# Structural and Mechanical Properties of Titanium Niobium Alloys

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**Statement of Purpose:** Titanium and titanium alloys are widely used as biomaterials because they present biocompatibility, high corrosion resistance and favorable mechanical properties which are considered as important requirements for application of a biomaterial. Ti-6Al-4V alloys are appropriate for orthopedic prostheses due to the addition of alloying elements that significantly improves its mechanical properties. However, some studies showed that vanadium and aluminum may be toxic to the human body (HON, 2003). Titanium niobium (TiNb) alloys can be a new alternative to be employed in orthopedic prostheses. Niobium is a biocompatible element that stabilizes the beta phase of titanium alloys. Some work in the literature showed that the addition of niobium to titanium can decrease the elastic modulus of the alloy (SILVA, 2010) and enhanced the corrosion resistance (Wang et al, 2009). The purpose of this research was produce Ti-Nb alloys and evaluate their structural and mechanical properties and compare with the Ti.

**Methods:** Ti-Nb alloys were produced with a weight percentage of 10 and 20 wt. (%) of niobium. Melting of the alloys was performed at the Laboratório de Anelasticidade e Biomateriais (UNESP/Bauru) using an arc-melting furnace with a nonconsumable tungsten electrode and water-cooled copper crucible in an argon-controlled atmosphere. The precursor materials used were commercially pure titanium grade 2 (99.7% purity from Tibrasil) and niobium (99.8% purity from CBMM) After melting, were obtained two lingots (Ti-10 wt. (%) Nb and Ti-20 wt. (%) Nb alloys) with 80 g each one. The cylindrical samples with 8 mm of diameter and 1mm of height were grounded with SiC abrasive paper granulated in 200, 400 and 600 and polished with colloidal silica in suspension. After that the samples were washed in a ultrasonic bath in three steps : acetone, ethyl alcohol and deionized water, 15 minutes in each one. The structural changes were analyzed using X-ray diffraction techniques, Bragg-Brentano geometry, 0,15°/min and $CuK_{\alpha}$ radiation. The mechanical properties were evaluated by instrumented indentation technique. It was used a pyramidal Berkovich tip, with 10 loading/ unloading cycles with a maximum load of 400mN, using Oliver-Pharr method.

**Results:** After analysis using X- ray diffraction it was observed the presence of α and β phases as expected. It was verified that the quantity of the β phase was related with the Nb concentration, which means, that the increase of the Nb concentration leads an increase of the β phase stability.

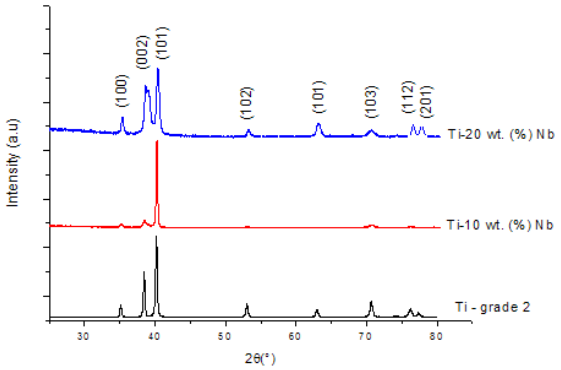


Figure 1. X-ray diffraction for the Ti-10 wt. (%) Nb and Ti-20 wt. (%) Nb alloys.

Nanoindentation results showed that the increase of the Nb concentration into the Ti-Nb alloys enhances the elastic modulus in comparison with Ti. Lower elastic modulus values are desirable when the metallic implant is subjected to mechanical stresses because small differences between elastic modulus of the implant and bone tissue reduce the stress shielding effect.

**Conclusions**: It was possible produce Ti-Nb alloys with 10 and 20 wt (%). The increase of Nb concentration stabilizes β phase and decreases the elastic modulus of the Ti-Nb alloys.

**References.**

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