# Surface Modification Of Tissue Engineering Scaffold Using Laser Processing

By

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# ABSTRACT

Tissue engineering is a recent and promising area of research in which efforts are being made to generate tissue substitutes that can replace the human tissue in its shape and function in case of organ or tissue failure. The scaffold should have certain properties to be useful for tissue engineering purposes and allow the biological cells to divide and grow over the scaffold. From these properties, the scaffold should be fabricated from biodegradable and nontoxic polymers. The nanoscale topography of the scaffold's surface strongly influences cell function, adhesion and proliferation.

In this study, modification of PCL scaffold surfaces using specific excimer laser beam parameter produced formation of highly distributed, regular ripple on the scaffold surface with size range from 200-600 nm , the water contact angle measurement , FTIR spectroscopy , roughness and surface analysis using SEM and AFM ,biodegradation test, In vitro biological testing imaging showed enhancement of the surface roughness, surface wettability which in turn enhanced cell attachment , proliferation and the degradation rate of the scaffold .

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# List of Abbreviations

| Abbreviation | Meaning |
|---|---|
| TE | Tissue engineering |
| PCL | Polycaprolacton |
| PDGFs | Platelet derived growth factors |
| TGF-β | Transforming growth factor β |
| VEGF | Vascular endothelial growth factor |
| EGF | Epidermal growth factor |
| ECM | Extracellular matrix |
| PLLA | Poly(L.lactide) |
| PGA | Poly(glycolic acid) |
| PLGA | Poly(L.lactide) and poly(glycolic acid) copolymer |
| HA | Hydroxyapetite |
| β-TCP | β-tricalcium phosphate |
| CO2 | Carbon dioxide |
| 2-D | Tow dimensional |
| 3-D | Three dimensional |
| SFF | Solid freeform fabrication |
| CAD | Computer-aided design |
| CT | Computerized Tomogaraphy |
| MRI | Magnetic Resonance Imaging |
| 3DP | Three Dimensional Printing |
| SLA | Stereolithography |
| FDM | Fused Deposition Modeling |
| *T*m | Milting temperature |
| *T*g | Glass transition temperature |
| ° C | Degree Celsius |
| h | Hour |
| UV | Ultra violet |
| RGD | Arginine-glycine-aspartate |
| RFGD | Radio frequency glow discharge |
| SAM | Self assembled monolayer |
| μCP | Microcontact printing |
| LB | Langmuir–Blodgett Deposition |
| LSE | Laser Surface Engineering |
| °K | Degree Kelvin |
| s | Second |

| Abbreviation | Meaning |
|---|---|
| Ti | Titanium |
| KrF | krypton fluoride |
| ArF | argon fluoride |
| RM | Resolidified material |
| MW | Average molecular weight |
| DMEM | Dulbecco's Modified Eagles Medium |
| SBF | Simulated body fluid |
| PBS | Buffer phosphate saline |
| r.p.m | Revolution per minute |
| PRF | Pulse repetition frequency |
| No. | Number |
| SEM | Scanning Electron Microscope |
| AFM | Atomic Force Microscopy |
| STM | Scanning tunneling microscopy |
| DSC | Differential Scanning Calorimetry |
| FTIR | Fourier transform infrared spectroscopy |
| Ra | Average plane roughness |
| vs. | Versus |
| O.D | Optical density |

# PREFACE

Tissue engineering (TE) is a new discipline that has made rapid advances in medical applications. TE holds promises of eliminating re-operations by using biological substitutes to solve problems of implant rejection, cross infections associated with xeno-grafts and allografts, and shortage in organ donation. Development of suitable biodegradable materials and scaffolds for seeding cells is the key of Tissue engineering. Synthetic polymers such as Polycaprolactone (PCL) are used for tissue engineering applications. PCL is highly degradable via hydrolytic mechanisms under physiologic conditions. PCL is increasingly used in tissue engineering applications due to their safety, degradability and osteoconductivity. The main disadvantage of PCL is its low cell adhesion potential. There are many methods for scaffold fabrication; chemical methods as foaming, freeze dryer, phase separation, physical methods as laser sintering, prototype machine and compression. Herein a PCL scaffold was fabricated via uniaxial compression.

The aim of this work is to modify the surface of the PCL scaffold using different laser parameters in order to increase the cell adhesion potential which greatly influences the cell proliferation and differentiation.

The thesis consists of five chapters organized as follows: An introduction to the areas related to this work is given in the first chapter. This includes a brief introduction to Tissue engineering.

In chapter two, a review to the previous work and the trials to surface modification of scaffold materials are presented. The Review covers the work conducted by researchers to modify the surface of tissue engineering

scaffolds from 19… to 2011. Chapter two also presents in details the laser surface modification trials and ends with the objective of this study.

The materials used in this work together with the methods applied for surface modifications are explained in details in chapter 3.

In chapter four, the results obtained from this work are presented in details. A full discussion of these results is also presented in the same chapter.

Finally the thesis ends with a conclusion and suggestion for future work are given in chapter five which is followed by the list of references and the appendixes.

# Chapter 1

# Introduction

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