

Preparation and Characterization of Nanofiber Matrices for Tissue Engineering

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INTRODUCTION: Tissue engineering is an exciting and revolutionary strategy to treat patients who need a new organ or tissue. In this approach tissues or organs can be potentially engineered with a number of different strategies, but a particularly appealing approach utilizes a combination of a patient's own cells and polymer scaffolds. Polymer scaffolds act as analogues to the natural extracellular matrices, which can provide a space for new tissue formation and potentially control the structure and function of the engineered tissue.^{1,2}

Various polymers have been utilized to date in tissue engineering. A copolymer of poly(lactic acid) and poly(glycolic acid) (PLGA) is one of the most widely used synthetic polymers.³ Fibroin is a main component of silkworm silk, and has been frequently used in the areas of biomedical science and engineering.⁴ In this study, nanofiber matrices were prepared as synthetic extracellular matrices by electrospinning a solution of either PLGA or silk fibroin (SF), and their characteristics were investigated. The effects of structural changes of the nanofiber matrices on cellular responses were also studied.

METHODS: Nanofibers were prepared by electrospinning a solution of either silk fibroin or PLGA (50:50) dissolved in hexafluoro-2-isopropyl alcohol (HFIP), and were collected on a target drum. A voltage of 16 kV was applied to the collecting target, and the flow rate of the solution was 2 mL/min. A scanning electron microscope was used to investigate morphology of nanofibers. Characteristics of the nanofibers were also investigated using FT-IR, ¹³C solid-state CP/MAS NMR, XPS, and contact angle measurements. Normal human epidermal fibroblasts were cultured in Dulbecco's modified Eagle's medium supplemented with 10% fetal bovine serum. Adhered cells on nanofiber matrices were photographed with an optical microscope, and the number of cells on the matrices was quantified using an MTS solution.

RESULTS: Nanofibrous nonwoven matrices were prepared by electrospinning a regenerated silk fibroin solution, and their mean diameter was 380 nm. Changes in the characteristic absorption peak

of the amide I and II bands of SF nanofibers during water vapor treatment were investigated using time-resolved measurements of IR absorption bands. The water vapor-treated SF nanofiber matrices showed good cellular compatibility, compared with traditional methanol-treated ones. PLGA nanofiber matrices with the mean diameter of 340 nm were also prepared, and treated with plasma in the presence of either O₂ or NH₃ gas. The hydrophilic characteristics of the plasma-treated PLGA nanofiber matrices dramatically increased, and the growth rates of cells on the matrices were also increased, compared with non-treated PLGA nanofiber matrices.

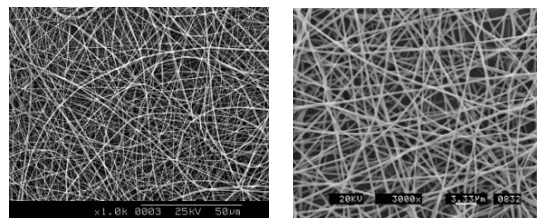


Fig. 1: SEM images of SF (left) and PLGA (right) nanofiber matrices.

DISCUSSION & CONCLUSIONS: Structural changes of PLGA and SF nanofiber matrices treated with plasma and water vapor, respectively, influenced cellular behaviour on these synthetic extracellular matrices. This approach to controlling the adhesion and proliferation of cells by varying chemical and/or physical structures of nanofibers may be useful in the design and tailoring of novel biomaterials for tissue engineering applications.

REFERENCES: ¹ K. Y. Lee, D. J. Mooney (2001) *Chem Rev* **101**:1869. ² J. J. Marler, J. Upton, R. Langer, J.P. Vacanti (1998) *Adv Drug Deliv Rev* **33**:165. ³ R. C. Thomson, et al (1999) *Biomaterials* **20**:2007. ⁴ A. Motta, et al (2004) *J Biomat Sci Polym Edn* **15**:851.

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