Formulated Drug-Releasing, Anti-Biofilm and Cell Adhesion Properties of Implantable and Highly-Ordered TiO_2 Nanotubes

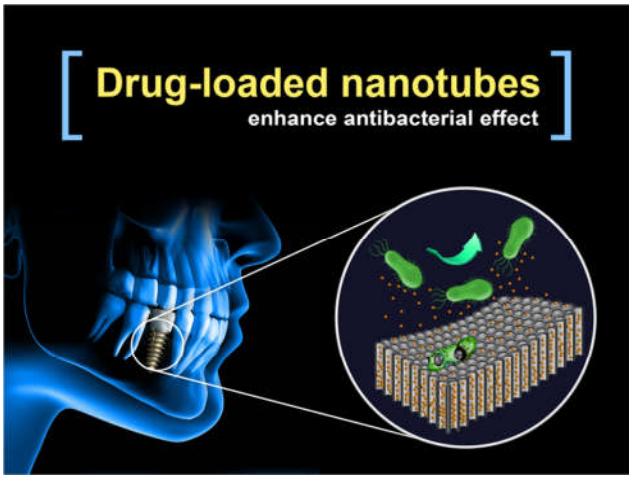
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Abstract

Ti6-4 alloy as implant is widely used in medical application. However, the bio-inert behavior of Ti does not react well with the human tissues and sometimes needs surface treatment to play a better role inside the body. For such a purpose, TiO_2 nanotubes of different dimensions and architectural fashions at the nanoscale level are being evaluated. Such nanotubular surfaces can closely mimic the intricate nanoscale structure of human bone and can also be used for osteoinductive growth factor or antibacterial/anti-inflammatory drug delivery. These newer generations of titanium surfaces may have significant advantages in overcoming the limitations of conventionally available titanium implants.

In this study, the anodizing process has been carried out to generate TiO_2 nanotube arrays on Ti 6-4 implant surfaces. All the prepared nanotubes are filled with the vancomycin by immersion and electrophoresis method. Drug release behavior, antibacterial treatment, protein adsorption and cell attachment of drug-loaded nanotubes are investigated by UV-vis, flow cytometry, Mc-Farland assay, BSA absorption, and FESEM, respectively. The results show that the most uniform morphology, appropriate drug release, cell viability and antibacterial treatment can be achieved by anodizing in the range of 60-75 V. This voltage range improves the adsorption of BSA proteins in bone healing and finally promotes osteoblast activity and osteointegration. Also the electrophoresis drug loading shows the anodized samples absorb the drug 60% more than the immersion method in the voltage range of 75 V, while this has no effect on the adsorption of more vancomycin for smaller diameters. Moreover, the present study indicated that an anodized sample without drug loading had no antibacterial activity. In addition, drug releasing from drug-modified nanotubes is measured and a mathematic formula investigates the determination of the amount of vancomycin against MIC (Minimum Inhibitory Concentration) to find the optimum vancomycin dosage.



Recent publications

1. M. Mansoorianfar (2017), Preparation and characterization of TiO2 nanotube arrays on Ti6Al4V surface for enhancement of cell treatment, Surf. Coat. Technol. 321: 409-415.
2. H. Chouirfa (2019), Review of titanium surface modification techniques and coatings for antibacterial applications, Acta Biomaterialia 83: 37-54.
3. Y. Zhukova (2017), The Role of Titanium Surface Nanostructuring on Preosteoblast Morphology, Adhesion, and Migration, Adv. Healthcare Mater. 6: 15: 1601244.
4. G. Mi, D. Shi (2018), Reducing Bacterial Infections and Biofilm Formation Using Nanoparticles and Nanostructured Antibacterial Surfaces, Adv. Healthcare Mater. 7, 13, 1800103.

Biography

Mojtaba Mansoorianfar is PhD in Materials Science and Engineering, Biomaterials. His experience is focused on metallic membrane used in bio medical application especially in orthopedic and dentistry. Designing, fabrication and modification of implants with enhanced drug carrier and antibacterial properties creates new pathways for improving osseo-integration, osseo-conductivity and reducing bone healing time. I have developed this after years of experience in research and now is being developed. The foundation is based on Nanjing Forestry University grants under Prof. Li supervision.

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Notes/Comments: