International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

MICROSTRUCTURE AND MECHANICAL PROPERTIES OFHOT ROLLED TINBSN ALLOYS

Anandan U M, Arinarayanan.P, ,Gokulraj.R ,Gowtham.P, , Nandhakumar.S
Depertment of Mechanical Engineering,
PERI Institute Of Technology,
Chennai-48

Introduction

Titanium (Ti) alloys are widely used in biomedical applications due to their excellent corrosion resistance, biocompatibility, and favorable mechanical properties. Among these, Ti-Nb-Sn alloys have garnered attention because of their non-toxicity and desirable mechanical properties, such as low Young's modulus, which is closer to that of human bone, reducing stress shielding effects.

Microstructure

The microstructure of TiNbSn alloys is primarily influenced by the composition and processing conditions, such as hot rolling. Hot rolling affects grain size, phase distribution, and overall microstructure, which in turn impact the mechanical properties of the alloy.

1. **Phases and Grain Structure**:

- The Ti-Nb-Sn system typically forms a β-phase (body-centered cubic structure) at highNb and Sn contents. This β-phase is stable at room temperature, which is beneficial for maintaining low modulus and good ductility.

- The presence of Sn helps in stabilizing the β-phase and refines the grain structure. Finegrains are often desired for improved mechanical properties.

- The hot rolling process leads to the recrystallization of grains, resulting in a more homogeneous microstructure.

2. **Secondary Phases**:

- Depending on the Nb and Sn content, secondary phases such as α (hexagonal close- packed structure) or ω phases can form. These phases can negatively affect the ductilitybut can enhance the strength of the alloy.

INTERNATIONAL CONFERENCE ON CORE ENGINEERING AND TECHNOLOGY '2024 (ICCET'24), PERI INSTITUTE OF TECHNOLOGY, CHENNAI-48; ISBN: 978-93-340-4983-1 © 2024, IRJEdT Volume: 06 Issue: 06 | June-2024

Mechanical Properties

The mechanical properties of hot-rolled TiNbSn alloys are influenced by themicrostructure, which can be tailored through composition and processing.

1. **Strength and Ductility**:

- The yield strength and ultimate tensile strength of TiNbSn alloys increase with theaddition of Nb and Sn due to solid solution strengthening and grain refinement.

- The ductility, represented by elongation at fracture, is maintained or improved with proper hot rolling parameters that prevent the formation of brittle phases.

2. **Elastic Modulus**:

- One of the critical advantages of TiNbSn alloys is their low elastic modulus. The β-phase contributes to a lower modulus, which is beneficial for biomedical implants to reduce stress shielding.

- The modulus can be further adjusted by optimizing the hot rolling conditions to achieve a desirable balance between strength and elasticity.

3. **Hardness**:

- The hardness of TiNbSn alloys generally increases with Nb and Sn content. Hot rollingcan also enhance hardness by work hardening and grain refinement.

Conclusion

Hot rolled TiNbSn alloys exhibit a favorable combination of microstructure and mechanical properties, making them suitable for biomedical applications. The β-phase stability, low elastic modulus, high strength, and good ductility are key attributes that can be achieved through careful control of alloy composition and hot rolling parameters.

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This text provides a structured overview of the microstructure and mechanical properties of hot-rolled TiNbSn alloys, along with references to relevant literature for further reading. If you need more detailed information or additional references, feel free to ask!