Development of new powder metallurgy route to fabricate a Ti-Nb Beta-Titanium alloy

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About me

- Hello, I am Bhupendra Sharma. I grown and accomplished my basic education in the city of IIT-JEE entrance coaching hub (Kota, Rajasthan) in India. My city and it's environment became the main reason and motivation for my selection of one of the most prestigious institutions in India (known as "IIT") as an Engineering student. Although, after accomplishing my masters in science, I worked as a Jr. Lecturer in a renowned coaching institute situated in the capital of India. Simultaneously, I prepared for my goal of getting higher education from IITs and finally got selected in GATE. I chose Materials Science and Engineering (IITH) because of my interest in metals and familiarity with the atoms. In Ritsumeikan University, I am a doctoral student and working in powder Metallurgy under the guidance of professor Kei Ameyama. I want to be a good materials researcher in my life.

Introduction

In recent years, Ti-Nb based alloys have attracted significant interest as a promising material for biomedical applications, such as body implants. These Ti-Nb-based alloys are considered suitable for such biomedical applications due to their unique combination of physical and chemical properties, i.e. low young modulus, comparable to that of the human bone, coupled with excellent corrosion resistance and bio-compatibility. However, preparing fine-grained Ti-Nb-alloys, with high strength and retained low young modulus, via conventional ingot metallurgy processing approach has been an important and critical issue due to the difficulties associated with the thermo-mechanical treatment of these alloys at elevated temperature. Powder metallurgy is considered an efficient and attractive method to prepare fine-grained alloys with controlled/tailored microstructure. Especially, near-net shape processing capabilities of powder metallurgy processing, i.e. avoiding post fabrication machining, makes it even more suitable for the fabrication of Ti-based alloy components. In the present work, a new powder metallurgy route has been developed to fabricate fine-grained beta Ti-Nb-based alloys from elemental powders

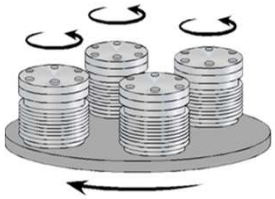
Scope and Objective

- To establish a new powder Metallurgy route to fabricate Beta Titanium alloys (Ti-Nb) with controlled microstructure and mechanical properties
- This powder Metallurgy route would be capable to produce Ti and its alloys based biomaterials with controlled microstructure and mechanical properties.
- This route is easy to produce near net shape and low cost Ti alloys when compared with other processing methods.

Methodology

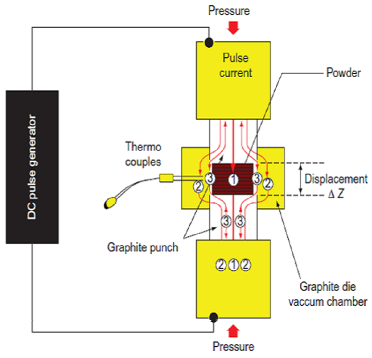
TiH_2 Powder	Elemental-Nb
60 Wt%	40 Wt%

Ti-40Nb Powder mixture

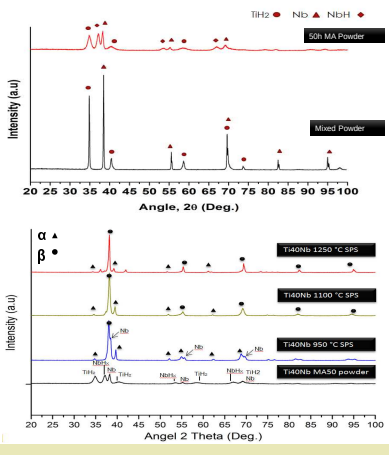


50 hr Mechanical Alloying

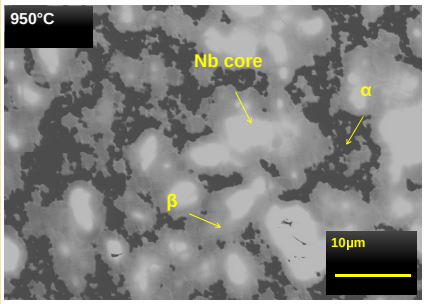
Spark Plasma Sintering

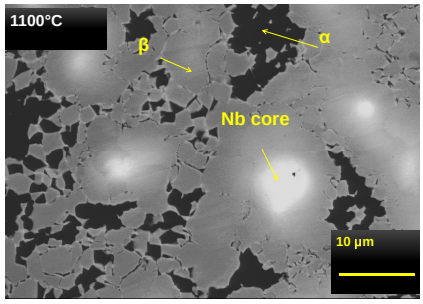


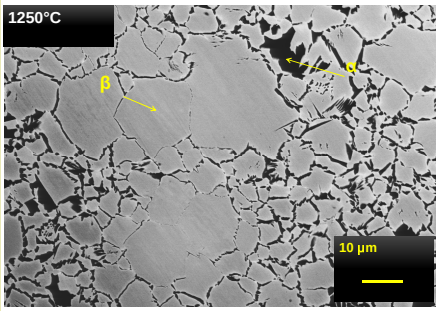
XRD of Ti-40Nb mixed & MA Powder



Results and Discussion







Future work

- Analysis of Mechanical properties such as Tensile test, compression test and young modulus.
- Development of ternary β-Ti alloys (Ex. Ti-Nb-Sn) through this method and it's mechanical analysis.

Summary/Conclusions

- A new powder metallurgy method is developed to produce Ti-Biomaterials from TiH_2 and Nb elemental powders.
- Below a specific sintering temperature, 950°C, the composition is heterogeneous (α,β and Nb core) and further increase in sintering temperature up to 1250°C, results almost completely homogeneous β Ti-alloy.
- Grain size increases with sintering temperature.

References

1. Joanne L. Murray. Bulletin of Alloy Phase Diagram, June 1981, Volume 2, Issue 1, pp 52-61.
2. M. Suárez, A. Fernández, J.L. Menéndez, R. Torrecillas, H. U. Kessel, J. Hennicke, R. Kirchner and T. Kessel (2013). Challenges and Opportunities for Spark Plasma Sintering: A Key Technology for a New Generation of Materials, Sintering Applications, Dr. Burcu Ertug (Ed.), ISBN: 978-953-51-0974-7, InTech, DOI: 10.5772/53706.