BIOLOGICAL EVALUATION AND SURFACE PROPERTIES OF Ti-DLC COATINGS DEPOSITED BY MAGNETRON SPUTTERING

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Abstract

During the last few decades, a growing demand for medical implants may be observed on the market. This is a consequence of both the increasing number of people suffering from disabilities as well as technological development. As a result of growing number of trauma injuries, orthopaedic and bone implants are one of the branches of the medical device industry showing the fastest growth opportunities. However, the commonly applied metallic implants do not exhibit total chemical stability in human body environment and hence, possess relatively poor surface properties [1]. For that reason, even the corrosion resistant metals may release degradation products and cause adverse biological response[1]. Consequently, surface modifications of metallic implants which enhance the biological response of the human body towards the surface of the implant are recently gaining a lot of interest.

One of the most extensively studied solutions include the application of diamond-like carbon (DLC) coatings which exhibit a combination of highly desirable properties in the context of biomedical applications [2]. Furthermore, the properties of DLC coatings, such as cell behaviour and body reaction towards its surface, may be further improved by doping with various elements [3]. Therefore, the modified DLC coatings are nowadays extensively researched in terms of their possible medical applications.

In the case of orthopaedic implants the enhancement of the osseointegration process is highly desirable in order to assure the proper bone-healing, what according to the literature may be achieved by the addition of titanium (Ti). The incorporation of Ti into the DLC matrix does not only promote the bone marrow cells proliferation, but also simultaneously reduces the activity of the osteoclast-like cells as indicated by Shroeder et al. [4]. Similarly, also Thorwarth et al. demonstrated that carbon coatings containing TiO exhibit promising results concerning the proliferation and differentiation of human osteoblasts [5].

Nevertheless, in spite of the numerous studies considering the biological behaviour of Ti-incorporated DLC coatings, there is lack of conclusive reports considering the biological applications of coatings deposited by a magnetron sputtering technique. Taking this into consideration, a complex biological evaluation of Ti-DLC coatings followed by their surface characteristics was performed, since surface properties have a direct role in different post-implantation reactions including protein adsorption and cell proliferation [1].

The examined coatings were deposited on two commonly applied metallic biomaterials (AISI 316 LVM steel and Ti6Al7Nb alloy) using a magnetron sputtering technique. The surface characteristics of the deposited Ti-DLC coatings included the analysis of surface morphology (SEM), chemical composition and structure (XPS, FTIR) as well as surface wettability and surface free energy (sessile drop technique and Owens-Wendt's model). The biological assessment of the deposited coatings was based on two complementary cell proliferation and viability assays (LIVE/DEAD and XTT test) performed with the use of two different cell lines, i.e. endothelial cells line EA.hy926 and osteoblast-like cells line Saos-2.

The obtained results allowed to check the influence of titanium on the biological response of two different cell lines towards the Ti-DLC coatings deposited using magnetron sputtering method as well as to correlate the obtained results with the surface properties of the investigated coatings.

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