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DEVELOPMENT OF A NEW Ti-Mo-Nb-Fe SYSTEM ALLOY

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Introduction

Titanium alloys are often studied for biomedical applications due to their mechanical properties, corrosion resistance, and biocompatibility. β-type alloys are interesting because their lower elastic modulus may reduce stiffness mismatch between implants and bone, limiting stress shielding. Molybdenum and niobium stabilize the β phase, while iron is also an effective β stabilizer and a relatively low-cost alloying element. Combining these elements offers an alternative for developing new titanium alloys suitable for implant applications.

Objectives

The objective of this study was to produce and characterize the Ti-4Mo-20Nb-2Fe alloy in the as-cast condition, evaluating its microstructural characteristics and mechanical properties, with emphasis on phase identification, hardness, and elastic modulus, in order to assess its potential for biomedical applications.

Methodology

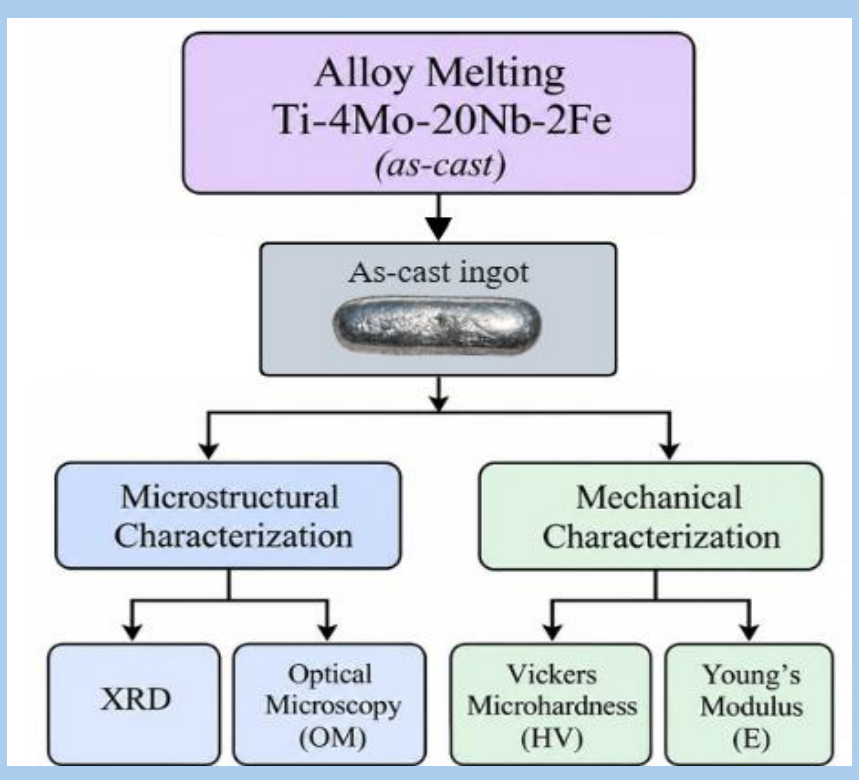


Figure 1. Flowchart of the experimental procedure for the Ti-4Mo-20Nb-2Fe alloy

Results and Discussion

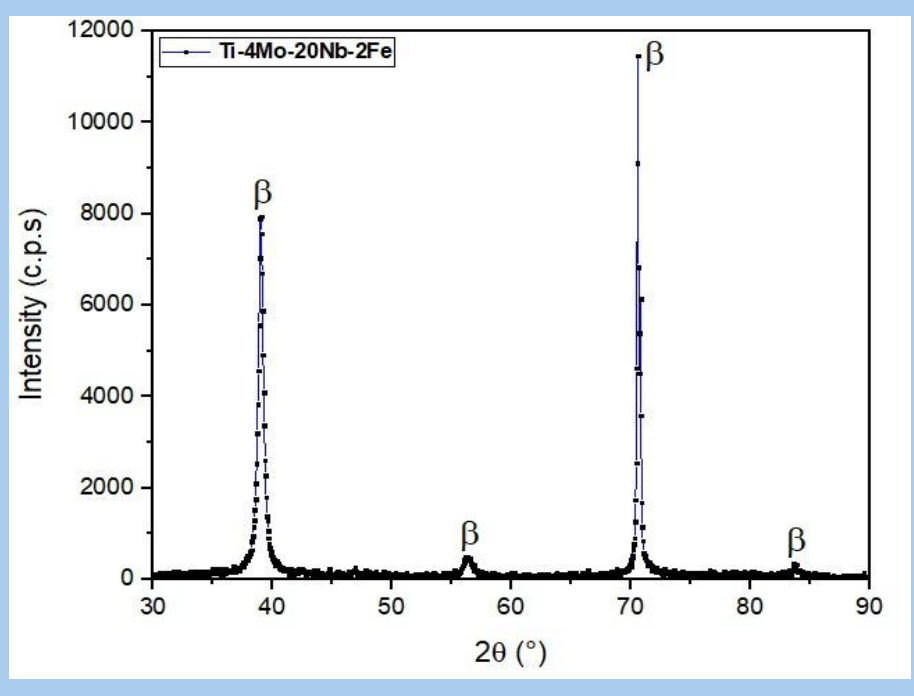


Figure 2. X-ray diffraction pattern of the Ti-4Mo-20Nb-2Fe alloy in the as-cast condition.

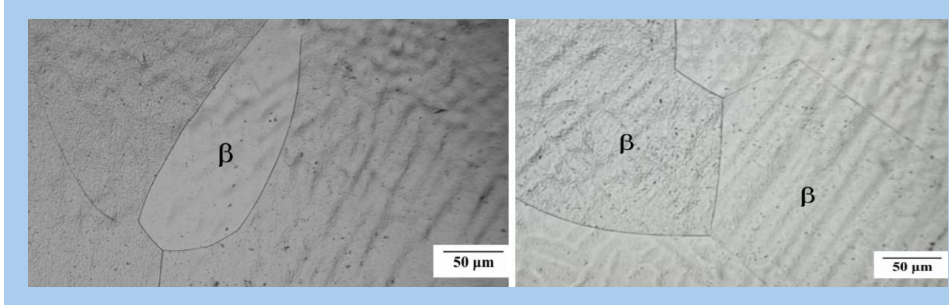


Figure 3 – Optical micrographs of the Ti-4Mo-20Nb-2Fe alloy in the as-cast condition, at a magnification of 500×: (a) first analyzed region; (b) second analyzed region

Material	Condition	H/E
Ti cp	Commercial	2.60
Ti-6Al-4V	Commercial	2.93
Ti-4Mo-20Nb-2Fe	As-cast	3.82

Table 1 – Comparison of the H/E ratio between the developed alloy and reference materials.

Conclusions

The Ti-4Mo-20Nb-2Fe alloy presented a single-phase β structure, an H/E ratio of 3.82, and a Young's modulus of 82 GPa. Compared with grade 2 titanium and Ti-6Al-4V, the alloy showed a higher H/E ratio and lower elastic modulus. These results, combined with the relatively low cost of its alloying elements, highlight its potential as an alternative for biomedical applications.

References

EHTEMAM-HAGHIGHI, S. et al. Phase transition, microstructural evolution and mechanical properties of Ti-Nb-Fe alloys induced by Fe addition. *Materials & Design*, v. 97, p. 279–286, 2016. DOI: 10.1016/j.matdes.2016.02.094.

MOSHOKOA, N. et al. Influence of intermetallic phase (TiFe) on the microstructural evolution and mechanical properties of as-cast and quenched Ti-Mo-Fe alloys. *Scientific Reports*, v. 14, p. 10461, 2024.

XU, L. J.; CHEN, Y. Y.; LIU, Z. G.; KONG, F. T. The microstructure and properties of Ti-Mo-Nb alloys for biomedical application. *Journal of Alloys and Compounds*, v. 453, n. 1–2, p. 320–324, 2008.

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