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Titanium Oxynitride Coatings Deposited By Magnetron Sputtering For Improvement Of Cardiovascular Stent Design

Oana Cristina Duta[1], Denisa Ficai[1], Anton Ficai[1], Ecaterina Andronescu[1], Nataliia Beshchasna[2], Muhammad Saqib[2], Jörg Opitz[2], Honorata Kraśkiewicz[3], Łukasz Wasyluk[3], Oleg Kuzmin[4], Vladimir Pichugin[5]

[1] University Politehnica of Bucharest, Faculty of Applied Chemistry and Material Science
1-7 Polizu St., Bucharest, Romania
oana_cristina_duta@yahoo.com
[2] Fraunhofer Institute for Ceramic Technologies and Systems
Maria-Reiche Street 2, 01109, Germany
[3] Balton Sp. z o.o.
Modlińska 294, 03-152 Warsaw, Poland
[4] VIP Technologies
Prospect Academicheskiy 8/2, 634055, Tomsk, Russian Federation
[5] Tomsk Polytechnic University
Lenin Avenue 30, 634050 Tomsk, Russian Federation

Extended Abstract

In the most cases, vascular stents are made of metals and can suffer insufficient biocompatibility being in contact with living tissue. This translates in cell toxicity, protein and platelet adhesion or fibroblast growth [1]. In order to overcome these disadvantages stent coatings are used. Among various coating materials used for improving of the stent perormance noble metals, polymers, drugs, biological agents, organic materials and ceramics have been applied [2].

Titanium oxynitride (TiO_xN_y) coating presents a good oportunity to significantly reducing major drawbacks of bare metal stents based on the excellent biocompatibility of titanium [3, 4]. The presence of nitrogen in the coating structure leads to increase of platelet adhesion and fibrinogen binding [4]. TiO_xN_y coating also prevents a migration of nickel, molibden, chromium and other metals from the stainless steel scaffold. Such coatings with protective and bioactive potentials can be efficiently deposited via plasma techniques, in particular, magnetron sputtering.

The aim of this work was to develop a new type of stent with improved characteristics, made of stainless steel coated with TiO_xN_y film deposited at different O_2:N_2 ratio (1:2; 1:5 and 1:10) in a reactive atmosphere of abnormal magnetron discharge. Argon (Ar) has been used as a plasma-forming gas.

A very important aspect that must be taken into acount when an artificial implant is put in contact with the living tissue is the way it reacts with the body fluids, proteins and amino acids adsorbtion may occur. To determine if these coatings allow the protein adhesion on the surface, the stents obtained were immersed in simulated body fluid with the pH of blood (7.4) that contains albumin, the major protein found in human blood, at the normal body temperature (36.5ºC) for 1, 3, 7, 14 and 28 days. The surfaces were analysed by FT-IR microscopy and the images were recorded according to the peak from 840 – 884cm^{-1}. In all cases, large area are scanned in order to obtain significant results. FTIR microscopy was used especially to analyse the surface of the titanium experimental models coated with TiO_xN_y. The release of the ions was also monitored by ICPMS.

The O_2:N_2 ratio induce different morphology of the depositions, especially grain size and protein adhesion from albumin supplemented SBF. Once with the increasing of the nitrogen content, the adsorption of albumin decreases significantly. The best results are obtained for the samples TiO_xN_y having a O_2:N_2 ratio of 1:1 where, practically, no protein or salts deposition occurs after 8 or only limited depositions at the wrists are where some detaching appear. These data open new perspectives in using these titanium oxynitrides as coating materials for stents and other metallic implants where limited/selective adsorption are needed to avoid the failure of the implants.

Keywords: Titanium Oxynitride, Magnetron Sputtering, Surface Properties, Protein Adsorption, Stability In Simulated Body Fluids, Microscopic Evaluation By FTIR.

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