# Controlled Mineral Coatings on PCL Films

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**Statement of Purpose:** A variety of active proteins and peptides have therapeutic potential for bone regeneration. However, the lack of suitable long term delivery systems limits the therapeutic use of these novel protein based drug systems. In some cases the required protein dosage is too high due to poor delivery and therefore increases the cost and limits its use in the clinical setting. One potential mechanism for controlling protein release could involve development of inorganic coatings that incorporate and release therapeutic proteins. In this study, we begin to develop an approach for protein release from calcium phosphate mineral coatings on poly(ε-caprolactone) (PCL) materials. Changes in the surface functionalization of PCL films prior to mineral nucleation were investigated here for the nucleation of different morphologies of a calcium-phosphate mineral, which we hypothesized would exhibit different dissolution rates and ultimately different protein release profiles.

**Methods:** PCL films were fabricated using solvent casting and mineralized by incubation in modified simulated body fluid (mSBF), which is a solution with similar ionic composition and temperature of blood plasma. Prior to mSBF incubation, PCL films were hydrolyzed to expose carboxyl groups on the films using different concentrations of NaOH (0.1M, 0.5M, 1.0M) or different exposure periods (60, 90, 180 minutes). The morphology and temporal analysis of mineral growth was characterized using scanning electron microscopy (SEM), and the mineral phase was determined with x- ray diffraction (XRD). Mineral dissolution was measured by incubating the mineral coated films in a 1.0M Tris, 80µM NaCl buffered to physiological pH, and determining the calcium and phosphate concentration in solution over time.

**Results:** Incubation of films exposed to different hydrolysis conditions in mSBF, resulted in the nucleation of calcium phosphate mineral layers that exhibited different morphologies (Fig. 1). SEM data also demonstrated that for most of the conditions, a two week incubation period was sufficient for the formation of a continuous mineral coating (Fig. 2). Based on XRD data, the mineral nucleated on the films was identified as hydroxyapatite (Fig. 3). The dissolution rate of the mineral, represented here by the release of calcium ions over time in buffer, showed significant differences among the different experimental groups (Fig. 4).

**Conclusions:** Current results demonstrate that it is possible to nucleate different morphologies of a hydroxyapatite mineral by changing the hydrolysis pre treatment of PCL films. Dissolution of the mineral layer varies based on PCL pre-treatment, which implies that it may ultimately be possible to obtain different release profiles of proteins incorporated into these coatings. Such a system could be used in bone tissue engineering for the release of therapeutic proteins and peptides.

**Figures:**

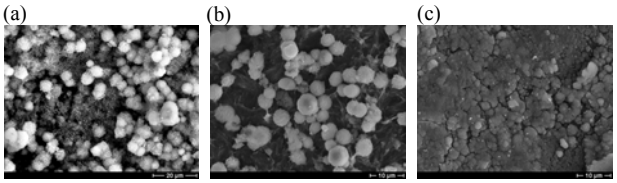


Figure 1: SEM micrographs showing the morphology of mineral nucleated after 14 days of incubation in mSBF on PCL films that were hydrolyzed for 180 minutes at different (a) 0.1M NaOH (b) 0.5M NaOH (c) 1.0M NaOH

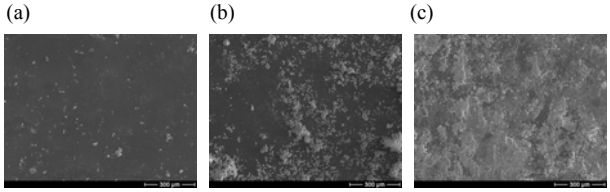


Figure 2: Temporal study of mineral growth. SEM micrographs taken after (a) 7days, (b) 10 days, and (c) 14 days of incubation in mSBF.

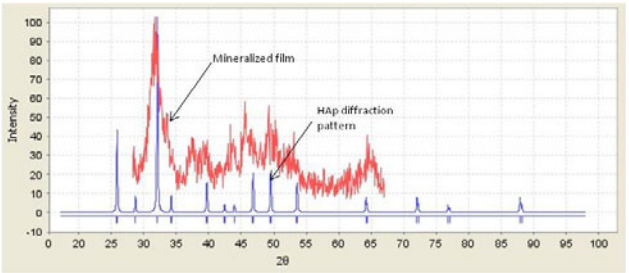


Figure 3: X-Ray diffraction pattern of samples hydrolyzed at 1.0M NaOH for 180 minutes.

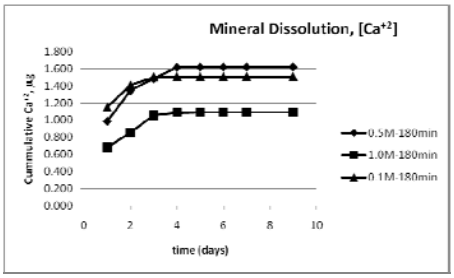


Figure 4: Mineral dissolution in a 1.0M Tris solution