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Bactericide release-based antibacterial yet biocompatible and bioactive surfaces

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Implant-related bacterial infections remain a serious problem that is not solved yet. Herein we combined several antibacterial agents to achieve synergistic effects and broader protection of widely used metallic implants. Various strategies for development of bioactive and bactericidal films with various antibacterial components (Ag nanoparticles, antibiotics) that can rapidly inhibit infection and provide long-lasting antibacterial effect are considered. Approaches to the fabrication of bactericidal surface included doping with bactericidal elements, loading of antibiotic into specially formed surface cavities, and a combination of these methods. Surface modification to produce a specific surface relief can also be utilized to control bactericide metal ion release. The obtained results show that under optimal surface chemistry and topography conditions the material can be biocompatible, bioactive and bactericidal. Different types of synergistic effects are discussed: (a) dependence of Ag^+ ion release versus Ag content in the film and surface roughness and (b) enhanced antibacterial activity of Ag^+ ions and antibiotics. It is demonstrated that silver can be successfully coupled with different types of antibiotics to provide innovative hybrid metal-ceramic bioconstructions that are able to deliver precise doses of bactericide agents within a certain period of time and are equally effective against gram-negative and gram-positive bacteria and fungus. In addition, crosslinking reaction between gentamicin and TiCaPCON film resulted in the formation of a relatively stable drug/film conjugate preventing rapid dissolution of gentamicin and ensuring its long-term (for 72 h) antibacterial protection. These results open up new possibilities for the production of cost-effective, scalable, and biologically safe implants with pronounced antibacterial characteristics for future applications in orthopedic field.

Keywords
Films
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