

TRIP AND TWIP as Key Tools to **Design** Advanced AM Alloys for Aviation Structures

T³Design

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Brief description of the consortium partners



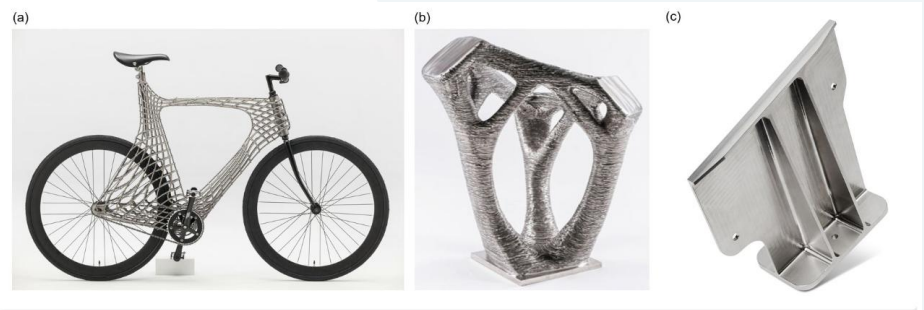
- Expertise in light metal processing
- Expertise in alloy characterization
- Advanced processing technologies incl. wire-arc directed energy deposition (waDED)



- Expertise in Density Functional Theory
- Expertise Computational Materials Science

Aim of the project / Background of the project

- Additive manufactured structures contain large numbers of notches (geometric and metallurgical)



Aims:

- Development of alloys using Transformation Induced Plasticity and Twinning Induced Plasticity for waDED
- Development of an efficient integrated numerical/experimental alloy screening method
- Testing of the approach in advanced titanium alloy compositions

Project results – Processing

- ... among many others!

Plasma Arc Directed Energy Deposition – **PA-DED**:

- Non-consumable tungsten electrode;
- Two different arcs – pilot and main arc;
- Higher process control.
- Conventional diameters: \varnothing 1.0 – 1.2 – 1.6 mm;
- Limits alloy availability and deposition rates.
- Due to PA-DED adjustability – Thicker wires are possible:
 - **\varnothing 3 mm diameter** wire was used.



(Torch-system developed by INO in collaborative project GEPROBA, <https://projekte.ffg.at/projekt/4762069>)

Project results – Alloy

Titanium is an allotropic material:

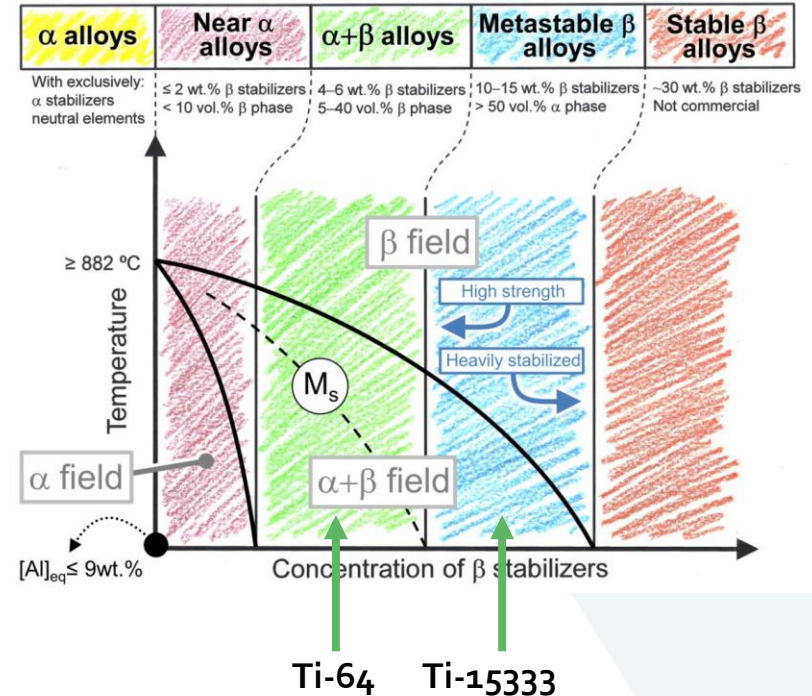
2 lattice structures (phases):

- α -phase (h.c.p);
- β -phase (b.c.c).

The current study focused on a metastable β alloy – **Ti-15V-3Cr-3Al-3Sn**:

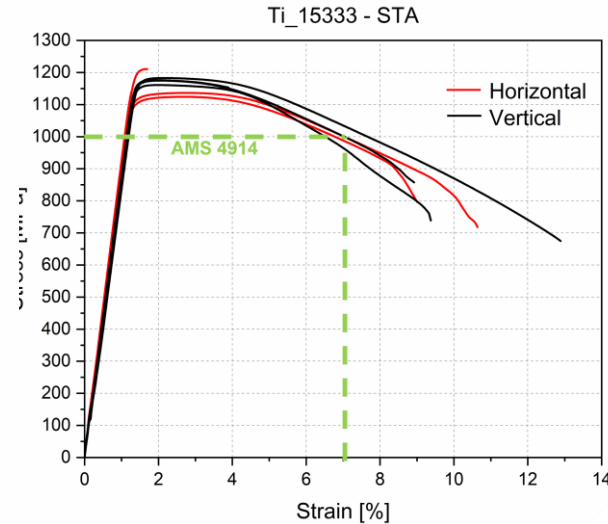
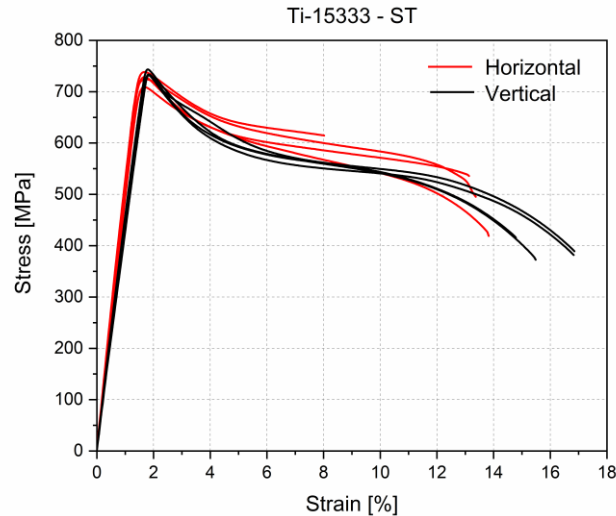
- Sheet;
- Rivets.

Dominant alloy in the market – Ti-6Al-4V



Project results – Properties

ST... Solution treated
STA... Solution treated and aged



- Surpassed AMS standard
- Observed new phenomenon of continuous softening in ST condition

Utilization of the project

- Foundation for large-scale European project presently under evaluation
- Project showed, for the first time, that the high-performance alloys Ti-15V-3Cr-3Al-3Sn and Ti-10V-2Fe-3Al can be processed by waDED with exceptionally good properties
- Project contributed to our position in the field of advanced titanium processing

Further steps/(potential) follow-up projects

- Project EMPowerMet coordinated by LKR/AIT presently under evaluation

