Antibacterial and non-fouling Cu/C:F nanocomposites deposited onto poly(ether-ether-ketone) folis

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The main aim of this study was investigation of antibacterial and biofouling properties of nanocomposites based on Cu nanoparticles produced by means of gas aggregation source of nanoparticles and embedded into hydrophobic fluorocarbon matrix deposited by low pressure RF magnetron sputtering. All biological tests were performed on nanocomposite coatings deposited on poly(ether-ether-ketone) foils used as substrate material. It is shown that such nanocomposites are capable to reduce by 5 orders of magnitude amount of *E. Coli* bacteria in solution within 6 hours of incubation as well as to maintain limited osteoblasts adhesion.

1. Introduction

Nowadays, polymers are applied in numerous ranges of industries comprising for example food packaging, medicine, aerospace and etc. This is connected with their low cost and favourable bulk properties. One of the relatively new and high-performance polymers is poly(ether-ether-ketone) (PEEK) that is considered as promising candidate for replacing metal implant components. However, similarly to other common polymers, PEEK possesses low biocompatibility, which limits its broader use. Because of this various methods were investigated to improve its surface properties such as for instance plasma treatment performed with aim to tailor its surface energy and biofouling.

Another issue that is in particular connected with body implants is possible colonization of their surfaces by bacteria that may lead to the formation of highly resistant biofilms and onset of infections. One possible strategy to lower probability of such undesirable events is coating of implants with antibacterial films. Probably the most studied antibacterial materials are the ones based on Ag nanoparticles. However, Ag at higher doses exhibit cytotoxicity and as it is readily accumulated in aquatic plants and animals its use appeared to represent serious environmental concerns. In this study, we therefore proposed to add antibacterial properties to PEEK foils by deposition of nanocomposites based on copper nanoparticles (NPs) embedded into a hydrophobic fluorocarbon matrix that in addition limits the adhesion of cells.

2. Experimental

Produced coatings had two layer structure (Fig. 1). PEEK foils were initially seeded by Cu NPs deposited by a gas aggregation source of nanoparticles. The films of Cu NPs particles were subsequently overcoated by C:F layer deposited by RF magnetron sputtering of PTFE target. The samples were characterised from the point of view of their morphology (AFM, SEM), chemical composition (XPS) as well as with respect to their biofouling and antibacterial activity. For the later *E. Coli* bacteria were selected as reference microorganism and the biofouling of produced nanocomposites was tested using .osteoblast cells.

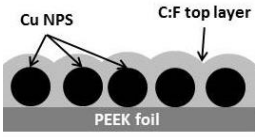

Fig. 1. Schematics of structure of prepared nanocomposites

3. Results

Biological tests showed promising antibacterial activity of prepared Cu/C:F nanocomposites that caused progressive reduction of *E. Coli* bacteria with incubation time. Moreover, it was found that both thickness of C:F overcoat layer and amount of deposited Cu NPs influence kinetics of bacteria reduction: the decline of bacteria count was more pronounced with increasing amount of Cu NPs and decreasing thickness of the top C:F coatings. For the highest amount of Cu NPs and the smallest thickness of matrix material in the nanocomposite 5-log reduction of bacteria capable to form colonies was observed after 6 hours of incubation in the bacteria solution. In addition, all samples showed non-fouling character.

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