Journal of Powder Metallurgy & Mining
ISSN: 2168-9806

Short Communication

Chemical Corrosion Behaviour of Powder Metallurgic Alloys in Fluorinated Artificial Saliva

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Introduction

The purpose of this research was to assess the impact of the Hot Isostatic Process (HIP) on the microstructure, phase stability, and corrosion resistance of Ti35Nb7Zr5Ta powder metallurgy alloys. The open circuit potential (OCP), potentiodynamic polarisation, electrochemical impedance spectroscopy (EIS), and ion release in physiological Fusayama solution were all used to assess titanium alloy corrosion resistance. The Ti–35Nb–7Zr–2Ta alloy exhibited good passivation behaviour due to its low current densities (108 A/cm^2) and strong polarisation resistance, as demonstrated by polarisation curves. According to the EIS data, the interpretation of an equivalent electric circuit (EEC) confirmed the production of a very stable oxide coating on the alloy, as shown by good capacitive behaviour, high impedance values (>106 cm^2) at low frequencies, and phase angles close to 90°.

The corrosion resistance of titanium alloys is highly dependent on the ambient circumstances (chemical composition, temperature, fretting) to which they are subjected, as well as the type of their oxide surface. Fluorine-ion-containing liquids, for example, stimulate the breakdown of the titanium oxide layer. Temperature, ion concentration, and electrochemical potential all enhance the rate of TiO_2 dissolution in fluorine solution [1]. Discovered that the Ti CP passive film is stable at fluorine concentrations less than 0.03 M. When the quantity of fluorine is raised, oxide film disintegration and active dissolution are activated.

Traditional powder metallurgical titanium alloys have various disadvantages, including residual porosity and chemical homogeneity, which limit their usage in orthopaedic implants. Because it is a thermo-mechanical process that adds plastic deformation and enhances alloying element diffusion, the HIP post-process is capable of altering the density and titanium phases [2]. Following the compaction process, densification is approximately 79 percent (green section), and density increases to 96 percent after the sintering cycle [3]. Finally, complete density of beta titanium samples is attained during HIP post-processing. Porous alloys have a higher surface area exposed to the media, which makes the titanium alloy more corrosive.

Conclusion

The major sources of titanium alloys' biocompatibility is their microstructure, chemical, and phase compositions, which are connected to their surface integrity, corrosion resistance, and ion release. According to Davis et al. (2003), the metal ion concentration threshold for cell viability with bulk metals is 15.5 g/L for Ti, 8.5 g/L for Mo, and 172.0 g/L for Nb. The current investigation indicated that the HIPed powder metallurgical processing approach resulted in low metal ion release values in a scenario simulating 20 years of corrosion, indicating that this technology is suitable for producing beta titanium alloys with minimal cytotoxicity[4]. The galvanic coupling effect on the Ti–35Nb–7Zr–5Ta alloys was minimised by a rapid cooling rate during HIP thermo mechanical treatment, which increased passive film protectiveness [5]. The greater the beta phase percentage, the better the capacitive behaviour since it released a substantially lower ion concentration into solution. As a result, the thermo-mechanical treatments altered the biocompatibility of beta titanium alloys. Further in vitro studies should be performed to determine the cell proliferation and viability of these new PM titanium alloys to determine their degree of osteocompability.

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Received: 12-Jan-2022, Manuscript No. jpmm-22-55781; **Editor assigned:** 14-Jan-2022, Pre QC No. jpmm-22-55781 (PQ); **Reviewed:** 28-Jan-2022, QC No. Jpmm-22-55781; **Revised:** 30-Jan-2022, Manuscript No. jpmm-22-55781 (R); **Published:** 06-Feb-2022, DOI: 10.4172/2168-9806.1000195

Citation: Williams C (2022) Chemical Corrosion Behaviour of Powder Metallurgic Alloys in Fluorinated Artificial Saliva. J Powder Metall Min 6: 195.