EVALUATION OF CORROSION RESISTANCE OF MAGNETRON SPUTTERED DOPED DLC COATINGS WITH USE OF SALT SPRAY TECHNIQUE

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[ENGINEERING OF BIOMATERIALS 138 (2016) 104]

Introduction

Use of the implants, especially metallic ones is connected with several problems such as release of ions or wear debris to the surrounding tissues [1], formation of pathogenic biofilm [2], pure integration with host organism etc. Among the common ways of overcoming those obstacles is the use of various surface finishing methods. Deposition of diamond like carbon (DLC) on biomaterials becomes a promising solution because of the high mechanical properties and biocompatibility of such coatings [3,4]. Further evolution of that approach involves doping of synthetized films in order to tailor its properties in the desired fields. Nevertheless, still one of the key aspects of all the coatings is its uniformity and barrier properties preventing for example corrosion.

The corrosion can lead to the deterioration of structural integrity of the implant and resulting from that reduction of mechanical properties [5], but also invoke dangerous modifications in the body of the patient [6]. Released to the organism corrosion products act both locally, causing severe pathomorphological changes in implant-surrounding tissues, and systemically - affecting organs detoxification.

One of the many approaches enabling to evaluate the corrosion resistance of the materials involves use of salt spray technique. The following study comprised such investigation conducted on novel magnetron sputtered doped DLC coatings deposited on austenitic stainless steel AISI 316 LVM.

Materials and Methods

Deposition of DLC and doped DLC coatings was conducted on cylindrical samples made of AISI 316LVM. Specimens of 16mm in diameter and 6mm of height were mechanically grinded and polished and afterwards ultrasonically cleaned in acetone for 10 minutes.

All the coatings were deposited with use of multi-target DC-RF magnetron sputtering system with two graphite and one target made of pure dopant: Si or Ti (all from Kurt j. Lesker Company). The pure carbon film was deposited at 0.6 Pa pressure in the reaction chamber, 10 sccm of Ar and 200W deposition power (for both graphite targets). The amount of dopant was changed by varying the sputtering RF power on dopant's target.

The corrosion resistance of coated metallic samples and uncoated substrate material was performed in salt spray corrosion S120ip machine (Ascott Analytical Equipment). Before placing the specimens into the salt spray chamber, they were cleaned in deionised water (10 min) and acetone (15 min) with the use of ultrasonic cleaning bath. The corrosive environment was 5% sodium chloride solution sprayed with the flow rate of 20 ml/min. The temperature in the chamber was constant and equal to 37°C. The total time of the corrosion test was 4 weeks. To evaluate the surface properties and possible corrosion symptoms, samples underwent investigation with use of microscopic observation (inverted metallographic microscope Eclipse MA100, Nikon), roughness measurements (contact profilometer, Hommel Tester T1000) and water contact angle measurements (sessile drop technique). Before the corrosion test and in last day of each week of incubation in salt spray chamber.

Results and Discussion

Although the surface appearance greatly changed along with the prolonging exposure to the corrosive environment (dark spots visible on the microscopic images), no signs of the corrosion were observed. The value of Ra parameter for all the samples increased from about 0.1 before contact with salt spray to over 0.4 after 4 weeks of incubation. Nevertheless, there were no pits or hollows visible on the performed roughness profiles. The contact angles for all of the examined cases decreased as the incubation was proceeding. The changes of the surface properties of the examined materials were related to the formation of the salt-based residues and not corrosive processes.

Conclusions

After incubation of samples in 5% salt spray at 37°C for the total period of 4 weeks, no particular signs of corrosion were observed on any type of specimen .

Acknowledgments

This research has been supported by the National Centre for Research and Development under the grant no. LIDER/040/707/L-4/12/NCBR/2013 entitled „MOBIOMED: Modified BIOmaterials – MEDicine future".

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