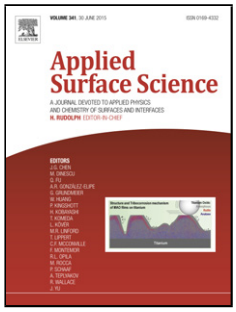
Accepted Manuscript



Title: Femtosecond laser-induced ripple patterns for homogenous nanostructuring of pyrolytic carbon heart valve implant

Authors: Bogusz Stępak, Paulina Dzienny, Volker Franke, Piotr Kunicki, Teodor Gotszalk, Arkadiusz Antończak

PII: S0169-4332(17)33597-3
DOI: https://doi.org/10.1016/j.apsusc.2017.12.016
Reference: APSUSC 37886

To appear in: *APSUSC*

Received date: 4-7-2017
Revised date: 13-11-2017
Accepted date: 3-12-2017

Please cite this article as: Stępak B, Dzienny P, Franke V, Kunicki P, Gotszalk T, Antończak A, Femtosecond laser-induced ripple patterns for homogenous nanostructuring of pyrolytic carbon heart valve implant, *Applied Surface Science* (2010), https://doi.org/10.1016/j.apsusc.2017.12.016

Femtosecond laser-induced ripple patterns for homogenous nanostructuring of pyrolytic carbon heart valve implant

Bogusz Stępak[1*], Paulina Dzienny[1], Volker Franke[2], Piotr Kunicki[3], Teodor Gotszalk[3], Arkadiusz Antończak[1]

1 –Faculty of Electronics, Wrocław University of Science and Technology, Wyb. Wyspianskiego 27, 50-370, Wrocław, Poland; 2 –Fraunhofer-Institute for Material and Beam Technology IWS, Business field Microtechnologies, Winterbergstraße 28, D – 01277 Dresden, Germany; 3 – Faculty of Electronics Microsystems and Photonics, Wrocław University of Science and Technology, Wyb. Wyspianskiego 27, 50-370, Wrocław, Poland; *corresponding author: bogusz.stepak@pwr.edu.pl

Highlights

- The formation of LIPSS under femtosecond laser irradiation on PyC is investigated.
- The irradiation conditions of transition between HSFL and LSFL is shown.
- Structures with periodicity smaller than 100 nm were obtained.
- The most suitable parameters for uniform structuring large areas are established.
- EDX and Raman spectroscopy are used to determine change in elemental composition.

ABSTRACT

Laser-induced periodic surface structures (LIPSS) are highly periodic wavy surface features which are frequently smaller than incident light wavelength that bring possibility of nanostructuring of many materials. In this paper the possibility of using them to homogeneously structure the surface of artificial heart valve made of PyC was examined. By changing laser irradiation parameters such like energy density and pulse separation the most suitable conditions were established for 1030 nm wavelength. A wide spectrum of periodicities and geometries was obtained. Interesting side effects like creating a thin shell-like layer were observed. Modified surfaces were examined using EDX and Raman spectroscopy to determine change in elemental composition of surface.

Keywords: femtosecond laser, heart valve, LIPSS, ripples, nanostructuring, surface modification

1. Introduction

Frequently observed laser induced periodic surface structures (LIPSS) consist of regular wavy structures referred to as ripples [1], periodic patterns or self-organizing nanostructures [2]. Their formation is sometimes compared with aeolian processes observed in everyday life such as wavy patterns on a sand created by wind [3]. Amplitudes and periodicity of laser induced ripples are in the nanometer range thus they are much smaller than laser beam diameter. Although it is widely known that they can be obtained on any material, including metals [4, 5], semiconductors [6-8], dielectrics [9-11], polymers [12, 13] and carbon-based materials [14-16], phenomena of their formation is not yet fully explained.

In the literature, there are several types of LIPSS distinguished. Frequently observed are low spatial frequency (LSFL) and high spatial frequency (HSFL) LIPSS. The first type, sometimes called "regular ripples" [2] have spatial periodicity Λ close to the laser wavelength λ and their orientation is