Effect of Thermal Annealing Temperature on Tri-Layered AgO/AgTaO/TaO Nanocomposite Coatings grown by PVD Magnetron sputtering

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Abstract:

The increasing prevalence of nosocomial infections, particularly those associated with surgical sites, necessitates the development of advanced antimicrobial coatings for surgical tools and implants. This study focuses on the surface modification and characterization of a nanocomposite layer comprising AgO/AgTaO/TaO on SS 316 L stainless steel using Physical Vapor Deposition (PVD) magnetron sputtering. The AgO/AgTaO/TaO coating aims to enhance the physicochemical, mechanical, and biological performance of the substrates. The thin films were annealed at 450°C and 750°C to study the effects of temperature on their properties. Characterization techniques, including Field Emission Scanning Electron Microscopy (FESEM), Energy-Dispersive X-ray Spectrometry (EDX), Atomic Force Microscopy (AFM), and X-ray Diffraction (XRD), were employed to analyze the surface morphology, elemental composition, and crystallinity of the coatings. Results showed that annealing at 450°C produced a smooth surface with a roughness of 0.107 nm and initiated TaO crystallization, while annealing at 750°C led to silver segregation and increased surface roughness. These findings suggest that the annealing temperature critically affects the coating's properties, potentially impacting its effectiveness in preventing bacterial adhesion and biofilm formation. The study underscores the potential of AgO/AgTaO/TaO nanocomposite coatings in improving the safety and performance of surgical tools and implants.