Abstract

A bacterial biofilm is a persistent structure of microorganisms composed of one or more species, embedded in an extracellular matrix. In recent decades, it has been recognized as a major factor in chronic infections, disrupting the body's homeostasis. The risk of its formation depends on many factors, including the properties of the biomaterial surface such as roughness, chemical composition, and surface energy. Due to the limited effectiveness of conventional treatment with antibiotics and antiseptics, implant surface modifications aimed at preventing bacterial adhesion have gained increasing importance. Modern implantology largely relies on titanium and its alloys, which are characterized by high biocompatibility and corrosion resistance. Despite these advantages, titanium alloys even when alloyed with vital elements, as in the case of Ti-13Nb-13Zr still require additional surface modifications to enhance their resistance to bacterial biofilm formation. Previous attempts to modify the surface with metallic or organic coatings have often been associated with risks of cytotoxicity or limited durability of the resulting layer. The aim of this study was to comprehensively characterize the physicochemical and biological properties of Ti-13Nb-13Zr alloy coated with SnO_2 using the ALD method. The results confirmed that the SnO_2 coating is homogeneous, continuous, and bilayered, with its thickness dependent on the number of deposition cycles. It exhibits strong adhesion to the substrate as well as increased resistance to abrasive wear, pitting, and crevice corrosion. Moreover, the coating effectively limits the release of titanium, niobium, and zirconium ions into the solution, acting as a protective barrier. Biological studies demonstrated that the SnO_2 coating reduces bacterial adhesion and inflammatory responses (by lowering cytokine levels) while simultaneously supporting cell proliferation. The most favorable properties were observed for the coating applied to a polished substrate. In summary, this study confirms the feasibility of producing a tin(IV) oxide coating on Ti-13Nb-13Zr alloy, providing advantageous physicochemical and biological properties.