Multifunctional hybrid sol-gel implant coatings on anodized titanium substrates to improve osseointegration and antimicrobial effectiveness

Abstract

To improve patient outcomes in orthopedic and dental implantation procedures, the development of multifunctional implant coatings that can inhibit microbial cell proliferation while promoting osseointegration have been sought out by clinicians. While recent developments in material science and cell biology have seen the development of such coatings, many proposed systems lack clinical translatability. For example, to reach the clinic, modern coating systems must be highly adherent to their substrate (to avoid delamination upon implantation), have sufficient wettability (to promote the fixation of cells), and facilitate the controlled and sustained release of antimicrobial factors (falling within the therapeutic window to prevent biofilm formation on the implant surface). In this study, to facilitate greater coating adhesion and surface wettability, titania nanotubes (TNTs) developed on the surface of titanium implant substrates by anodizing treatment, are proposed as an interface between the titanium substrate and outer coating. Further, to facilitate controlled and sustained release, an organic–inorganic hybrid (OIH) coating is proposed. 3-Glycidoxypropyl trimethoxysilane (GPTMS) and tetramethoxysilane (TEOS) will be used to obtain class II covalent inorganic/organic coupling with chitosan to control the biodegradation of the applied coating. Upon the incorporation of a silver salt ($AgNO_3$) into the hybrid sol–gel matrix, a desired silver release rate will be utilized as method for the prevention of biofilm formation on the outer surface of the substrate.