Nanoclay Enriched Electrospun Polycaprolactone Scaffolds for Bone Tissue Engineering

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Statement of Purpose: Poly(ε-caprolactone) (PCL), a semi-crystalline and hydrophobic polymer, has been investigated for a range of biomedical applications due to its biocompatibility, bioresorbility and high mechanical strength. PCL is an attractive polymer for bone tissue engineering, as it can be used to fabricate a wide range of scaffold materials. However, one of the problems with PCL is its slow *in vivo* degradation and lack of bioactivity. Here, we report synthesis, fabrication and characterization of nanoclay-enriched electrospun PCL scaffold. We hypothesize that addition of nanoclay will induce bioactivity of PCL scaffold and will facilitate scaffold degradation. The nanoclay used in this study is organically modified layered magnesium aluminum silicate platelets with 70-150 nm in diameter and 1 nm in thickness. A range of electrospun PCL scaffolds with different concentrations of nanoclay was obtained. The effect of nanoclay on fiber morphology, degradation rate, and *in vitro* bioactivity was investigated.

Methods: The fibrous scaffold was obtained using the electrospinning technique, in which PCL solution with the nanoclay was subjected to high voltage as shown in the Figure 1a. The fiber morphology was evaluated by scanning electron microscopy (SEM). Accelerated *in vitro* degradation of was performed by incubating the scaffold in 0.5 mM sodium hydroxide (NaOH) solution at 37 °C. The *in vitro* cell culture studies were done using the human mesenchymal stem cells (hMSCs). Alkaline phosphatase (ALP) was measured using a colorimetric endpoint assay.

Results: A range of electrospun scaffolds was fabricated by varying the nanoclay concentrations (0, 1 and 10% nanoclay) within the PCL scaffolds. The addition of nanoclay results in decrease in fiber diameter and increase in surface roughness of the electrospun fibers (Figure 1b). The enrichment of PCL scaffolds with nanoclay promote *in vitro* biomineralization in simulated body fluid (SFB) indicating bioactive character of the hybrid scaffolds. The slow degradation rate of PCL was also improved by the addition of nanoclay (Figure 2a). The feasibility of using nanoclay enriched PCL scaffold for tissue engineering applications is evaluated by using human mesenchymal stem cells (hMSCs). The addition of nanoclay significantly enhances attachment, proliferation and differentiation of hMSCs on the electrospun scaffolds. A significant increase in alkaline phosphatase activity was observed at higher silicate concentration (Figure 2b).

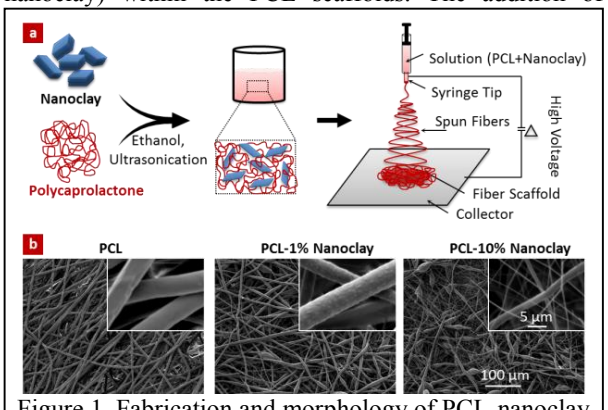

Figure 1. Fabrication and morphology of PCL-nanoclay scaffolds. The addition of nanoclay results in a decrease in fiber diameter and an increase in surface roughness.

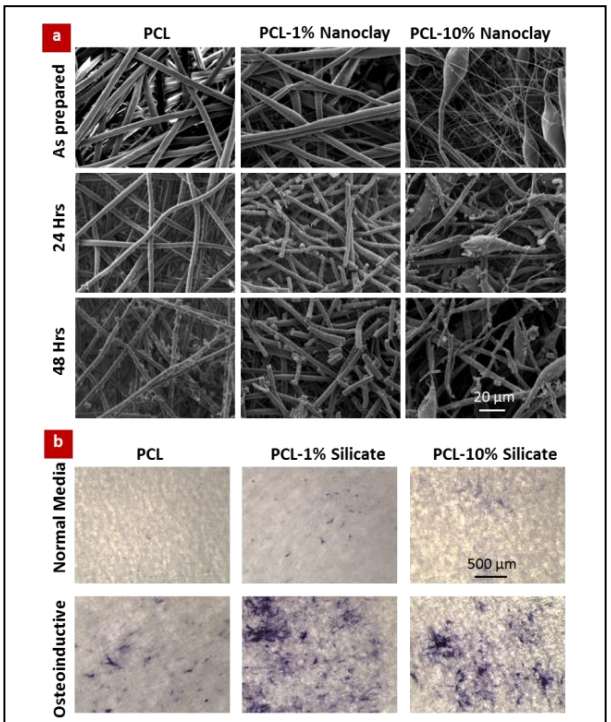

Figure 2. (a) *In vitro* bioactivity of PCL-nanoclay scaffold in SBF. (b) Upregulation of ALP was observed in hMSCs at higher nanoclay concentration.

Conclusions: A range of nanoclay enriched PCL scaffolds were obtained using electrospinning. The effect of nanoclay on surface morphology, *in vitro* biomineralization, degradation characteristics, mechanical properties and cellular interactions were evaluated. Overall, nanoclay enriched PCL scaffold can potentially be used for bone tissue engineering applications.