Selective Laser Melting of Ti6Al4V for Biomedical Applications

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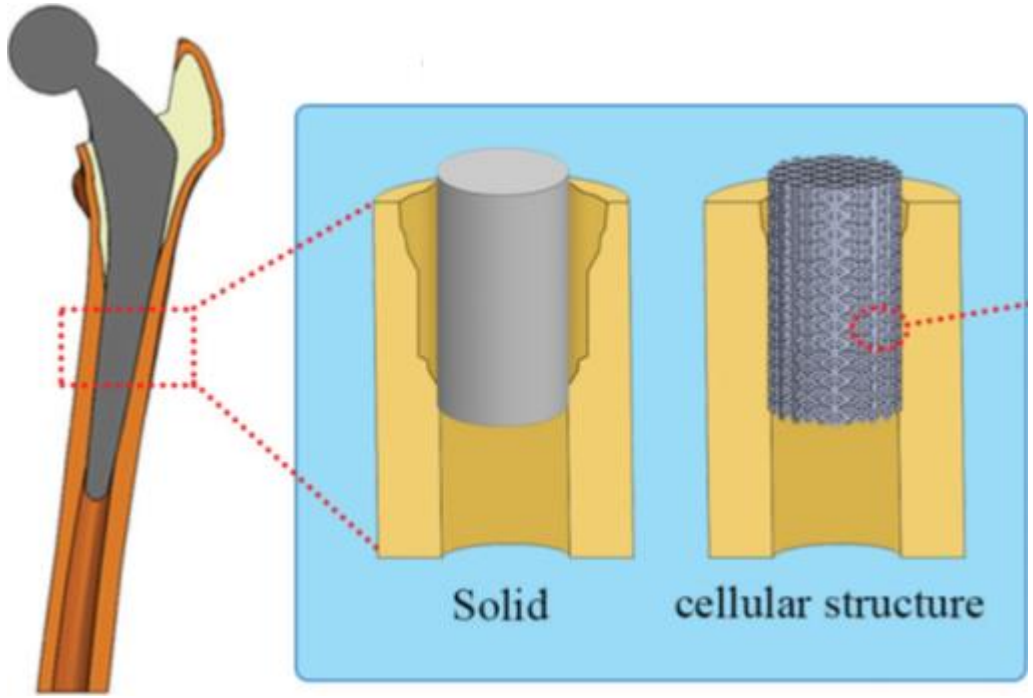
The most important issues

Difference of the Young's modulus between bone (10–30 GPa) and metallic implant materials (110 GPa for Ti and 248 GPa for CoCrMo alloy)

Osteolysis and aseptic loosening

Lack of bioactivity

- **Cellular structure (scaffolds)**
- **Hydroxyapatite (HAp)**



Tasks: SLM of Ti6Al4V-HAp

1- Selection and characterization of the base materials.
SEM - DSC

2- SLM of Ti6Al4V
Tensile – Hardness – SEM – XRD - DMA

3- SLM of Ti6Al4V
Tensile – Hardness – SEM – XRD - DMA

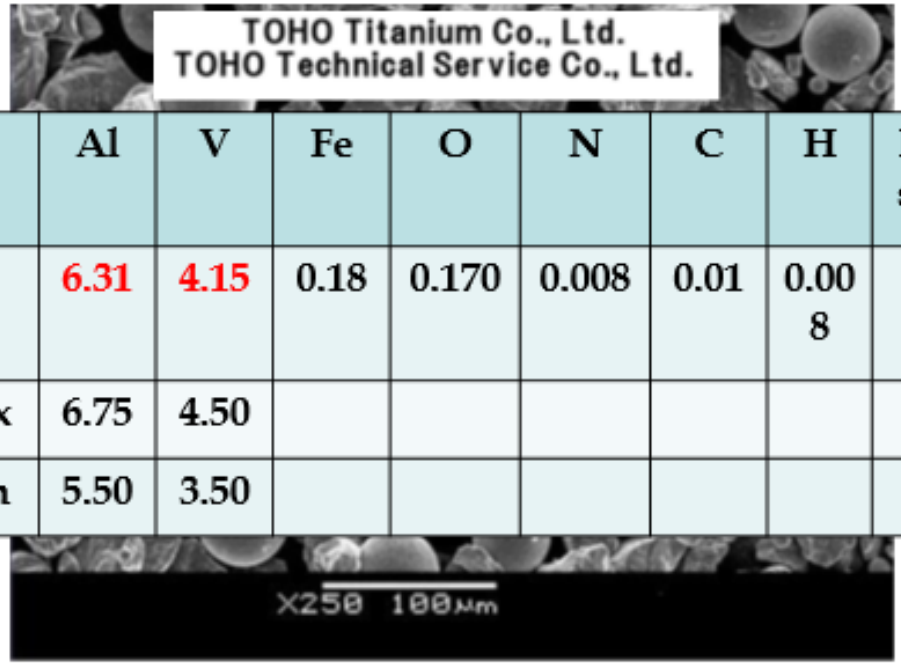
5- Design scaffold structure.
Tensile - DMA

6- Papers and thesis writing.

Experimental Work

- **Selection and characterization of the base materials**

1- Ti6Al4V Powder

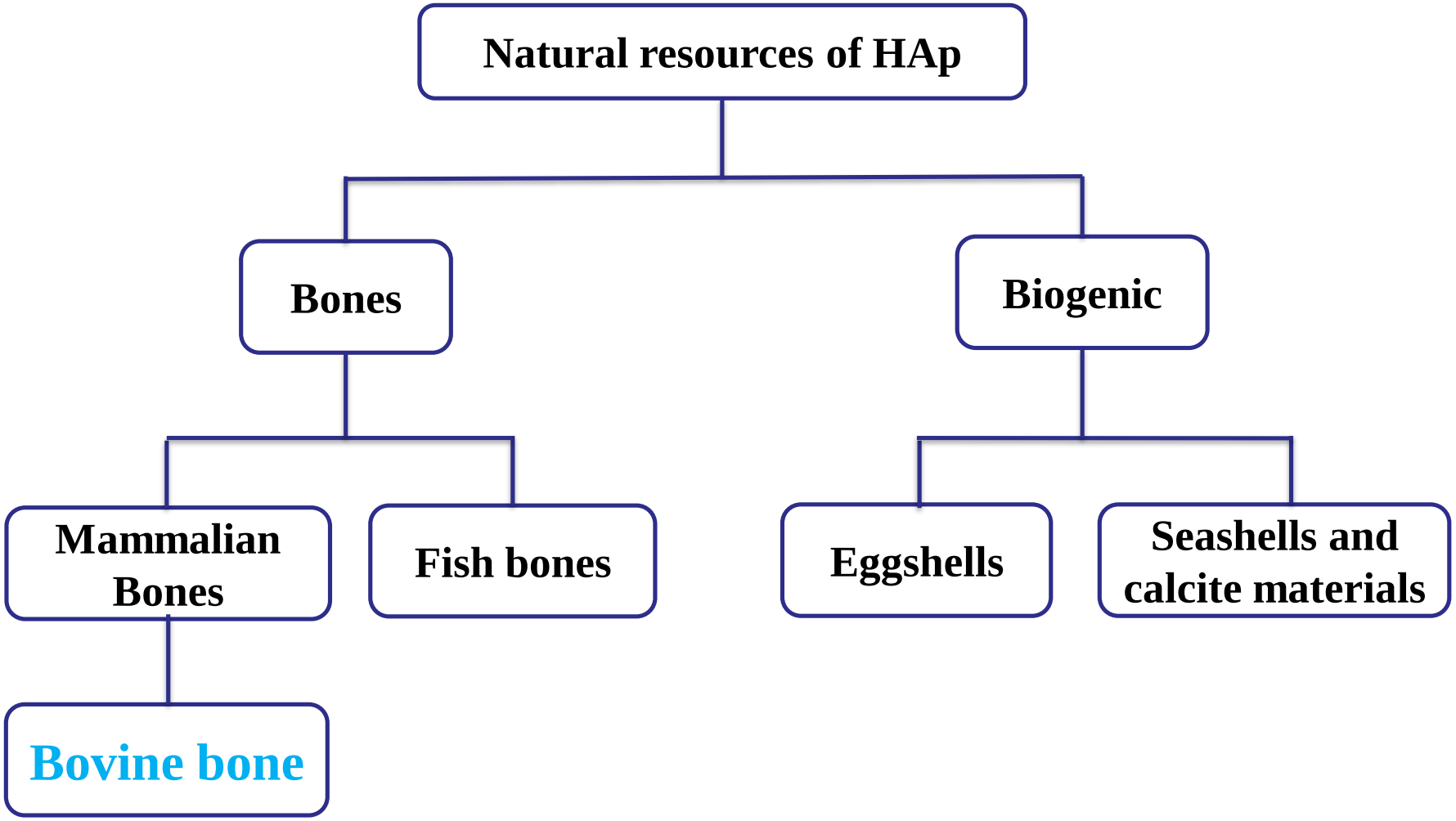


Mass%		Al	V	Fe	O	N	C	H	Particle size μm
Ti6Al4V (50%+50%)		6.31	4.15	0.18	0.170	0.008	0.01	0.008	63-150.
ASTM	Max	6.75	4.50						
	Min	5.50	3.50						

Fig.1 SEM micrographs of Ti-6Al-4V alloy powder

Experimental Work

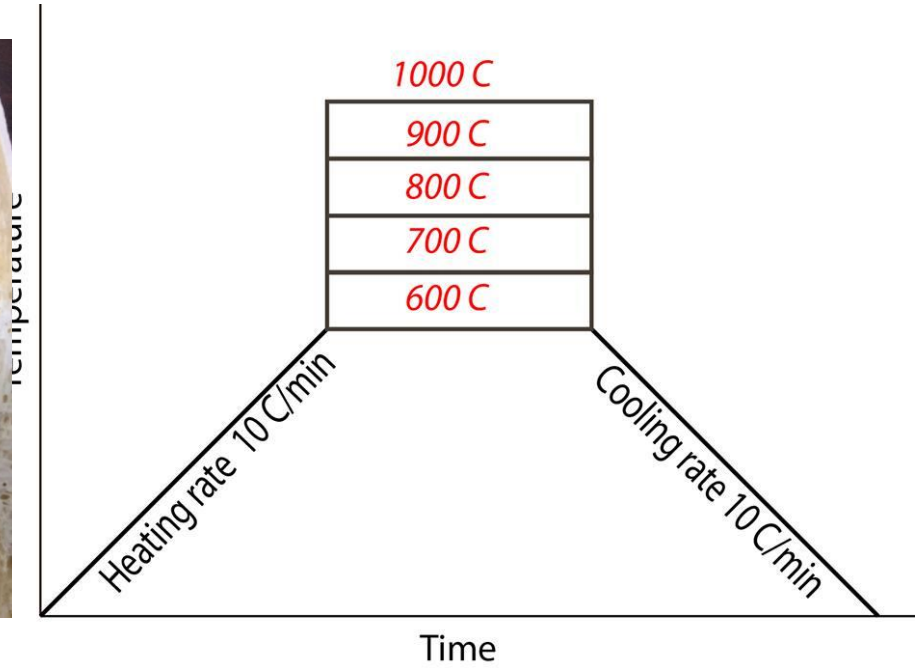
2- Hydroxyapatite Powder



Experimental Work

2- Hydroxyapatite Powder

Bovine bone after preparation



Calcination process

Bovine bone after calcination process

Results

2- Hydroxyapatite Powder

Energy Dispersive Spectroscopy (EDS) examination

Temp	Ca/P
600	2.425037
700	1.9907
800	1.865787
900	1.8547
✓ 1000	1.6 near 1.67 for human bone

Ca/p atomic ratio at various temperature

Sample	1000-a
	wt%
C	2.702
O	40.573
Na	1.101
Mg	0.716
Si	1.093
P	17.368
Cl	0.072
K	0.462
Ca	35.913

Chemical composition of bone at 1000 °C calcination temperature

Next Semester

- Study the effect of laser power and scan speed, and laser energy density on mechanical properties such as tensile test and hardness.

- Investigate the effects ofthe build orientation and heat treatments on the microstructureand mechanical properties of additively manufactured lattices tructures .

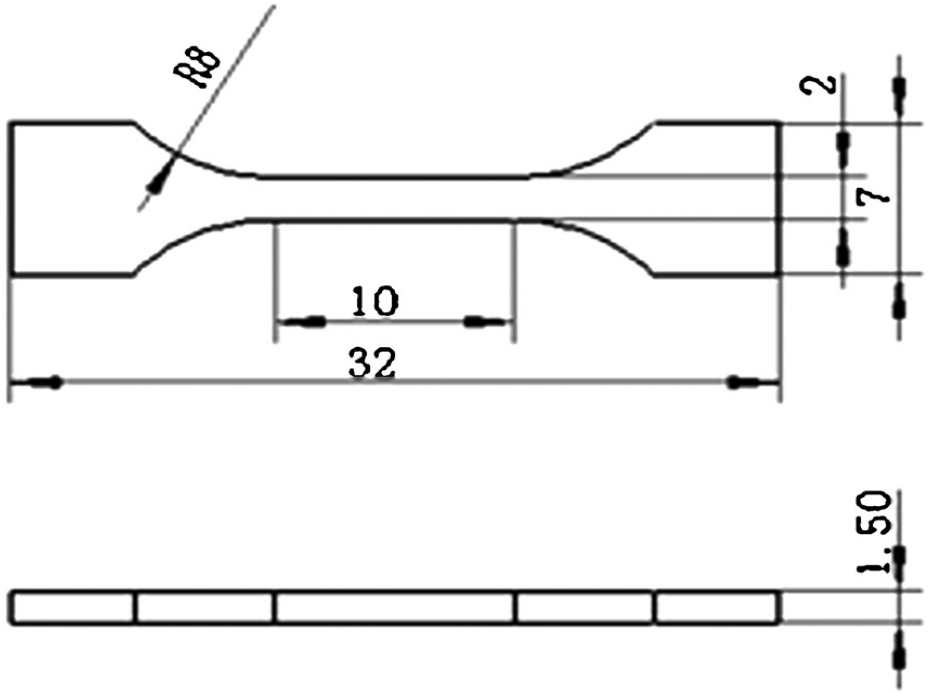
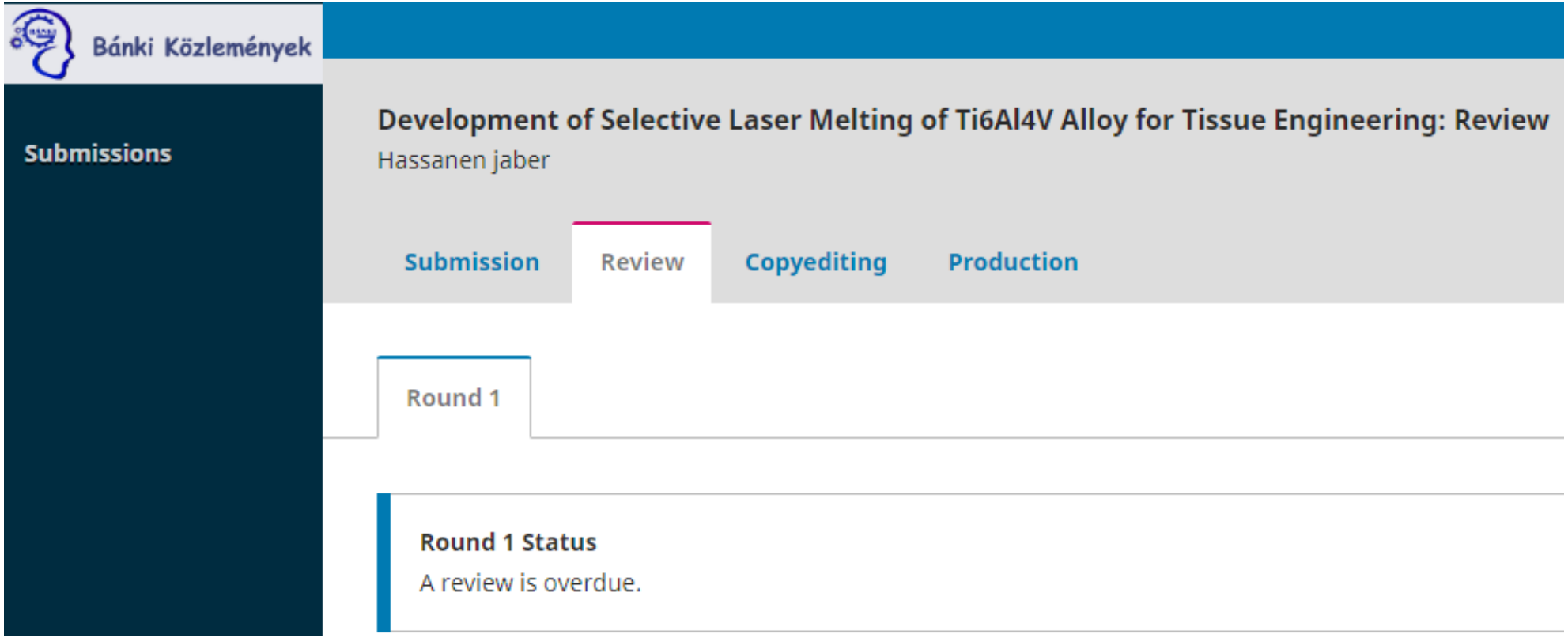


Fig. The size and shape of the tensile specimen.

Activities: Publications



Phase Transformations and Microstructure in Ti-6Al-4V

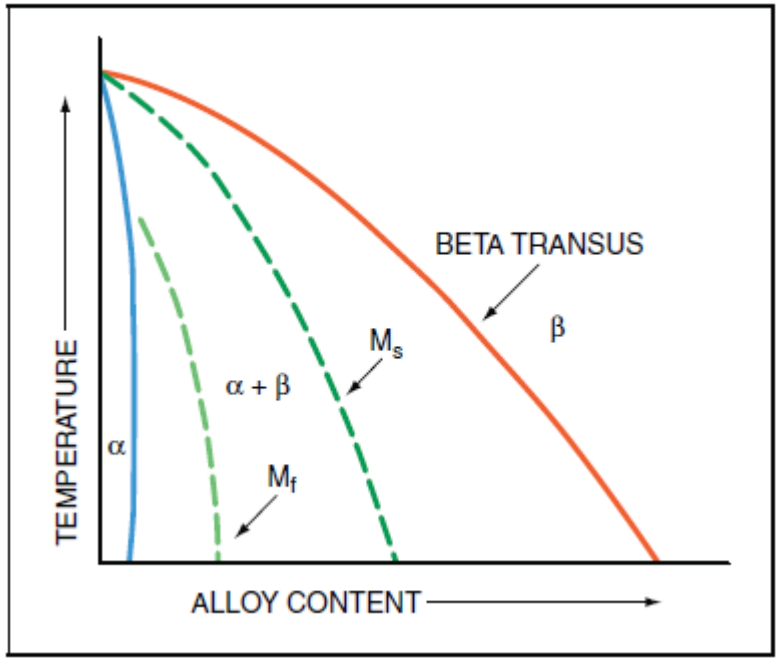
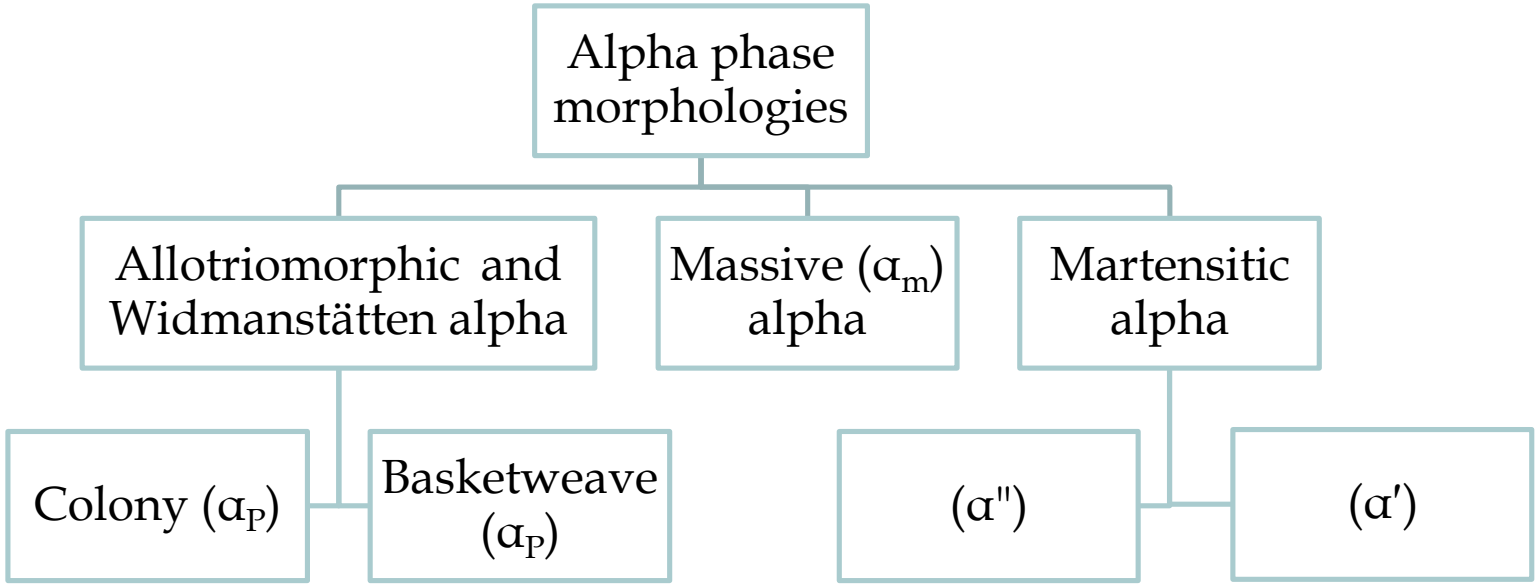
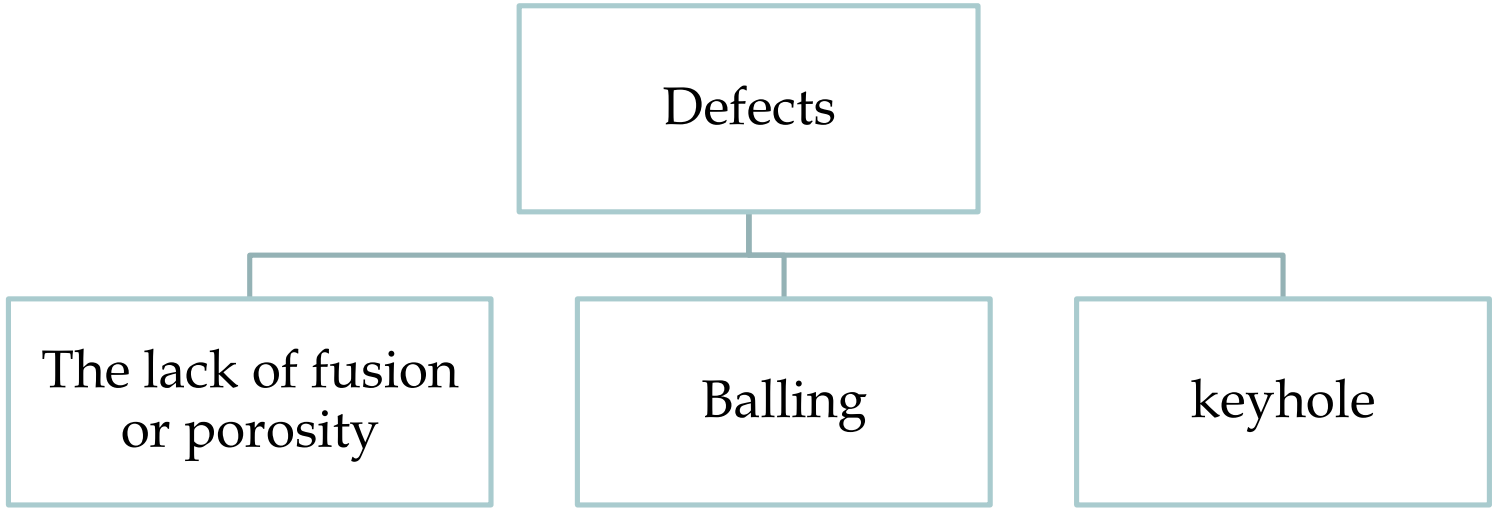


Fig. Typical Equilibrium Phase Diagram for Titanium Alloyed with an Isomorphous Beta Stabilizer



The Most Important defects for SLM Ti Alloys



Activities: Participation in the Education of Undergraduate Students

1. Tensile Test
2. Impact Test
3. Hardness Test
4. Crystalline Structures
5. Imperfections in Crystalline Materials
6. Solidification of Metals and Alloys
7. Phase (equilibrium) Diagrams
8. Iron-Carbon Alloy System

Activities: Doctoral Subjects

Subjects	Lectures
Titanium alloys	Dr. Peter Pinke
Phase Transformation	Dr. Tamás Réti
Fracture mechanism	Dr. Tunde Kovacs

Publications

- **Jaber H., Kovacs T. (2018)** Dissimilar Resistance Spot Welding of Ferrite-Martensite Dual Phase Steel/Low Carbon Steel: Phase Transformations and Mechanical Properties. In: Jármai K., Bolló B. (eds) Vehicle and Automotive Engineering 2. VAE 2018. Lecture Notes in Mechanical Engineering. Springer, Cham **First Online**10 May 2018 **DOI**https://doi.org/10.1007/978-3-319-75677-6_60. **Publisher Name** Springer, Cham **(Scopus).**
- **Jaber H., Kovacs T. (2019)** The Effect of Nano-Quenching Media on the Tensile Properties and Microstructure of Medium Carbon Steel. Interdisciplinary Description of Complex Systems Journal. in press (**WoS**)
- Jaber, H., Kovács, T. (**2018**). Similar and Dissimilar Resistance Spot Welds of DP600 and X8Cr17 steels sheets: Welding Current and Fracture Toughness. Bánki Közlemények 1(1), 67-72.
- Jaber, H., Kovács, T. (**2018**). Development of Selective Laser Melting of Ti6Al4V Alloy for Tissue Engineering: Review Bánki Közlemények. Under review

THANK YOU

Any questions