MICROSTRUCTURAL EVOLUTION OF Ti-13Nb-13Zr ALLOY DURING SINTERING

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Abstract With the prolonged average duration of life, there is an increase concern for repair of bone, joints and teeth which deteriorated and lose their functions. Thus, research of artificial materials for implants has assumed an important role in the implants development. The trend of the current research in orthopaedical implants is based in the development of titanium alloys with low modulus of elasticity, next to the bone, and toxic elements free. In this work, results of the Ti-13Zr-13Nb alloy sintering are presented. This alloy due its high biocompatibility and lower modulus of elasticity is a promising candidate for implants fabrication. Samples were produced by mixing of initial metallic powders followed by uniaxial and cold isostatic pressing with subsequent densification by sintering between 800 at 1500 °C, in vacuum. Sintering behavior was studied by means of dilatometry. Sintered samples were characterized for phase composition, microstructure and microhardness by X-ray diffraction, scanning electron microscopy and Vickers indentation, respectively. Density was measured by Archimedes method. It was shown that the samples were sintered to high densities and presented homogeneous microstructure from the elements dissolution. Processing parameters were optimized in order to reduce the interstitial pick-up (O, C, N and H) and to minimize grain growth during sintering.

Keywords: powder metallurgy, titanium alloys, near-net-shape.

1. Introduction

Titanium-based alloys are widely used as load-bearing orthopedic implants, due to their relatively good fatigue resistance and biological passivity. One of the examples is the application of Ti–6Al–4V as femoral stems in total hip replacements. However, these materials still suffer from a large degree of biomechanical incompatibility, due to their relatively high elastic modulus (about 120 GPa), compared with that of the bone (max. 30 GPa) [1].

When used as a hip implant, titanium overtakes a considerable part of the body loading, which shields the bone from the necessary stressing required to maintain its strength, density, and healthy structure. Such an effect, usually termed as "stress shielding", eventually causes bone loss, implant loosening, and premature failure of the artificial hip [2]. Moreover, the existing alloys can also release toxic ions (e.g. V and Al) into the body, leading to undesirable long-term effects. These result in the current implant life being around 10–15 years in vivo, whereas a desirable implant should last as long as the patient's life span, without causing any discomfort to the patient. The ideal material should possess good strength, high fatigue resistance, and a low elastic modulus [3].

Considerable efforts have been devoted by materials engineers to enhance the yield strength and to reduce the modulus. Any reduction in the stiffness of the implant, for example, through substitution of present orthopedic alloys with newer, lower modulus materials, is expected to enhance stress redistribution to the adjacent bone tissues, therefore minimizing stress

10110