Poly(ε-caprolactone)- based scaffolds functionalized with an antimicrobial agent

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INTRODUCTION

Despite the rapid development of medical sciences, tissue transplantation still faces limitations such as prolonged healing and impaired functionality of regenerated tissues. Tissue engineering, particularly the use of scaffolds, offers a promising solution by providing a three-dimensional environment that supports cell adhesion, proliferation, and differentiation. In this study, poly(ε-caprolactone)-based scaffolds were fabricated using solvent casting/particulate leaching and 3D printing methods, followed by functionalization with a clindamycin phosphate solution.

RESEARCH METHODOLOGY

Sample designation



PCL_SCPL- scaffolds fabricated by SC/PL method



PCL_3D_15- 3D- printed scaffolds with 15 % infill density

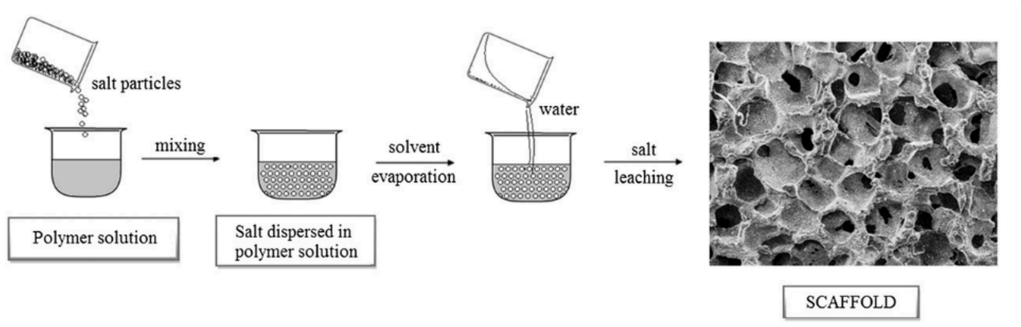


PCL_3D_20- 3D- printed scaffolds with 20 % infill density



PCL_3D_25- 3D- printed scaffolds with 25 % infill density

Fabrication using the solvent casting/particulate leaching (SC/PL) method



H. Janik and M. Marzec, "A review: Fabrication of porous polyurethane scaffolds," Mar. 01, 2015, Elsevier Ltd. doi: 10.1016/j.msec.2014.12.037

Fabrication using 3D printing via fused filament fabrication method

Hexagonal tissue scaffolds with 15 %, 20 %, 25 % infill densities were designed in PrusaSlicer and fabricated using PrusaMK3S+ 3D printer.

Optical microscopy

Micrographs were taken using Delta Optical Genetic Pro microscope at 5x and 10x magnifications, and pore diameters were determined based on the images. Porosity was calculated using the formula:

$$P = \left(1 - \frac{m}{\rho_L \cdot V}\right) \cdot 100\%$$

P- average porosity [%], m- average mass of tissue scaffold [g], ρ_L- average density of solid material (PCL) [g/cm³], V- average volume of tissue scaffold [cm³]

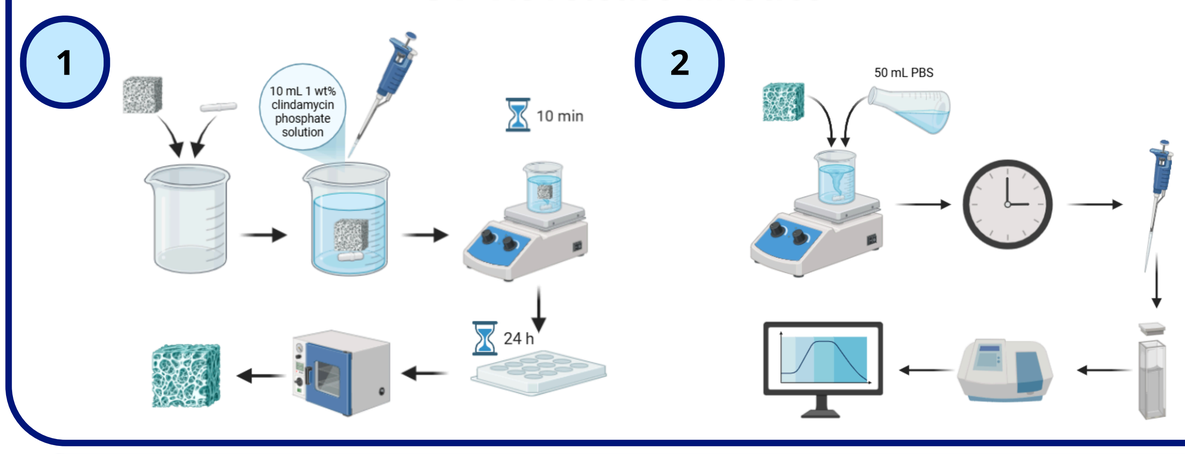
Compression testing

Scaffolds were subjected to compressive strength testing according to ISO 604 using a Zwick/Roell Z020 universal testing machine at a maximum deformation of 50%.

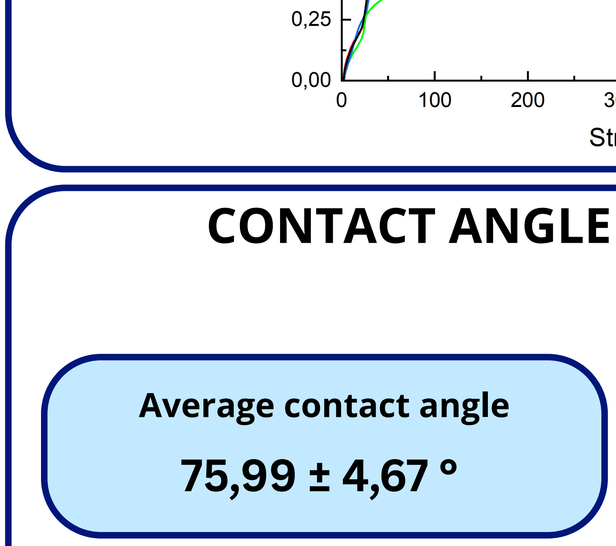
Contact angle measurements

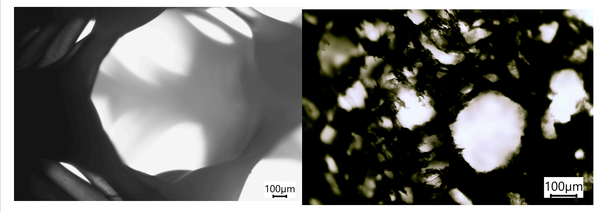
The water contact angle was measured using a Rame-Hart 90-U3-PRO goniometer employing the sessile drop method.

Modification with clindamycin phosphate solution and UV-Vis release kinetics



OPTICAL MICROSCOPY

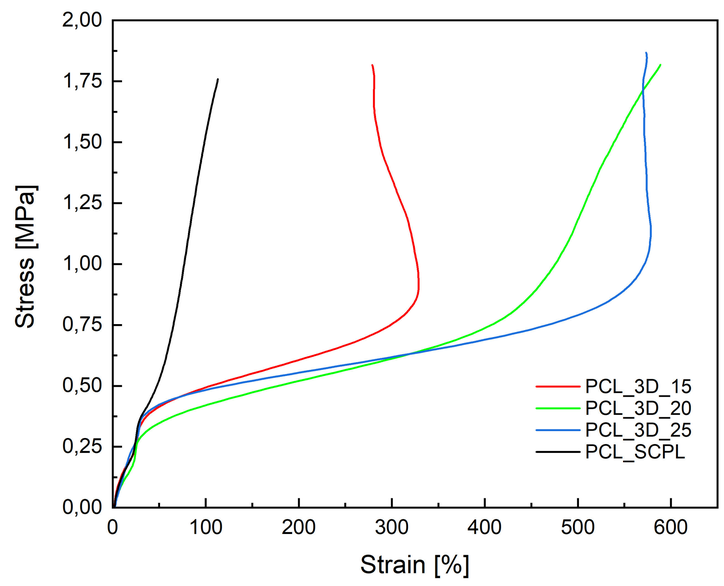




Average porosity

78,69 ± 0,02 %

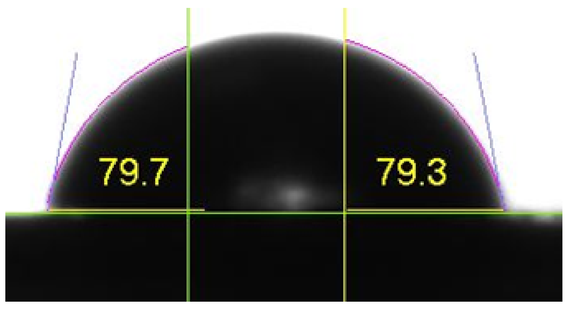
COMPRESSION TESTING



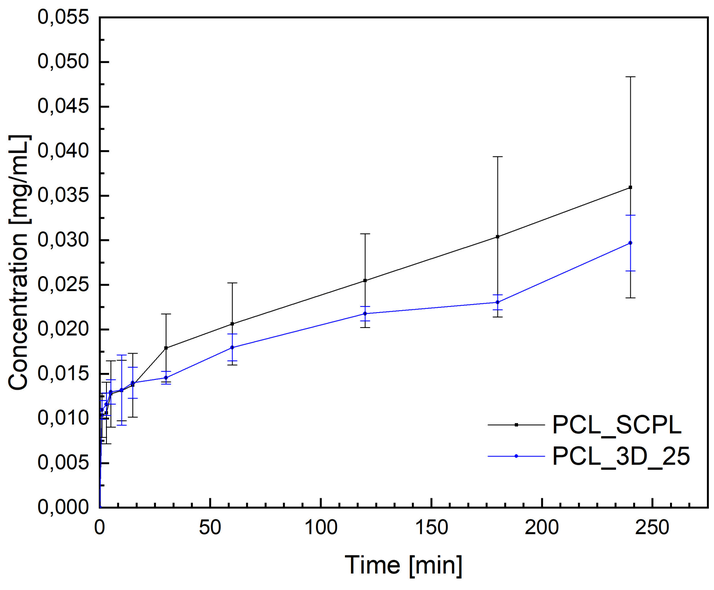
CONTACT ANGLE MEASUREMENTS

Average contact angle

75,99 ± 4,67 °



MODIFICATION WITH CLINDAMYCIN PHOSPHATE SOLUTION AND UV-VIS RELEASE KINETICS



The results indicate that the fabrication method significantly influences scaffold properties, enabling precise tailoring to specific clinical applications through the selection of polymer, fabrication technique, and appropriate modifications. Consequently, scaffolds can serve as personalized therapeutic tools, optimized for individual treatment needs, including the introduction of antibiotics or other bioactive agents.