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Nanomechanical Properties of Electrospun PLGA Nanofibers

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1 Introduction

The objective of this study was to measure the mechanical properties of electrospun PLGA nanofiber and the microtopographic and force spectroscopy images in real time upon nanoindentation with atomic force microscope (AFM).

2 Materials and Methods

Copolymer Poly (D, L-lactide-co-glycolide) (PLGA) (85:15, PLA:PGA) was commercially purchased and nanofibers were fabricated by electrospinning technique. Force spectroscopy imagines were obtained in contact mode by driving the cantilever tip in the Z plane and were used to calculate the force of indentation represented by the amount of the tip deflection from sample's surface. Cantilevers with a nominal force constant of k = 0.12 N/m and oxide-sharpened Si3N4 tips were used to apply nanoindentation against the fiber's surface. Young's modulus (E) was calculated from force spectroscopy data using the Hertz model, which defines a relationship between contact radius, the nanoindentation load, and the central displacement:

$$E = \frac{3F(1-\nu^2)}{4\sqrt{R}\delta^{3/2}}$$

Where E is the Young's modulus, F is the applied nanomechanical load, ν is the Poisson's ratio for a given region, R is the radius of curvature of the AFM tip, and δ is the amount of indentation.

3 Results

1. PLGA nanofiber fabricated from electrospinning was imaged under SEM (**Fig. 1**). The average diameter of the electrospun PLGA nanofibers was 760±210 nm. The images showed randomly arranged nonwoven PLGA nanofibers.

2. Representative force-volume (FV) images demonstrated surface topography in the Z range of a few hundred nanometers (**Fig. 2A**); FV image (**Fig. 2B**) showed the deflection of the AFM tip in given Z positions from which force plots (**Fig. 2C**) were selected. The deflection of the cantilever tip was plotted as it approached and retracted from the nanofiber surface during extension and retraction of piezo scanner (**Fig. 3**). The Young's modulus E = 42 ± 26 kPa calculated from Hertz model.

3. Human MSC seeded in PLGA nanofiber scaffold remained continuing growing after 7 days (**Fig. 4B**) and showed different cell profiles from the 2D culture (**Fig. 4A**), due to the differentiation of hMSC into osteoblasts (**Fig. 4C**) and chondrocytes (**Fig. 4D**) lineages.

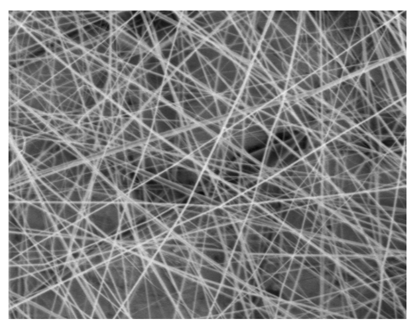

Figure 1

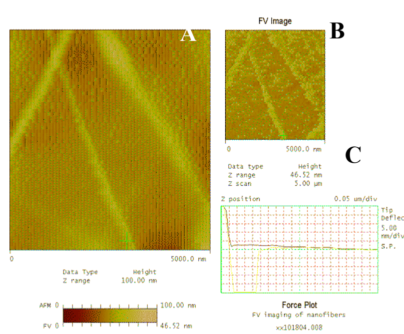

Figure 2

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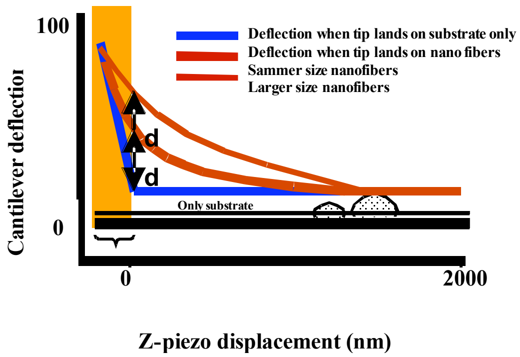

Figure 3

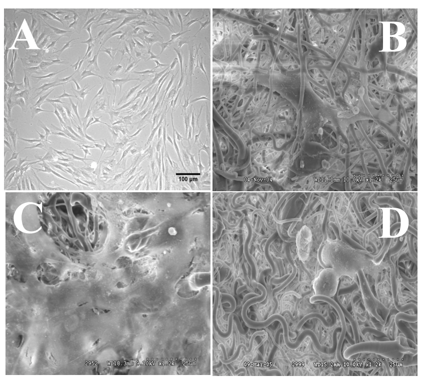

Figure 4

4 Conclusion

Electrospun PLGA nanofiber demonstrated nanoscale features and had a mechanical stiffness that is apparently compatible with cell seeding. How mechanical properties of electrospun nanofibers influence cell behavior such as growth, differentiation and apoptosis warrants additional study.

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