PULSED LASER DEPOSITION OF MAGNESIUM-DOPED CALCIUM PHOSPHATE COATINGS ON POROUS POLYCAPROLACTONE SCAFFOLDS PRODUCED BY RAPID PROTOTYPING

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Introduction

Polycaprolactone (PCL) is a popular polymer in tissue engineering (TE) due to its degradability and low melting point, allowing easy processing into porous 3D structures by methods such as BioPlotting®, a rapid prototyping technique. Thus allows layer-by-layer production of scaffolds with highly defined dimensions and internal architecture (e.g. porosity, pore size). However, poor cell attachment and proliferation on PCL necessitates surface modification. In this study, PCL scaffolds were coated with calcium phosphate (CaP) using pulsed laser deposition (PLD). PLD has been used to coat metallic biomaterials, but PLD coating of polymeric biomaterials remains relatively unexplored. PLD permits doping with elements such as magnesium (Mg) without adversely affecting stability and biocompatibility of CaP coatings. Positive effects of Mg enrichment of inorganic biomaterials *in vitro* have been reported.

Materials and Methods

Porous scaffolds of PCL of dimensions 1 cm x 1 cm, pore side length 0.5 mm were prepared using a Bioscaffolder device (Sys-Eng) as described previously [1] (FIG. 1).

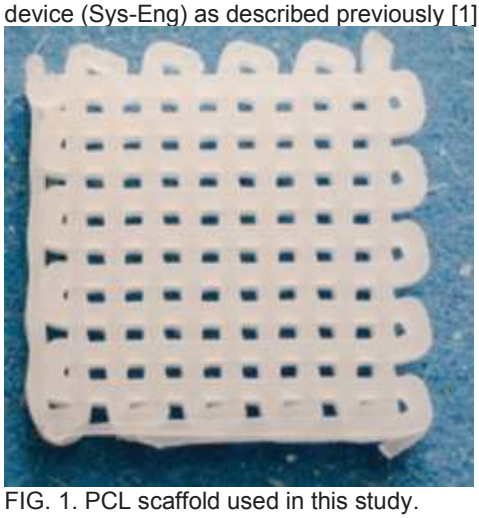

FIG. 1. PCL scaffold used in this study.

Production of hydroxyapatite (HA) and HA+Mg (0.6 w/w %) targets and their deposition by the PLD method was performed as described previously [2]. Three sample groups were prepared: uncoated PCL, PCL coated with CaP and PCL coated with CaP+Mg. Coatings were analysed physicochemically by SEM, EDS and ATR-FTIR and biologically using Saos-2 osteoblast-like cells.

Results and Discussion

SEM images (FIG. 2) showed that coatings were adherent to the substrate. CaP and CaP+Mg coatings were similar, so Mg did not affect coating morphology.

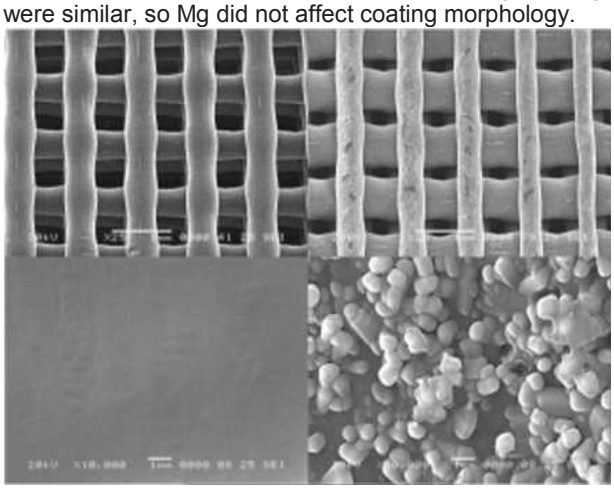

FIG. 2. SEM images of uncoated PCL scaffold (left) and scaffold coated with CaP using PLD (right).

EDS analysis demonstrated the absence of Mg on uncoated scaffolds. CaP+Mg-coated scaffolds contained 0.59±0.13% mass percentage of Mg. ATR-FTIR analysis also proved CaP coating deposition. Spectra of PCL scaffolds coated with CaP and CaP+Mg also showed no obvious differences, demonstrating that magnesium did not significantly influence the type of CaP phase formed.
Confocal microscopy on day 3 after seeding revealed well spread cells homogenously distributed on the sample struts. The overall relative activity of ALP was significantly higher on samples coated with CaP+Mg than on all other samples (FIG. 3).

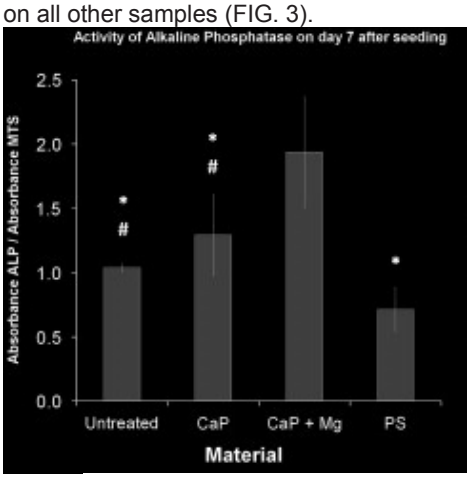

FIG. 3. Activity of alkaline phosphatase (ALP).

Conclusions

CaP and CaP+Mg coatings were successfully deposited by PLD at room temperature on porous PCL scaffolds fabricated by rapid prototyping. All PCL scaffolds supported Saos-2 cell attachment and growth. Activity of the early osteogenic differentiation marker ALP was highest on samples coated with CaP+Mg. The results show that CaP coatings can improve behaviour of bone cells seeded on PCL with a view to bone TE.

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References

[1] Jacobs et al. Surf Coat Technol, 232 (2013), 447–455.
[2] Mroz et al. Micron, 40 (2009),140–142.