

Design, development, and laser powder bed fusion of Ni#Al intermetallic-based superalloys

Summary

A fully funded four-year PhD position is available for an Early-Stage Researcher in the field of additive manufacturing, with a specific focus on the design, development, and laser powder bed fusion (LPBF) of Ni#Al intermetallic-based superalloys. Ni#Al-based superalloys offer superior mechanical performance compared to conventional Ni-based superalloys due to their extra high content of strengthening intermetallic phase. These materials are particularly well-suited for high-temperature applications, such as components in the hot sections of aero engines, where mechanical strength, thermal stability, and low density are essential. However, the additive manufacturing of these alloys presents processing challenges -such as cracking and defects - that require a careful and comprehensive approach to overcome.

Research field:	Production and materials engineering, robotics, transport and logistics
Supervisors:	Prof. Dr. Irina Hussainova Dr. Tatevik Minasyan
Availability:	This position is available.
Offered by:	School of Engineering Department of Mechanical and Industrial Engineering
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

Project goals

The core aim of this PhD project is to design and develop novel Ni#Al intermetallic-based superalloys for high-temperature applications, particularly in the hot sections of small engines. By developing new alloy chemistries, the project aims to achieve a combination of appropriate processability and high mechanical strength which are critical challenges in additive manufacturing of these materials.

A huge portion of the work will involve the use of thermodynamic simulations and calculations to guide alloy design and predict cracking susceptibility. These simulations will provide insights to narrow down suitable compositions for the LPBF process.

Once the compositions are selected, the project will focus on optimizing the LPBF process, including parameter development and optimization of multi-stage heat treatments. The goal is to achieve controlled microstructural evolution that ensures desired mechanical properties at elevated temperatures. Finally, the PhD researcher will be involved in the design, fabrication, and performance evaluation of prototype components demonstrating the alloy's potential for use in high-temperature environments.

What we offer

- A four-year PhD position at one of the most international and research-intensive technical universities in Estonia
- Participation in pan-European and national research projects
- The opportunity to conduct interesting research in a highly collaborative, international environment
- Access to advanced LPBF systems and post-processing facilities
- Opportunities for international conference participation, research exchanges, and networking with well-known universities and research centers
- Active collaboration with industrial and academic partners

Candidate requirements

- A Master's degree in Materials Science, Metallurgy, Mechanical Engineering, or a related field
- A strong interest in additive manufacturing, alloy design, and laser processing technologies (prior research experience materials characterization, mechanical testing, alloy development or metallurgy will be advantageous)
- Solid understanding of thermodynamic calculations



- Strong analytical thinking and problem-solving abilities
- Motivation to engage in both computational modeling and experimental research

About the department

The Department of Mechanical and Industrial Engineering at TalTech focuses on practical engineering challenges, including self-driving vehicle technologies, development of new coatings, and additive manufacturing of various alloy systems. Our Bachelor's, Master's, and PhD programs graduate hundreds of students each year, and we also work closely with industry by providing engineering services - from simulation and modeling to production process optimization.

TalTech is equipped with modern laboratories for powder metallurgy, additive manufacturing, laser processing, and materials testing, including optical, metrology, and chemical analysis. This provides a strong foundation for advanced research and development in materials engineering.

Additional information

For further information, please contact Dr Tatevik Minasyan (tatevik.minasyan@taltech.ee) and Prof Irina Hussainova (Irina.hussainova@taltech.ee) or visit <https://taltech.ee/en/department-mechanical-and-industrial-engineering>

Main supervisor: Tatevik Minasyan

Co-Supervisor: Irina Hussainova

Co-Supervisor: Pablo Daniel Enrique



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