Evaluation of Corrosion and Biocompatibility Properties of Oxide Films on Ti6Al4V Alloy: Comparative Analysis of Anodization and Plasma Treatment

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The study focuses on the corrosion resistance and biocompatibility properties of oxide films formed on Ti6Al4V alloy. Ti6Al4V ia a widely used material in biomedical applications due to its excellent mechanical properties and biocompatibility. Traditional and novel surface treatment methods, specifically anodization and plasma treatment, were employed to produce oxide films, which were then evaluated and compared to the native oxide layer that forms naturally on the alloy.

Oxide films on Ti6Al4V alloy were generated using two different methods: anodization and plasma treatment, both of which yielded a blue surface finish. Comprehensive characterization of these films was conducted using Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS), X-ray Diffraction (XRD), and Raman spectroscopy to analyze their structural and chemical properties.

Electrochemical resistance of the films was assessed using potentiodynamic polarization tests and electrochemical impedance spectroscopy (EIS) in a simulated physiological environment (0.9 wt% NaCl solution at body temperature). Additionally, in vivo tests were performed to study the ion release and biocompatibility over a six-week period. The subsurface layer of the oxide films was also examined through microstructural analysis.

The type of oxidation process significantly influenced the composition and distribution of oxides of individual alloying elements within the films. Anodization and plasma treatments resulted in different oxide distributions across the film thickness, which in turn affected the corrosion behavior and the specific alloy elements released into the environment during corrosion reactions.

Electrochemical tests revealed variations in electrochemical resistance, with anodized films exhibiting superior resistance compared to plasma and native oxide films. In vivo tests confirmed that the amount of released ions and biocompatibility varied with the type of oxide film, highlighting the importance of the oxidation method in determining the material's performance in physiological environments.