Effect of Anodization Voltage and Solution Temperature on the Crystallization of Tantalum Pentoxide Thin Films

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Successful biomedical implant surfaces must have antibacterial and cytocompatible properties to promote cell growth and osseointegration. Titanium, the most commonly used material in biomedical implants/devices, has poor bioactivity, resulting in slow osseointegration time and an increased risk of post-implantation complication. Tantalum pentoxide (Ta_2O_5) is an attractive alternative due to its corrosion resistance in acidic environments and its enhanced bioactivity as a rough or porous surface. Anodization is a simple and cost-effective method for producing porous Ta_2O_5, but conventional processes rely on hazardous electrolytes that limit scalability. This study investigated the effects of anodization voltage and electrolyte temperature on the crystallinity and porosity of Ta_2O_5 formed in a non-toxic electrolyte composed of 10% dibasic potassium phosphate in glycerol. Electropolished Ta samples were anodized for five minutes under the conditions 50-60V at 170-190°C and 20-30V at 200°C to produce a Ta_2O_5 surface layer. Surface morphology and porosity were analyzed using scanning electron microscopy (SEM), while crystallinity was characterized by X-ray diffraction (XRD). It was determined that Ta_2O_5 crystallinity was strongly voltage dependent. The results demonstrated that higher temperatures resulted in increased pore size, while higher voltages yielded increased pore uniformity and increased crystallinity. These findings suggest that non-toxic anodization methods can reliably produce porous, crystalline Ta_2O_5, potentially improving its accessibility for biomedical devices, implants, and other medical applications.

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