

TU Graz mission!

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ÚSTAV KONSTRUOVÁNÍ
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VUT v Brně

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TU Graz mission

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- Live at Graz
- TU Graz
- Ti6Al4V at elevated temperatures
 - Aim of the work
 - Material and methods
 - Results
- Benefits of the internship



Project information

International mobility of researchers at the Brno University of Technology

- **Graz University of Technology**
 - Institute of Material Science, Joining and Forming (IMAT)
 - Prof. Christof Sommitsch
 - Institute of Production Engineering (IFT)
 - Prof. Rudolf Pichler
- 1. 5. 2018 – 31. 10. 2018
- 12th International Seminar Numerical Analysis of Weldability in Seggau

Live at Graz

Graz = Austrian Brno

- 289 440 inhabitants
- Second largest city
- 4 universities, 50 000 students



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- Schlossberg, Uhrтурm, Eggenberg



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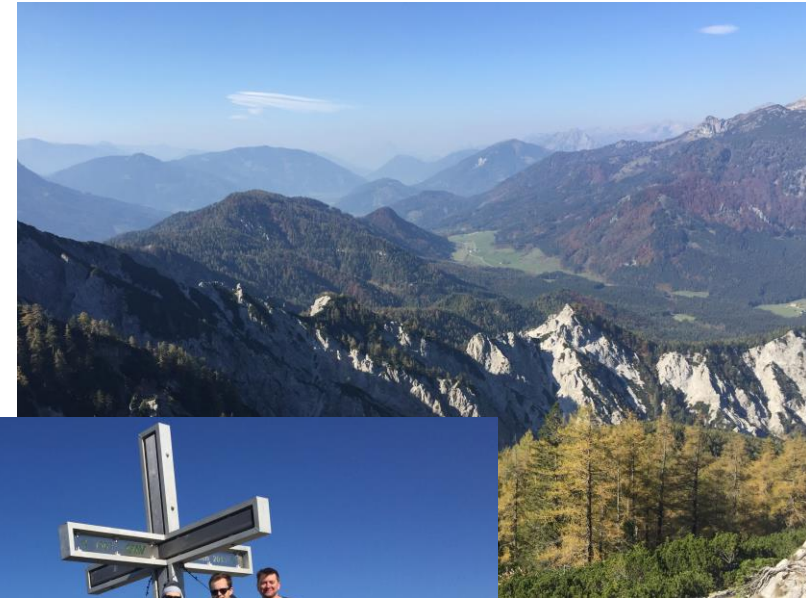
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Live at Graz



TU Graz



TU Graz - IFT



TU Graz - IMAT



Graz research

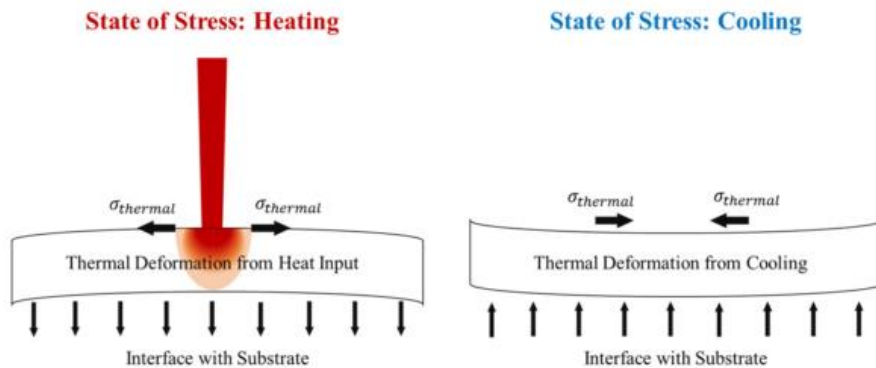
Ti6Al4V at elevated temperatures

- State of the art
- Aim of the work
- Material and Methods
- Results

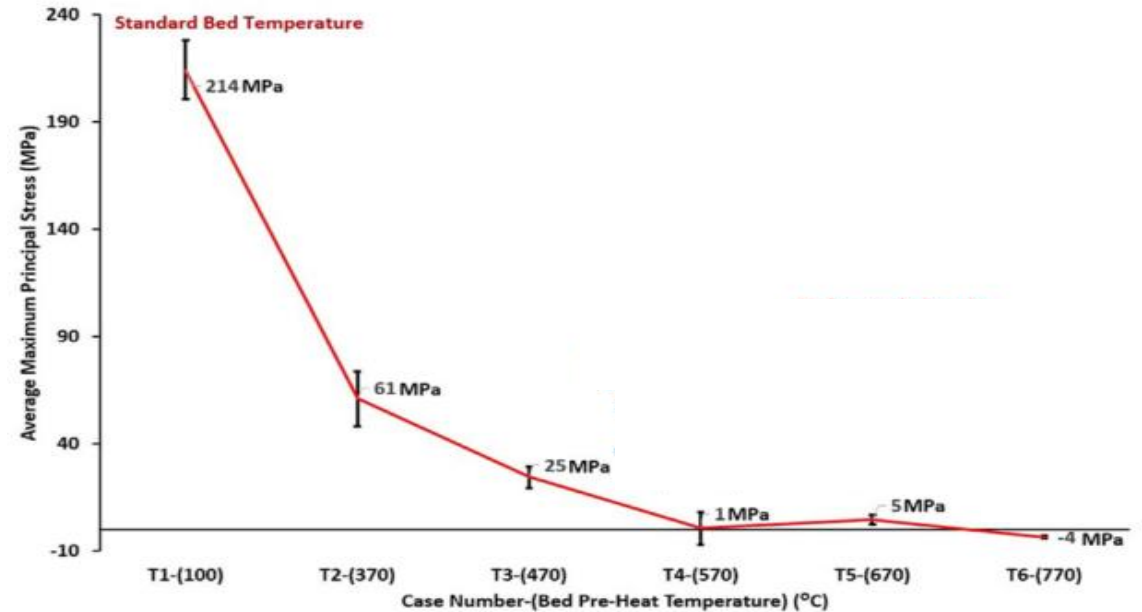
Ti6Al4V at elevated temperatures

State of the art

- Microstructure change
 - α' martensite to $\alpha+\beta$
- Increasing of ductility
- Decreasing of residual stress



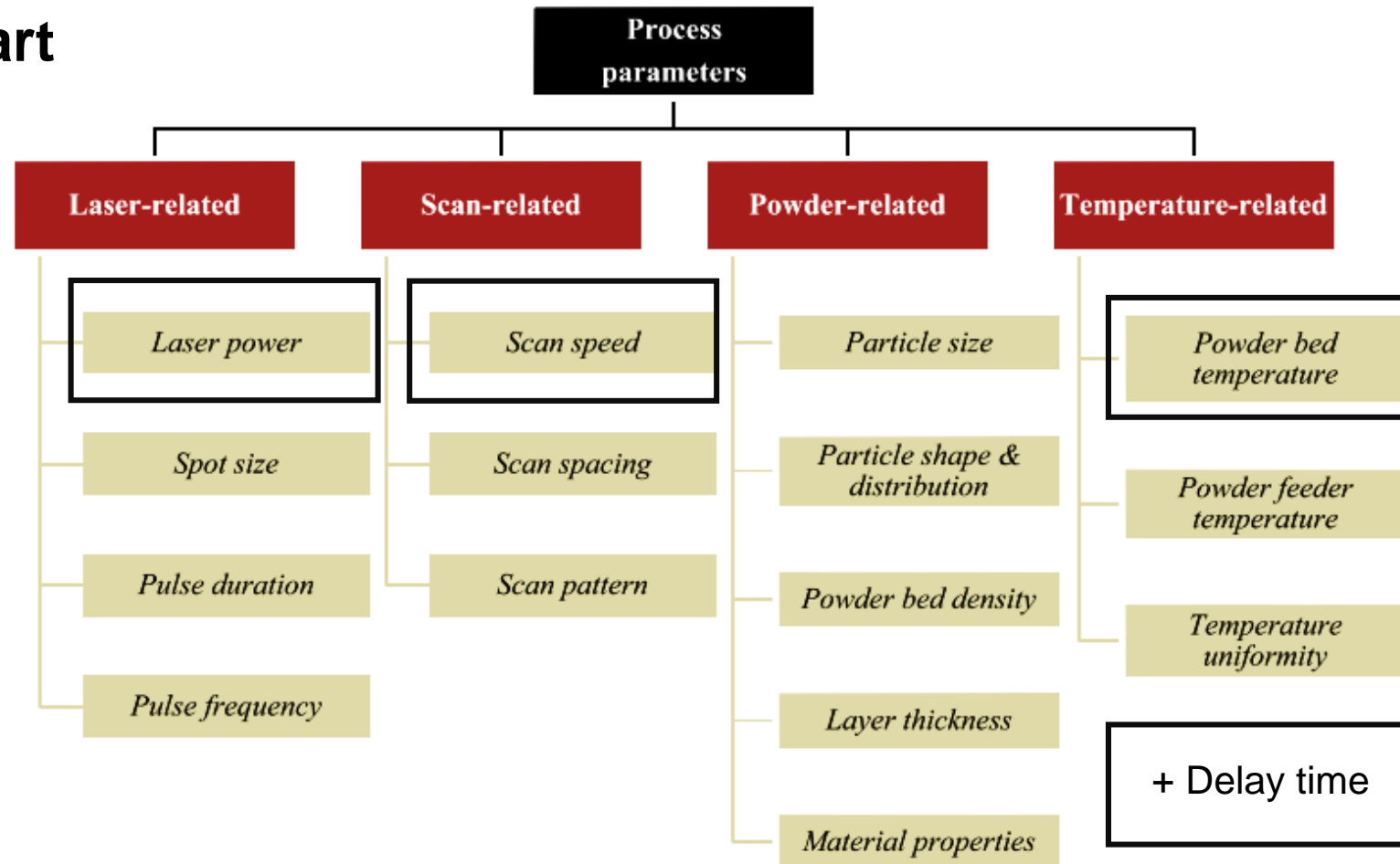
Patterson 2017



Haider 2017

Ti6Al4V at elevated temperatures

State of the art



Aboulkhair 2014

Ti6Al4V at elevated temperatures

Research goal

- Determination optimal process parameters for printing with minimum residual stresses under high preheating temperature
- Decrease the amount of necessary support structures by high temperature preheating

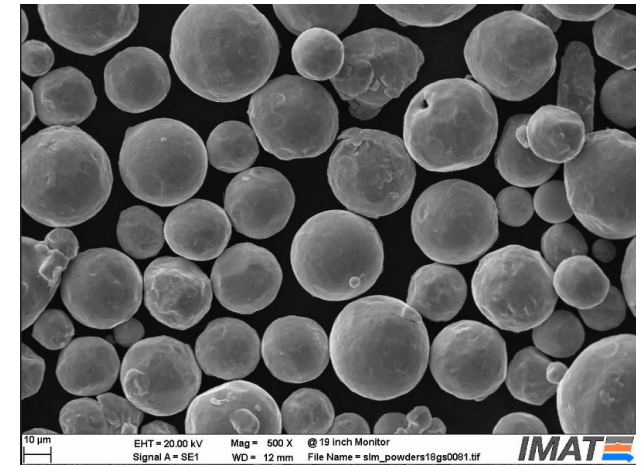
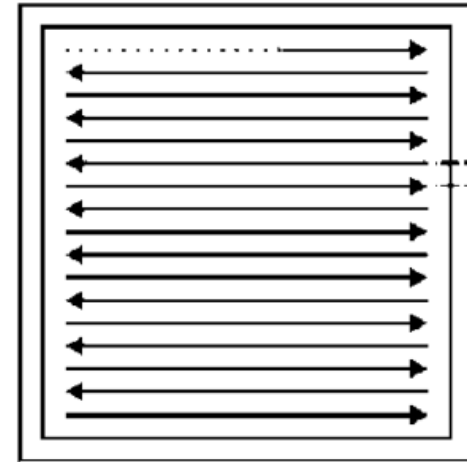
Ti6Al4V at elevated temperatures

Material and Methods

- Ti6Al4V powder
- Variable Parameters:
 - Hatch laser velocity: (700 – 1100) mm/s
 - Hatch laser power: (275 – 100) W
 - (65.5 – 15.2) J/mm³
 - Border laser velocity: (350 – 800) mm/s
 - (5.7 – 2.5) J/mm²
 - Delay: (0 – 60) s
 - Preheating: (200 – 550) °C
- Surface Response Design
 - 30 samples, 10 build jobs
 - Minitab 17

Standard parameters

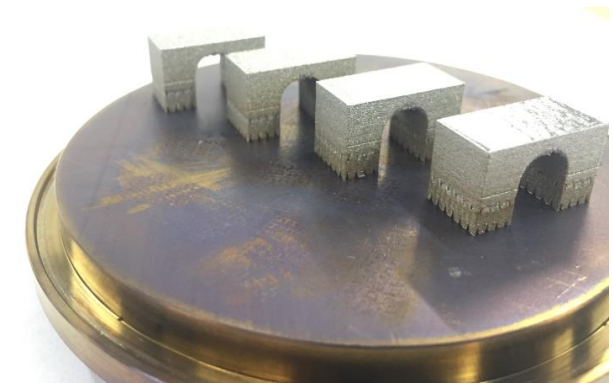
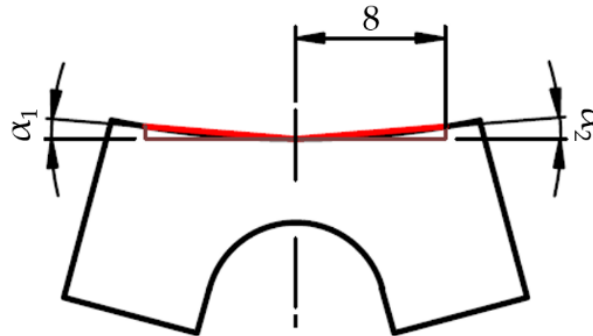
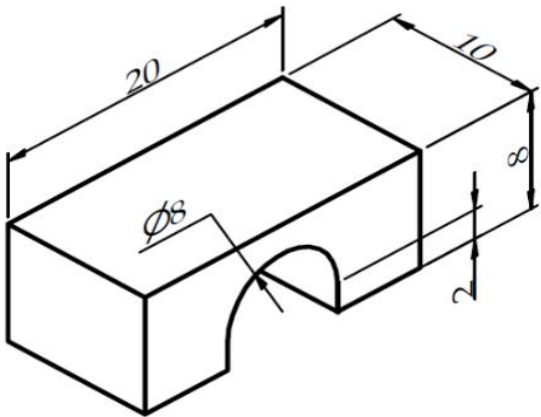
- Hatch: 60.3 J/mm³
- Border: 5.7 J/mm²
- Delay: 0 s
- Preheating: 200°C



Ti6Al4V at elevated temperatures

Material and Methods

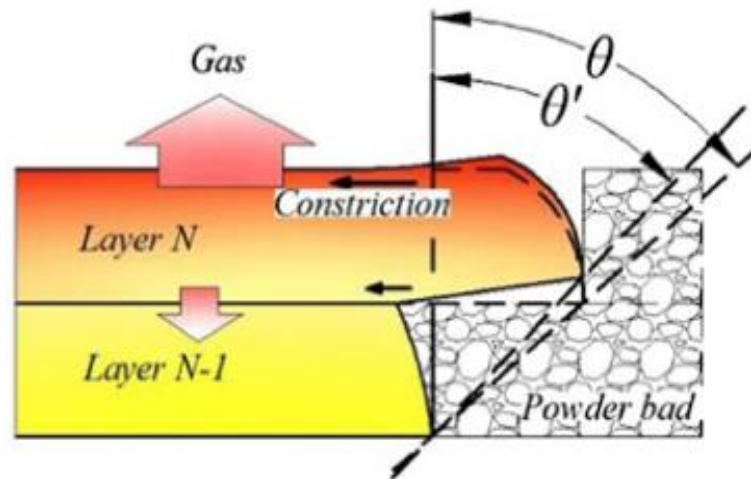
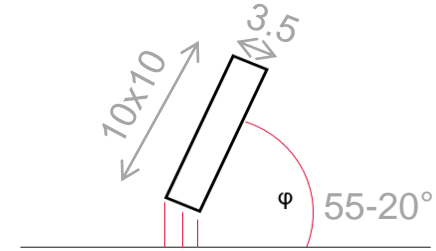
- Bridge samples – Kruth design
- Distortion – 3D optical scanner (Atos Triplescan)
- Relative density – Optical method



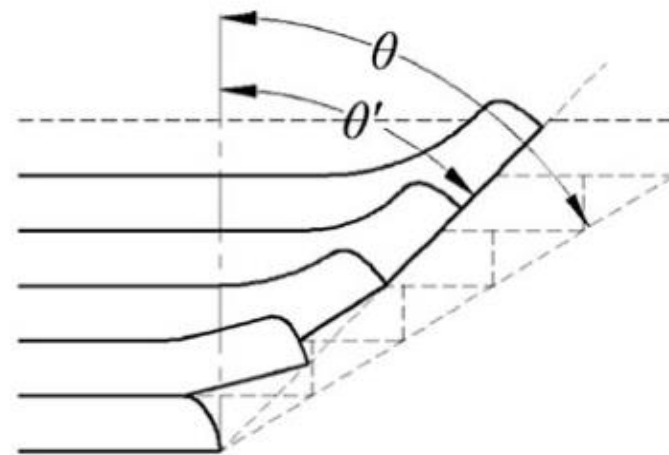
Ti6Al4V at elevated temperatures

Support structures reduction - Inclined samples

- Less residual stress -> lower inclination



(a) warping principle



(b) warping accumulation

Wang 2013

Ti6Al4V at elevated temperatures

Conclusion

- Preheating to 550°C
 - Lowered the distortion
 - Positive effect on relative density
- Delay time
 - Higher delay -> higher distortion
 - Almost no effect on relative density
- Energy density
 - Higher energy density -> lower distortion

Graz mission

Benefits of the intership

- New contacts
- Professional preheating device
- Method for drying reactive powders
- DoE and SRD
- Archimedes method, SEM, LOM
- Drilling method
- Seggau conference
- Presentation on IMAT
- Ti mixtures research cooperation

Thank you for your attention!

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www.ustavkonstruovani.cz