P-23

Radiation effects induced in solids and biological materials by intense XUV and X-ray beams

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It is often said that the x-ray investigation techniques are non-invasive in terms of conservation of specimen structure, as well as its physical and, where applicable, biological properties. However, it is well known, that structural destructions and functional modifications are inherently associated with irradiation of all types of samples. Radiation damage is an important issue not only in case of biological matter but also should be taken into consideration when studying the inorganic solids.

With the advent of increasingly sophisticated and powerful X-ray sources: first synchrotrons and more recently short-wavelength free electron lasers, the importance of damage–related considerations is rapidly growing. The achievable dose rates using 3rd generation synchrotron beams are, typically, on the order of a few to a dozen or more kGy/s. The X-ray free electron lasers can deliver a MGy doses of monochromatic unfocused radiation in a single pulse only, that lasts typically few tens of femtoseconds.

In our concise communication we compare the doses and fluences delivered by X-ray beams from different sources. We focus on basic radiation damage mechanisms occurring both in inorganic solids and in biological matter. Discussed are also the secondary effects of strong ambient ionization around the sample, capable to significantly modify the properties in near-surface regions of even inorganic solids, as well as post-radiative effects in live tissues, like bystander effect or, waking numerous controversies, impact of very low doses on carcinogenic transformation.

P-24

Evaluation of characteristics of physical and chemical in vitro study of modified titanium surfaces

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Introduction

Development of dental implantology is focused, among other things, on devising active surface of the implant, conditioning acceleration of the implant's integration with the bone. Increased roughness, characteristic for group of implants with developed surface, altered topography and chemically modified implant's surface determines increased implants stability.

Objective

Evaluation of characteristics of titanium modified to develop its surface in in vitro studies.

Materials and methods

Titanium discs with four different surfaces were used: turned (TS); aluminium oxide-blasted (Al_2O_3); resorbable material blasted (RBM); sandblast and then etched with a mixture of acids (SAE). Titanium discs were tested using scanning electron microscopy for analysis of the surface's topography, spectroscopic analysis for surface's chemical composition, 2D and 3D profilometric analysis for the surface's roughness.

Results

SEM image of the turned surface shows parallel folds on discs surface, Al_2O_3-blasted and RBM surfaces presents numerous cavities, and clearly sharp-edged rims, SAE surface is similar to sand-blast surfaces but has less sharp contours. Spectroscopic analysis revealed titanium and carbon as a main ingredients of all samples. Al_2O_3 surface also contains aluminum and sodium and RBM surface calcium and phosphorus. In SAE surface, the etching resulted in increased the amount of carbon. 2D and 3D roughness parameters revealed diversity of roughness profiles and existence of statistically significant homogenous group among examined titanium surfaces.

Conclusions

Topographic structure of the surfaces in SEM images corresponds to the results obtained in profilometric measurements. TS control surface is isotropic while the remaining surfaces – Al_2O_3-blasted, RBM, SAE – are anisotropic. Physical and chemical modifications of titanium surface change its microstructure (typical for SAE) and increase its roughness (highest for Al_2O_3-blasted and RBM surfaces). The introduced modifications develop titanium surface – 10 times for SAE surfaces, 16 times for Al_2O_3-blasted surfaces, and 20 times for RBM surfaces.