# Poly(ε-caprolactone)/gelatin composite electrospun scaffolds with porous crater-like structures for tissue engineering

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## Statement of Purpose

Electrospinning has been widely used to fabricate scaffolds imitating the topography of cells' natural extracellular matrix (ECM). However, conventional electrospinning techniques produce tightly compacted nanofiber layers with only superficial pores and a lack of bioactivity, which limit the usefulness of electrospinning in biomedical applications. Thus, here we report the development of a porous poly(ε-caprolactone) (PCL)/gelatin composite electrospun scaffold with crater-like structures. Porous crater-like structures (average diameter: 200-400 μm) were created on the scaffold by a gas foaming/salt leaching process which provided an interconnected porous network in the scaffold. In addition, the combination of PCL and gelatin allowed the scaffold to have both the structural stability of PCL and the bioactivity of gelatin. Various ratios of PCL/gelatin (concentration ratios: 100/0, 75/25, and 50/50) composite electrospun scaffolds with and without crater-like structures were characterized by their microstructures, surface chemistry, degradation, mechanical stability, and ability to facilitate cell growth and infiltration. Porous PCL/gelatin composite electrospun scaffolds with crater-like structures are expected to provide a structurally and biochemically improved three-dimensional (3-D) ECM-mimicking microenvironment.

## Research Design and Methods

Electrospun scaffolds were fabricated using different ratios of PCL/Gelatin (three different ratios of PCL/gelatin concentration; 100/0, 75/25, 50/50) at 21kV. Crater-like structures were created by gas foaming/salt leaching process. Scaffolds at varying PCL/gelatin ratios with and without crater-like structures were characterized by the following techniques. Surface topography of scaffolds was visualized using scanning electron microscopy (SEM). Surface chemistry of scaffolds was analyzed using Fourier transform infrared spectroscopy (FTIR). The mechanical stability of scaffolds was measured by Dynamic Mechanical Analyzer (DMA). Human mesenchymal stem cell (hMSC) proliferation on scaffolds was tested using MTS assay. hMSC infiltration through the scaffolds was analyzed by Hematoxylin & Eosin (H&E) staining.

## Results

The crater-like interconnected pores were successfully created on 100/0, 75/25, and 50/50 PCL/gelatin scaffolds. These pores may allow for better cell infiltration and serve as an exchange path for nutrients and metabolic waste throughout the scaffold (Figure 1).

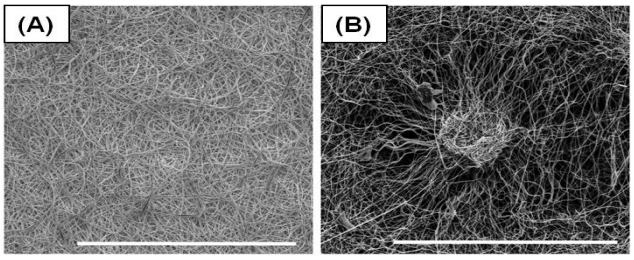


Fig.1. (A) 100/0 PCL/gelatin electrospun scaffold without crater-like structures and (B) with crater-like structures (Scale bar = 300 μm).

75/25 PCL/gelatin composite electrospun scaffolds demonstrated similar mechanical stability and elasticity to the 100/0 PCL/gelatin scaffolds. Surface chemistry and human mesenchymal stem cell (hMSC) proliferation results of the 75/25 PCL/gelatin scaffolds were comparable with the 50/50 PCL/gelatin scaffolds. This indicated the 75/25 PCL/gelatin scaffolds possessed both mechanical stability and bioactivity. All ratios of scaffolds with crater-like structures showed fairly similar surface chemistry, degradation rates, and mechanical properties to equivalent scaffolds without crater-like structures; however, craterized scaffolds displayed higher hMSC proliferation and infiltration throughout the scaffolds after 7 days of culturing (Figure 2).

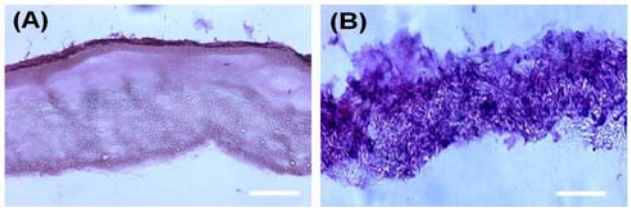


Fig.2. (A) hMSC infiltration through the 100/0 PCL/gelatin scaffold without crater-like structures and (B) with crater-like structures after 7 days of cell seeding (Scale bar = 100 μm).

## Conclusion

We developed a highly porous PCL/gelatin composite electrospun scaffold with crater-like structures as a tissue engineering scaffold. Crater-like structures provide an interconnected porous network within the electrospun scaffold, and gelatin incorporation into PCL allows the scaffold to possess bioactivity as well as structural stability. These characteristics of the composite scaffold enable it to structurally and biochemically replicate the 3-D ECM microenvironment, which provides a novel solution to the current challenges of electrospun scaffolds.

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