Self-Organized TiO_2–Nb_2O_5–ZrO_2 Nanotubes on β-Ti Alloy by Anodization

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Abstract : Surface properties such as topography and physicochemistry of metallic implants determine the cell behavior. The surface of titanium (Ti)-based implant can be modified to enhance the bioactivity and biocompatibility. In this study, a self-organized titania–niobium pentoxide–zirconia (TiO_2–Nb_2O_5–ZrO_2) nanotubular layer on β phase Ti35Zr28Nb alloy was fabricated via electrochemical anodization. Energy-dispersive X-ray spectroscopy (EDX), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and water contact angle measurement techniques were used to investigate the nanotubes dimensions (i.e., the inner and outer diameters, and wall thicknesses), microstructural features and evolution of the hydrophilic properties. The in vitro biocompatibility of the TiO_2–Nb_2O_5–ZrO_2 nanotubes (NTs) was assessed by using osteoblast cells (SaOS2). Influence of anodization parameters on the morphology of TiO_2–Nb_2O_5–ZrO_2 NTs has been studied. The results indicated that the average inner diameter, outer diameter and the wall thickness of the TiO_2–Nb_2O_5–ZrO_2 NTs were ranged from 25–70 nm, 45–90 nm and 5–13 nm, respectively, and were directly influenced by the applied voltage during anodization. The average inner and outer diameters of NTs increased with increasing applied voltage, and the length of NTs increased with increasing anodization time and water content of the electrolyte. In addition, the size distribution of the NTs noticeably affected the hydrophilic properties and enhanced the biocompatibility as compared with the uncoated substrate. The results of this study could be considered for developing nano-scale coatings for a wide range of biomedical applications.

Keywords : Titanium alloy, TiO_2–Nb_2O_5–ZrO_2 nanotubes, anodization, surface wettability, biocompatibility
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