SURFACE FUNCTIONALIZATION OF OPEN-CELL STRUCTURES WITH DLC COATINGS

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[ENGINEERING OF BIOMATERIALS 163 (2021) 37]

Introduction

Porous structure is a universal term used to describe the size, distribution and morphology of pores of a material. Porous structures can be classified by porosity types (closed and open pores) and by the arrangement of elementary cells (stochastic and non-stochastic) [1,2].

In recent years, there has been increased interest in additive manufacturing porous structures for biomedical applications. In this direction, the usefulness of structures with the triply periodic minimal surfaces (TPMS) topology was investigated [3-5].

The architecture of the implant (pores size, shape, volume fraction and distribution) affects not only mechanical properties. It also has a significant impact on ensuring the correct integration of the implant into the biological environment through the process of osseointegration and neovascularization [6,7].

In fact, not only the mechanical properties and porous structure are important in the osseointegration process. Surface properties such as roughness, antytrombogenicity and the prevention of pathogens adhesion play an important role in in the process of bone osseointegration.

Materials and Methods

In this study, nTopology (nTopology GmbH, Germany) software was utilized to design the cylindrical mapped TPMS lattice structures with shell gyroid unit cells.

The samples were fabricated using a ORLAS CREATOR® selective laser melting (SLM) machine. from 316L austenitic stainless steel powder with an average particle size of 45±15 μm, which was produced in gas atomized process by Oerlikon Metco Inc., USA (MetcoAdd^{TM} 316L-A).

The surface of the samples was modified with the use of DLC coating.

Due to the complex open-cell structure of the samples, it is necessary to analyse the degree of surface coverage by the layer. Coating tests were included, inter alia, the study of morphology with the use of the digital optical microscopy, confocal microscopy, scanning electron microscopy with EDS analysis (SEM-EDS), crystallographic structure and chemical composition with the use of the X-ray diffraction (XRD) and scratch test and microhardness test. The biological examined the cytotoxicity and bactericidal properties of DLC modified metallic samples compared with and non-modified.

Results and Discussion

The preliminary results show the differences between the samples covered by DLC coatings in compared with non-modified in mechanical properties and surface morphology.

Conclusions

The DLC coatings onto metal samples obtained by selective laser melting (SLM) method create possibilities to manufacturing biocompatible biomaterial with controlled surface activity.

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