide variety of applications and fields because of its large surface area to volume ratio, flexibility in surface conditions and superior mechanical performance compared with any other form of materials. Nanofibers can be obtained easily via electrospinning method, which is a simple and efficient method to fabricate nanofiber non-woven mats [1].

Recently, the nanofiber non-woven mats have extensively been applied for scaffold of tissue engineering [2,3], since the nanoscaled non-woven structure is similar to that of native extra cellular matrix. The authors have produced and evaluated nanofibers made from biocompatible and biodegradable polymers for scaffold. Therefore, when nanofiber non-woven mats are used as scaffold, cells would not enter into a scaffold because of its high bulk density in the direction of the thickness.

In this study, authors have contrived a convenient method to make spongiform nanofiber 3-dimensional fabric, which has spaces in moderation for scaffold. The property and tissue compatibility of nanofiber fabric made by this method was investigated.

Methods: Poly (glycolic acid) (PGA, polyglycolide, Sigma-Aldrich, Inc., USA) was dissolved in 1, 1, 1, 3, 3, 3 hexafluoro-2-propanol (Wako Pure Chemical Industries, Ltd., Japan) at concentration of 80 mg/ml. The solution was then loaded into a 5 ml syringe and placed in a syringe pump (Model "11" Plus, Harvard Apparatus, Inc., USA) for metered dispensing at 5 ml/hr. The positive output lead of a high voltage supply (Nippon-Stabilizer Industry Co. Ltd., Japan), set to 30 kV, was attached to a 21 gauge needle on the syringe. Spinning stainless bath filled with t-butyl alcohol (t-BuOH, Wako Pure Chemical Industries, Ltd., Japan) was used as a grounded target. A grounded target was placed 30 cm from the needle tip. Figure 1 shows a schematic diagram of the electrospinning system for the fabrication of spongiform nanofiber fabric.

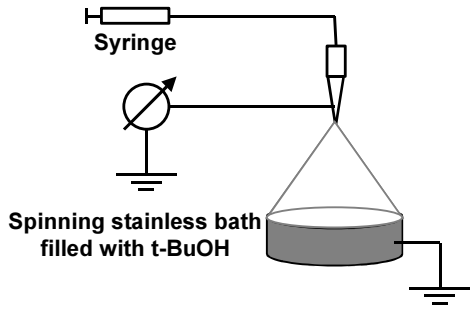

Figure 1. Schematic diagram of the electrospinning system for the fabrication of spongiform nanofiber fabric.

After making nanofibers in the spinning stainless bath via electrospinning method, nanofiber fabric was vacuum-freeze dried using a t-BuOH freeze dryer (VFD-21S, Vacuum Device Inc., Japan) in 1 day. Specimens were punched out from the nanofiber fabric.

The fiber diameter and structure of nanofiber fabric were observed by scanning electron microscope (SEM, JSM-5600LV, JEOL Ltd., Japan).

Results/Discussion: Figure 2 shows a photo and cross-sectional SEM image of PGA spongiform nanofiber fabric made by this study. The nanofiber fabric cinsisted of fibers with diameters ranging from 400 nm to 1500 nm. Most of the fiber diameter are less than 1μm, and the average diameter is 750 nm (± 230 nm). The nanofiber fabric had a spongy structure with large spaces between the nanofibers. Comparing with usual nanofiber non-woven mat, spongiform nanofiber fabric had approximately 1/4 bulk density of that.

As a result of implantation of specimens in vivo, cells proliferated well in the spongiform nanofiber fabric.

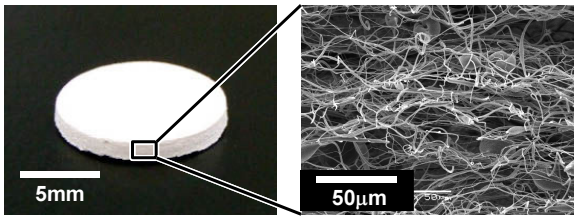

Figure 2. Photo and cross-sectional SEM image of PGA spongiform nanofiber fabric.

Conclusions: PGA spongiform nanofiber 3-dimensional fabric was successfully formed in this study. Spongiform nanofiber fabric had lower bulk density than nanofiber non-woven mats. The resultant spongiform nanofiber fabric could be useful as a scaffold for 3-dimensional tissue culture.

Acknowledgements: This work is supported by Research Promotion Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan. Leading project: Development of artificial organs utilizing with Nanotechnology and materials science.

References:

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