EFFECT OF SURFACE TITANUM MODIFICATION ON INTERACTION WITH GRAPHENE OXIDE COATINGS

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Introduction

Titanium from many years is used in biomaterials engineering as a material with high biocompatibility. For years, their surface have been also modified to improve biocompatibility, bioactivity, chemical resistance, or gives special properties such as biomimetic, and change surface roughness or surface energy [1,2]. Among the various modifications of the titanium surface also coatings based on carbon nanomaterials are used [3]. One potential use of such systems is the electrodes for brain stimulation in the treatment of central nervous system diseases. In the design of electrodes for brain stimulation, it is important that the coatings adhere well to the titanium surface. The main purpose of the work was to modify the titanium surface with argon ion beam, pyrolytic coatings and chemical digestion to evaluate which of the proposed modifications have the best effect on the adhesion of the graphene oxide coatings.

Materials and Methods

The titanium (Gr2) plates in 0.5 mm thickness were used in this investigation. To modification of Ti surface three different methods were used namely: etching in 5%HF, chemical vapour deposition method (CVD) to synthesis pyrolytic layers and plasma enhanced chemical vapour deposition method (PECVD) for treatment of Ti surface of Ar ion beam. All samples were investigated using different methods like confocal microscopy for roughness measurement, goniometer for analysing of surface wettability and SEM for morphology and microstructure investigation. Then, on the treated Ti samples the graphene oxide (GO) coatings using electrophoretic deposition method (EDP) were prepared. The impact of titanium substrate modification on the adhesion of the GO coatings was determined by a scratch test using Micro-Combi-Test (MCT), CSM Co.

Results and Discussion

The analysis of SEM microphotographs of the treated Ti samples indicates that the morphology and microstructure were different and strongly depends on modification method (FIG. 1).

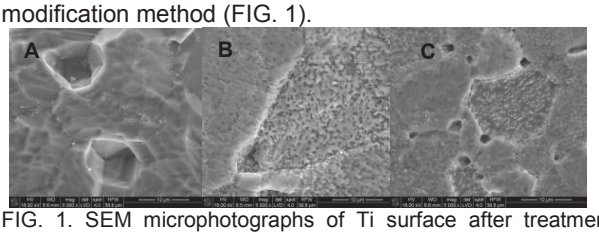

FIG. 1. SEM microphotographs of Ti surface after treatment using 5%HF (A), pyrolytic carbon (B), Ar ion beam (C).

Microstructural differences have also been confirmed by confocal microscopy (FIG. 2). The roughness value determined by this device confirms that the higher roughness is observed for the sample after HF etching (FIG. 2A). 5%HF is a agent which strongly interact with Ti surface changing significantly their morphology and topography. Pyrolytic carbon and Ar ions are not as aggressive as HF and the Ti surface roughness modified these agents is much lower.

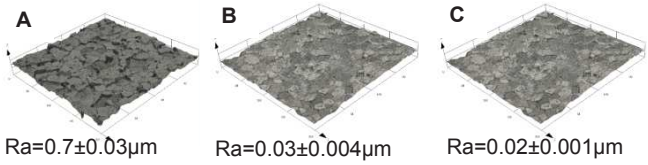

FIG. 2. 3D images of Ti surface after treatment using 5%HF (A), pyrolytic carbon (B), Ar ion beam (C), and values of roughness (Ra).

Treated methods of Ti surface have influence on surface wettability. The highest contact value was observe for Ti after modification using pyrolytic carbon in turn the lowest contact value which was observed for Ti after treatment in Ar ions (TABLE 1).

TABLE 1. Water contact angle for treated Ti samples.

Samples	Water contact angle [°]
Ti after HF	84.7±5.63
Ti with pyrolytic carbon	95.5±2.59
Ti after Ar ions beam	73.6±2.27

Verification of the modification methods of the Ti plates was done on Ti samples on which GO coatings were deposited using EPD method. All three samples with GO coatings was investigated using scratch test and the force value at which the first abrasion was observed and the force at which the GO coatings was completely destroyed were analysed (TABLE 2).

TABLE 2. Scratch test results.

Samples	Force initiating the destruction [N]	The force that destroys the coating [N]
Ti after HF	0.26	2.5
Ti with pyrolytic carbon	0.26	5.0
Ti after Ar ions beam	0.27	4.5

These result shows that not high roughness have the significant impact on adhesion of GO coatings to Ti surface but probably wettability and chemical affinity of the Ti surface to coatings is decisive. Pyrolytic carbon because it is a carbon material similar to the graphene oxide coatings are most likely to interact with each other which results is growing of destructive force. In the case of Ti after Ar ions beams modification, probably lower wettability of this surface in comparison with other materials have significant impact on increasing of destructive force of GO coating. The GO is hydrophilic materials which can interact stronger with surface characterised by higher wettability.

Conclusions

These results shows that Ti surface modification using different technique are successful in changing surface topography and wettability and increasing interaction between Ti and GO coatings deposited on its surface using EPD technique.

Acknowledgments

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