ANTIBACTERIAL PROPERTIES OF CARBON FIBERS MODIFIED WITH TITANIUM SOL

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[ENGINEERING OF BIOMATERIALS 163 (2021) 119]

Introduction

Thanks to the properties of the graphene layer containing π electrons, the surfaces of some carbon materials, both in the nano and micro scale, are materials with an extremely wide range of applications. These are applications related to carbon materials with antibacterial properties. It has been proven many times that nanofiber forms of carbon, such as CNT (carbon nanotubes), graphene, fullerene or CNF (carbon nanofibers) are materials with antibacterial properties [1-4].

However, their applications require the development of composite material systems in which carbon nanoforms are one of the constituents, i.e. modifier, giving the desired application properties [5,6].

On the contrary, micro-carbon fibers, especially made of organic precursors after thermal treatment at moderate temperature (low-carbonized carbon fibers) and subjected to intensive oxidation treatment, are a material not burdened with limitations related to the potential toxicity of carbon nanoforms, and additionally characterized by high functionality.

The aim of the study was to obtain carbon nonwovens made of fibers in a micrometric scale, and then to process them in titanium sol in order to give them antibacterial properties.

Materials and Methods

Carbon nonwovens were made of polyacrylonitrile nonwoven precursor, preliminary stabilized at oxidative atmosphere followed by carbonization at 1000°C and then additionally treated in an oxidizing medium. The material prepared in this way was surface modified with titanium sol. The subject of the study were the as-received carbon nonwovens and nonwovens modified with titanium sol. Both materials were characterized based on Raman spectroscopy, XPS research and SEM/EDS analysis. Then, the antibacterial activity of both materials was tested. The tests were carried out in accordance with the guidelines of the PN-EN ISO 20645 standard - Flat textiles - Determination of antibacterial activity - Diffusion method on an agar plate. The bacterial activity was analyzed against the reference bacterial strain: Escherichia coli ATCC 8739.

Results and Discussion

The results obtained in the study indicated that the carbon nonwovens being the subject of the study are materials with a low degree of crystallinity, with oxygen groups on their surface, characteristic for, the so-called "activated carbon" (carboxyl, carbonyl, lactone, phenol, bonded surface functional groups attached to the graphite-like layers' edges gives the acidic character of the activated carbon).

The spectroscopic data concerning the surface analysis of sol-modified nonwovens indicate that titanium dioxide with anatase structure is present on the surface of the fibers in the non-wovens. In the tests of antibacterial properties of both materials, carried out by the method of diffusion on agar plates, in which samples of the tested material were applied to the substrate inoculated with bacteria, the observation of the zone of inhibition of bacterial growth showed the antibacterial effect of fibers modified with titanium sol. Additionally, the test results were confirmed by the SEM observations (FIG. 1).

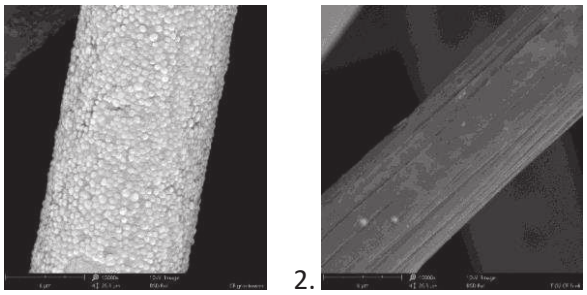

FIG. 1. SEM micrographs of carbon fibers after contact with bacteria (*Escherichia coli* ATCC 8739);
1- the surface of the unmodified fiber,
2- the fiber coated with titanium sol.

Conclusions

Modification of carbon nonwovens with oxygen groups on their surface with titanium sol is an effective method of manufacturing fibrous functional antibacterial materials that can be used in various types of filters intended for the purification of gaseous and liquid media.

Acknowledgments

This work has been supported by the National Science Centre, Poland under project "Polysiloxane layers modified by carbon nanotubes on metallic substrates" - 2017/25/B/ST8/02602

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