SURFACE ENGINEERING OF TITANIUM-BASED IMPLANTS VIA SOL-GEL BIOACTIVE COATINGS

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Implantable biomaterials play an important role in replacing or enhancing the function of major body systems. They can be made from polymers, ceramics, metals, metal alloys, or composite materials. Biomedical metal implant materials are of widespread application in clinical procedures that encompass dental implants, hip and knee replacements, bone plates, and screws, which plays a key role in the treatment of life-threatening disorders [1]. Different research challenges related to titanium-based implants are presented in Figure 1.

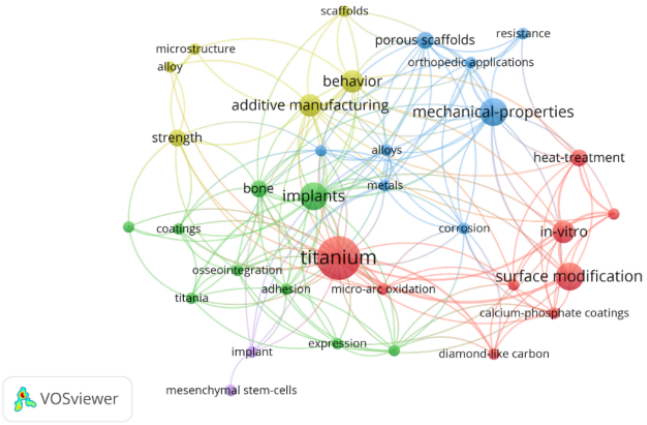

Fig. 1. Figure 1. Major Challenges in the Development of Titanium-Based Implants (generated using VOSviewer 1.6.20; © 2009–2023 Nees Jan van Eck and Ludo Waltman

One of the most commonly used alloys is Ti-6Al-4V, consisting of titanium with aluminum and vanadium as alloying elements (4–6 wt%). This alloy has relatively low density, is corrosion-resistant, and can withstand high mechanical loads. It is used to manufacture screws, plates, discs, needles, cylindrical, conical, and root-shaped implants. Commercially pure titanium (cpTi1) is also widely used due to its excellent biocompatibility in medical applications. However, unlike polymeric, ceramic, or composite implants, metallic implants may induce discomfort at the implantation site and cause tissue retraction. To enhance their biocompatibility, osseointegration, and chemical stability, the surfaces of medical implants often require modification [2] The aim of this project was to create a bioactive coating on biomedical implants and study their properties. Both Ti-6Al-4V alloy and cpTi1 were used as the substrate. The metal surfaces were first treated with acid and then coated with silicon dioxide-hydroxyapatite particles using the sol–gel method. FTIR, XRD, SEM, EDS, and surface roughness analyses were performed to evaluate the titanium alloy's surface and coating. A uniform and adherent bioactive coating was successfully formed on the surfaces of Ti-6Al-4V and cpTi1 alloys. Characterization confirmed the coating's structural integrity and surface properties, indicating its potential to enhance biocompatibility and osseointegration.

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[2] T. Wegener, T. Wu, F. Sun, C. Wang, J. Lu, and T. Niendorf, "Influence of Surface Mechanical Attrition Treatment (SMAT) on Microstructure, Tensile and Low-Cycle Fatigue Behavior of Additively Manufactured Stainless Steel 316L," METALS, vol. 12, no. 9, p. 1425, Sep. 2022, doi: 10.3390/met12091425.