

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	Hydroxyapatite
β -TCP	β -tricalcium phosphate
CO ₂	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
μ CP	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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