SILOXANE LAYERS MODIFIED WITH CARBON NANOFORMS FOR MEDICAL APPLICATIONS

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Introduction

One of the key problems of the biomaterial engineering is research in the field of surface modification of implantable materials. Layers deposited on metallic surfaces preserves from diffusion of corrosion products to the biological environment. Moreover, they provide required cell and tissue response on the implant inserted into the organism of the patient, appropriate to the particular application. Implants in the bone surgery, besides no corrosivity, should be characterised by bioactivity stimulating the osteosynthesis process. Whereas, implants for cardiac surgery should have non-thrombogenic properties of the surface to prevent pathological mineralization.

Therefore, functional biomaterials responding to the medicine demand might be obtained by the modification of the surface of the implantable material. It might be accomplished by deposition of the specified top layer. It is well known, a formation of materials with the use of methods and tools of nanotechnology might take place on two levels, namely by the modification of the nanoparticle itself or by the application of nanoparticle as the modifier of the particular material.

This second approach in mostly eliminates any danger resulting from nanoparticle toxicity and nowadays is considered as the effective way of fabrication of new materials with properties desired from the medical point of view[1,2].

Carbon nanoforms, such as multiwalled carbon nanotube (MWCNT) and graphene oxide (GO), ale materials of great efficiency in properties modification of biomedical material. The aim of the study was preparation and examination of nanocomposite layers based siloxanes modified with the use of carbon nanoforms. Interactions between carbon nanoforms and polymeric matrix modify the structure of the layer on the molecular level. Moreover, they give new unique properties, impossible to obtain in other ways. Furthermore, implementation of carbon nanoforms into the polymer gives the coating unique nanotopography – element of the structure essential in the contact with cells and biological environment. By appropriate selection of the type of functionalization of nanoparticles and by control of polymer structure (carbon/silicon atoms ratio) it is possible to obtain materials of differential properties: non-thrombogenic, germicidal as well as osteogenic.

Materials and Methods

Nanocomposite layers were obtained on the titanium surface with the use of electrophoretic co-deposition. The stable suspension of polysiloxane and functionalized MWCNTs in ethanol alcohol was prepared and applied in the deposition process.

The study included structural analyses using infrared and Raman spectroscopy as well as material testing in terms of corrosion resistibility and adhesion to the substrate. Biological tests referred to the *in vitro* bioactivity of the chosen materials determined in the so-called Kokubo test and cell examination in terms of proliferation and differentiation of NHOst cell cultures.

Results and Discussion

The produced layers are characterized by good adhesion to the substrate, they have isotropic fibrous topographies. SEM images (FIG. 1) depicted that siloxane uniformly coated MWCNTs and biomimetic morphology was obtained.

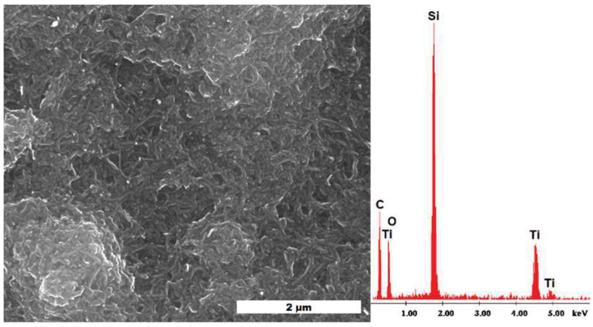

FIG. 1. SEM image and EDS analysis of the siloxane/MWCNTs nanocomposite layer

Spectroscopic examination confirmed desired phase and chemical composition. In *in vitro* tests, both bioactivity and biocompatibility were proven. After so-called Kokubo test hydroxyapatite was discovered on the sample surface. The cell activity was on the satisfactory level

Conclusions

Our research shows that that the modification of polymeric materials (siloxanes) with the use of carbon nanoforms is the effective method leading the formation of multifunctional materials characterized by elevated anticorrosive parameters such as good adhesion to the substrate. By suitable control of the layer components in terms of its chemical composition (functional groups on the carbon nanoparticle surface, the structure of polymeric matrix – C/Si ratio) it is possible to obtain coatings of high biocompatibility and bioactivity.

Acknowledgments

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References

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