Metka Benčina et al., Res. Rev. J Mat. Sci. 2017, 5:5
DOI: 10.4172/2321-6212-C1-005

TiO_2 nanotubes as potential vascular stents: effect of oxygen plasma treatment on crystal structure and surface properties

Metka Benčina[1], Ita Junkar[1], Tomaž Lampe[2], Aleš Iglič[2], Veronika Kralj-Iglič[2], Matjaz Valant[3] and **Mukta Kulkarni[4]**
[1]Jožef Stefan Institute, Slovenia
[2]University of Ljubljana, Slovenia
[3]University of Nova Gorica, Slovenia
[4]Palacky University,Czech Republic

Despite intensive research and applications of different techniques to improve surface properties of vascular stents, currently available metal stents and their coatings (*DES* - drug eluting stents) still lack of desired surface biocompatibility, mostly due to mechanical injuries, inflammation, as well as proliferation and migration of smooth muscle cells, often with progression to restenosis. Besides, the durability and stability of DES is still problematic and has been connected with high risk of thrombosis Biomimetic nano-sized materials, with their crystal structure, surface morphology and chemical properties are one of critical features for their potential use in vascular stent applications, which should support adhesion, proliferation and differentiation of endothelial cells and prevent abnormal growth of smooth muscle cells. For example, it was shown that titanium dioxide (TiO_2) nanotubes (NTs) topography is essential parameter in optimizing endothelial cell and smooth muscle cell responses to vascular implants. The purpose of this study is to investigate surface properties and crystal structure of TiO_2 NTs. Since the oxygen, plasma treatment plays significant role in surface treatment of biomedical devices due to surface cleaning and sterilization, its effect on the mechanical stability and surface chemical properties was evaluated. Vertically aligned arrays of TiO_2 NTs were synthesized on Ti metallic substrates with electrochemical anodization. The crystal structure was investigated with X-ray Diffraction Spectroscopy, while morphology and surface properties were analyzed with Scanning Electron Microscopy coupled with Energy Dispersive X-ray Analysis, X-ray Photoelectron Spectroscopy and Water Contact Angle analysis. Our results indicate that oxygen plasma treatment of TiO_2 NTs surfaces induces the formation of oxide layer on the surface of TiO_2 NT, which could result in enhanced biocompatibility. Moreover, plasma treatment removes undesired electrolyte residues on TiO_2 NTs surface and highly improves its wettability. We showed that plasma treated TiO_2 NTs possess long-term hydrophilicity and influence on crystallization of amorphous TiO_2 NTs to anatase and/or rutile crystal phase, which could be the reason for improved wettability. The optimized conditions (power, frequency and time) of oxygen plasma treatment on the mechanical stability of TiO_2 NTs are also presented. Oxygen plasma treatment can greatly improve the surface characteristics of biomimetic materials and enhance their biocompatibility. Restenosis and thrombosis still remain a serious concern and should be given a great deal of attention in order to produce improved tissue-material response.

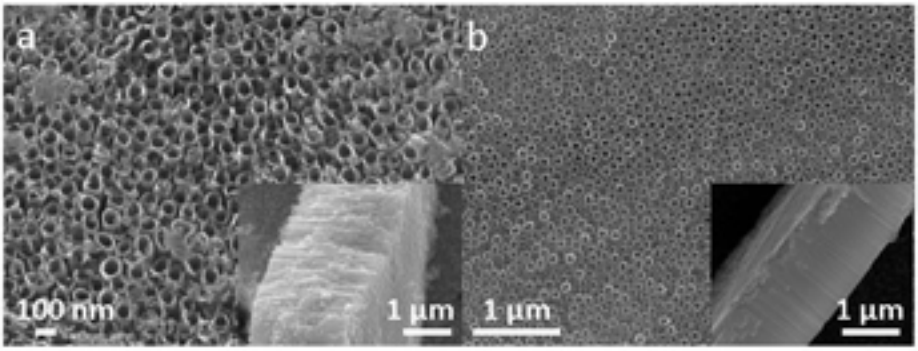

Fig.1: *SEM images of TiO2 NTs after plasma treatment at a.) non-optimized conditions; structure is destructed, NTs are partially closed and b.) optimized conditions; NTs are well defined, tops are open.*

Biography

Metka Benčina has her expertise in synthesis and characterization of nanomaterials for photocatalytic and biomedical applications. She produced novel metal oxides with pyrochlore structure and proved their absorption in visible range of EM spectrum and enhanced photocatalytic properties under UV and visible light irradiation. Currently she is fabricating TiO_2 nanostructural surfaces and investigating their applications in biomedicine - biosensors for detection and treatment of cancer cells, photo-assisted cancer treatment and biomimicking vascular stents. Her particular research interest is the effect of oxygen plasma treatment of biomaterials.

metka.bencina@ijs.si