SWEDEN'S KEY AM RESEARCH CENTRES IN THE ARENA

Education

ÖREBRO UNIVERSITY

Courses with contents of AM
- Manufacturing Engineering, MT111G, 7.5 Credits
- Manufacturing Engineering for MSc in Engineering, MT508G, 9 Credits

LULEÅ UNIVERSITY OF TECHNOLOGY

- Production Engineering
- Additive Manufacturing
  - Processes
  - Materials
  - Products (design and testing)

DALARNA UNIVERSITY

- MSc Course: Powder Metallurgy & Additive Manufacturing
- Master thesis supervision

UNIVERSITY WEST

Education on advanced Master's level within AM, PhD student training within AM, and various courses on AM for industry.

KARLSTAD UNIVERSITY

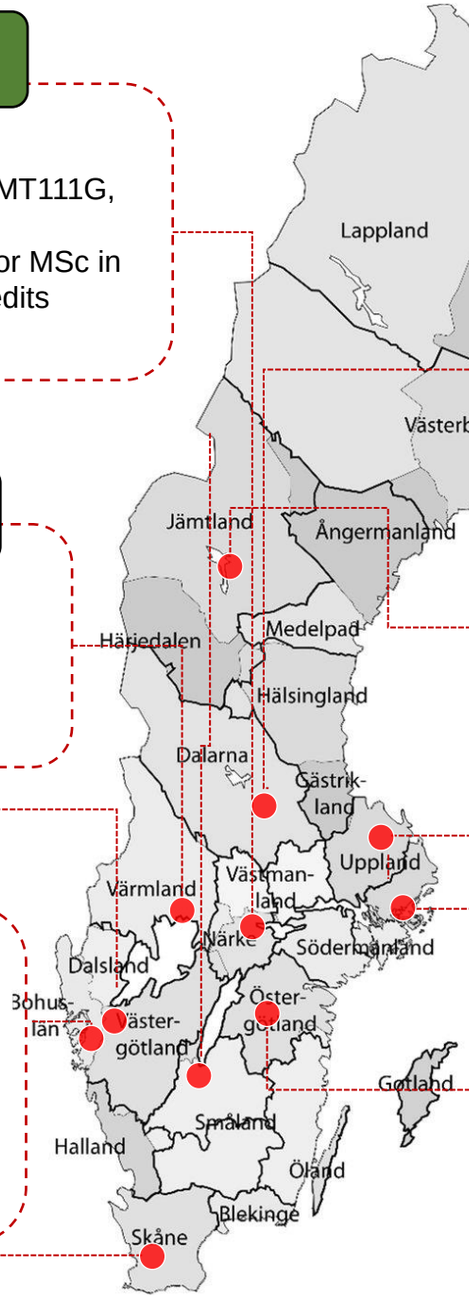
- MSc courses
- MASAM
- LPBF course book

MID SWEDEN UNIVERSITY

- Additive Manufacturing – B.Sc. in Mechanical Engineering (2020-)
- Additive Manufacturing – M.Sc. In Mechanical Engineering (2023-)

UPPSALA UNIVERSITY

- Master's program in additive manufacturing
- PhD student course: 3D-printing in biomedical materials
- Courses with contents of AM
- Master and PhD thesis
- Open seminar series on AM-topics



LUND UNIVERSITY

- Commissioned education on DfAM
- DfAM in several bachelor and master level courses

CHALMERS UNIVERSITY OF TECHNOLOGY

- Largest individual AM courses in Europe
- BSC and MSc course in AM
- Life-long education
- Summer course in AM
- Track course in AM
- Student projects
- Master and PhD thesis

LINKÖPING UNIVERSITY

- Master course on AM from 2022
- Several advanced courses include AM as a course part
- MSc and PhD thesis

KTH ROYAL INSTITUTE OF TECHNOLOGY

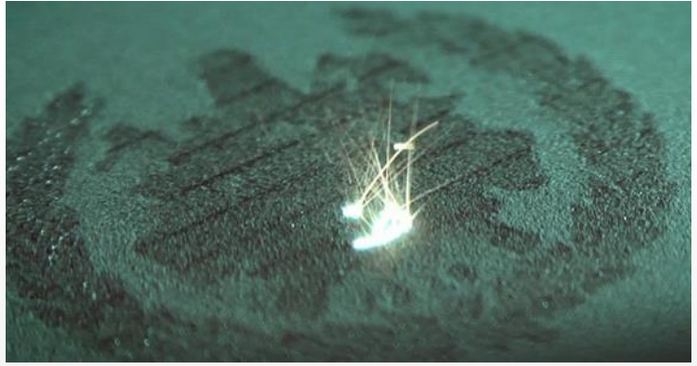
- MSc, PhD, thesis
- Student projects
- Courses: FMG3920
  MG2044
  MH2100
  MH2101

Prepared by Emmy Yu Cao
Annika Strondl
Esmaeil Sadeghi

The Swedish Arena for Additive Manufacturing of Metals

Chalmers University of Technology

Contact person: Eduard Hryha (hryha@chalmers.se)



MTT125 - Additive manufacturing

- BSc course, 7.5 credits
- 40 students/year for the Major subject ”Mechanical Engineering”
- Examiner: Lars Nyborg
- Aim: to gain knowledge of modern manufacturing with focus on additive manufacturing.
- Contents: pre-processing, product design, process know-how, basic aspects of manufacturing of metallic and polymeric products with respect to materials and processing technologies.

MTT120 - Additive manufacturing

- Master level course, 7.5 credits
- 70-80 studets/year
- Examiner: Eduard Hryha
- Aim: basic understanding regarding additive manufacturing as industrial method for manufacture of advanced parts.
- Contents: pre-processing, product design, process know-how, materials selection and basic aspects of manufacturing of metallic and polymeric products with respect to materials and processing technologies.

IMS075 - Additive manufacturing

- MSc/BSc level, 5 credits
- Summer course, on-line only, freestanding course
- for the Major subject ”Mechanical Engineering”
- Examiner: Lars Nyborg
- Aim: to gain some knowledge on additive manufacturing.

Other courses with contents of AM

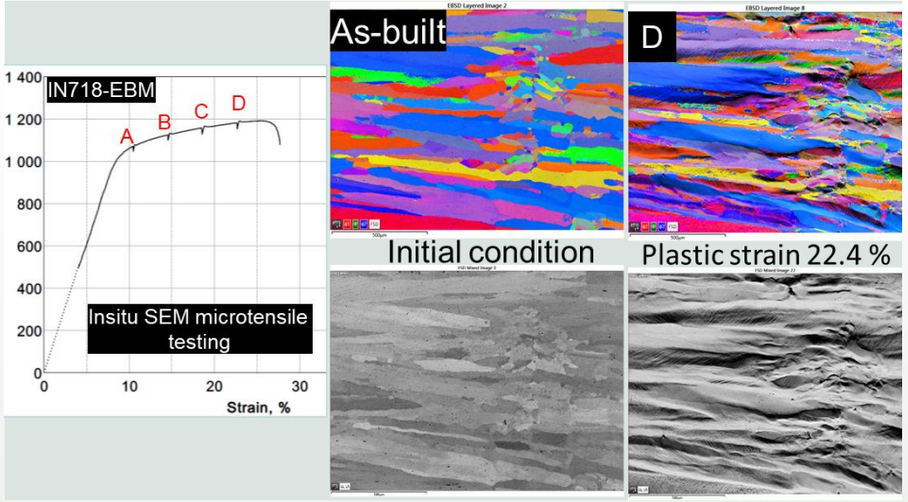
- MMT031 “Manufacturing engineering”
  Powder Metallurgy and Additive Manufacturing included
- LMU234 “Manufacturing engineering”
  Powder Metallurgy and Additive Manufacturing included

Others

- Largest individual AM courses in Europe
- Life-long education (Production 2030)
- Master/PhD thesis
- Student project, MSC/BS levels

Dalarna University

Kumar Babu Surreddi, kbs@du.se



Course information

- Powder Metallurgy with Additive Manufacturing, Basic level, 7.5 Credits

Contents: The course introduces the fundamental concepts of powder metallurgy with a special focus on additive manufacturing. The powder production, compaction, and sintering of powder metallurgical components are explained. The microstructure and mechanical properties of powder metallurgical components are discussed in terms of design and applications. A brief introduction to various metal additive manufacturing technologies is given. The concepts of raw material, process parameters and post-processing of metal additive manufacturing are discussed in relation to some case studies.

Master thesis related to AM

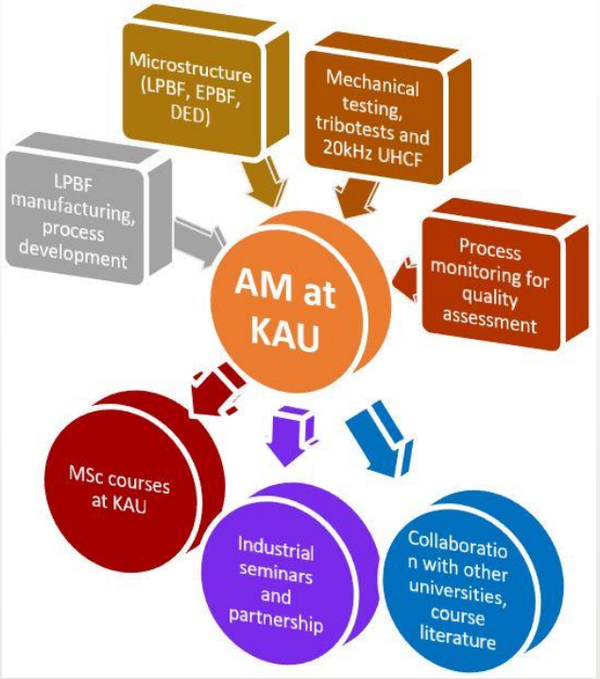
- Microstructure and Micro-Mechanical Characterization of As-built and Heat treated samples of Hastelloy X produced by Laser Powder Bed Fusion Process
- Investigations on microstructural and abrasive wear resistance behavior of additive manufactured high-speed steels
- Mechanical and tribological characterization of additive manufactured Co-free tool steels aimed for cutting tool bodies
- Mechanical and tribological characterization of additive manufactured Co-alloyed tool steels aimed for cutting tool bodies

Karlstad University

Pavel Krakhmalev, pavel.krakhmalev@kau.se

Courses and related activities

- AM topics (technology, formation of microstructure, basics of DfAM, CAD etc.) are integrated in MSc courses within civilingenjör i maskinteknik and short seminars for industries.
- KAU PhD courses in AM under development
- Participation in MaSAM – Master of Science in Additive Manufacturing KKS-supported project (MIUN, OU, KAU) 2021-2023



Others (Master/PhD thesis, student project, commissioned education, seminars, books…….)

2-3 MSc projects in AM yearly since 2019

Course book– “Fundamentals of Laser Powder Bed Fusion of Metals, 1st Edition”
ISBN - Paperback: 978-0-12-824090-8,
ISBN - eBook: 978-0-12-824091-5,
Imprint: Elsevier. https://www.elsevier.com/books-and-journals/book-companion/9780128240908

KTH Royal Institute of Technology

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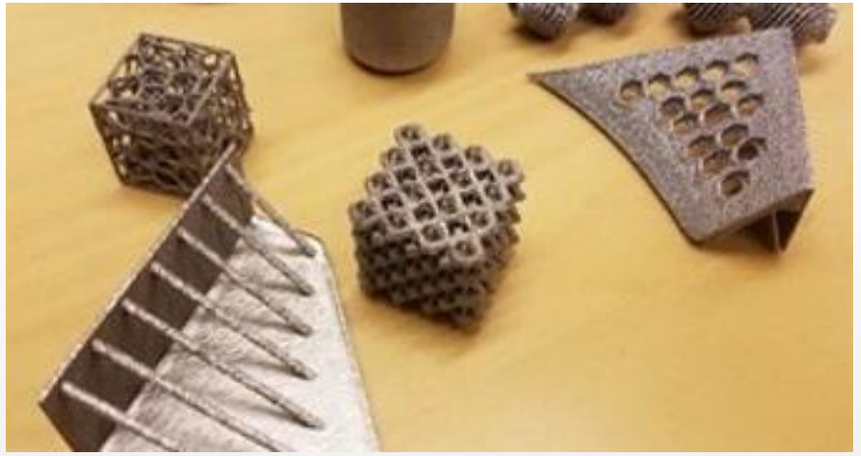


FMG3920 Additive processes, materials and design for metallic components 7.5 credits

- PhD level, Held at KTH, 5-15 students, 7.5 HP
- The major aim with the course is to give doctoral students in industrial production, material science, machine design and solid mechanics an interdisciplinary understanding of additive production with a focus on metallic materials. Different design, materials, processing technique and parameter perspectives are given based on different disciplines of teachers and researchers from different departments at KTH.
- https://www.kth.se/student/kurser/kurs/FMG3920

MG2044 Additive Manufacturing 6.0 credits

- Master level, Held, at KTH, 10-30 students, 6.0 HP
- This is a master course to give a specialised knowledge on
  - Technologies and materials for metal additive manufacturing
  - Technologies and material forms for polymer additive manufacturing
  - Post-processing of metals and polymers in additive manufacturing
  - Applications, design considerations and software for additive manufacturing
- https://www.kth.se/student/kurser/kurs/MG2044?l=en

Courses with contents of AM

- MG2009 Advanced Manufacturing Technology, 6.0 HP
- MH2101 Metal powder: production, handling and characterisation, 6.0 HP
- MH1022 Fabrication Processes of Metals and Bio Fibres, 7.0 HP
- MH2450 International Seminar in Materials Processes, 6.0 HP
- MH2000 Experimental methods, 6.0 HP
- MH2100 Powder Metallurgy, 6.0 HP

Others (Master/PhD thesis, student project, commissioned education, seminars, books…….)

Several active departments: production engineering, materials science, machine design, engineering mechanics

More than 10 completed master’s theses

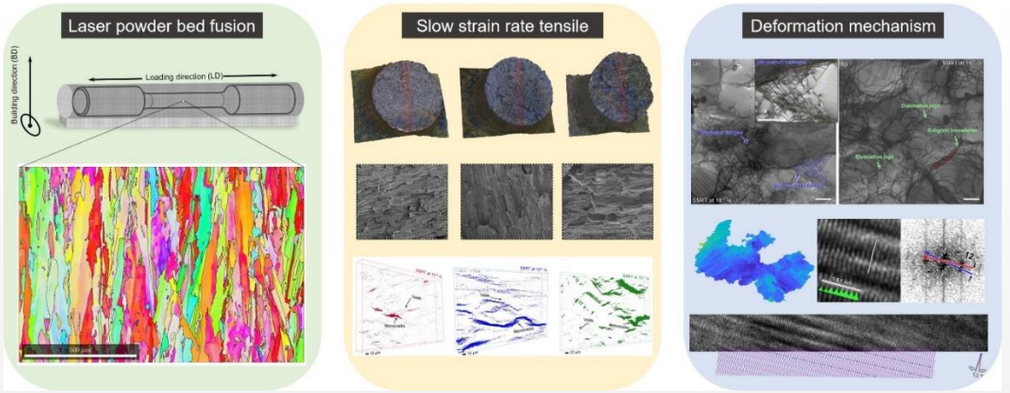
More than 5 ongoing master’s theses projects

More than 6 active PhD students

Regular student projects to help industrial partners

Linköping University

Johan Moverare: johan.moverare@liu.se



Course name

- Additive Manufacturing for Industrial Applications, 6 credits (TMKO05)
  - Course level: First cycle
  - Advancement level: G2X
  - In English
  - For program students: EMM, DPU, M, MEC, Mi
  - See study information for more details: https://liu.se/studieinfo/en/kurs/tmko05/ht-2022
- Introduction to Additive Manufacturing for Professionals, 6 credits (ETE341)
  - Course level: First cycle
  - Advancement level: G1X
  - In Swedish
  - Distance cource
  - See study information for more details: https://liu.se/studieinfo/kurs/ete341/ht-2022
- Additive Manufacturing: Tools, Materials and Methods (TFYA88)
  - https://liu.se/studieinfo/kurs/tfya88/ht-2022

Courses with contents of AM

- TMKO01 Advanced Materials and the Environment
- TMKO02 Materials and Manufacturing Technologies
- TMPS34 Manufacturing Engineering

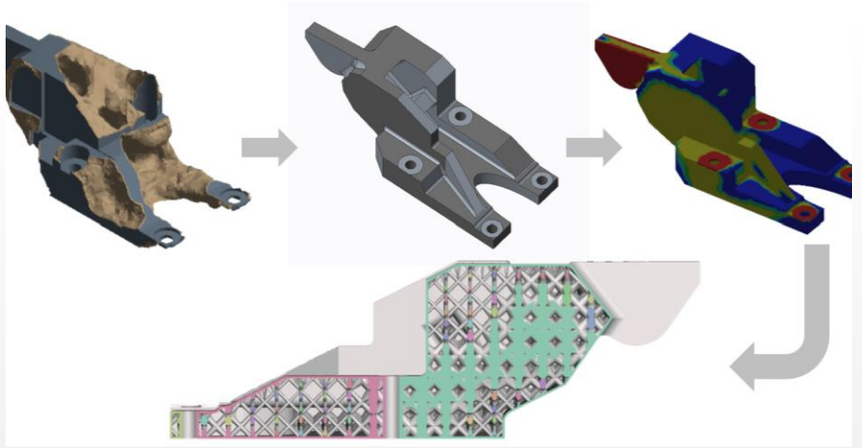
Others (Master/PhD thesis, student project, commissioned education, seminars, books…….)

On a regular basis we offer Bachlor and Master thesis topics within the field of Additive Manufacturing

PhD thesis

Lund university/LTH

Axel Nordin: axel.nordin@design.lth.se



Course name (provide information such as level, Nr of students, program, credits, aims, contents etc**)**

- Commissioned education on:
  - AM process: from CAD to part
  - Designing for AM
  - Economics of AM
  - Topology optimization
  - Generative Design and AM

Course name (provide information such as level, Nr of students, program, credits, aims, contents etc**)**

- Designer Tools 6 hp, G
- Design for L-PBF in metals and polymers
- Mesh-based design
- Generative design

Courses with contents of AM

- Introduction to Workshop Training 6 hp, G
- Designer Tools 6 hp, G
- Product development and Design Methodology 5 hp, G
- Design for X 7,5 hp, A
- Computer based design analysis 7,5 hp, A

Others (Master/PhD thesis, student project, commissioned education, seminars, books…….)

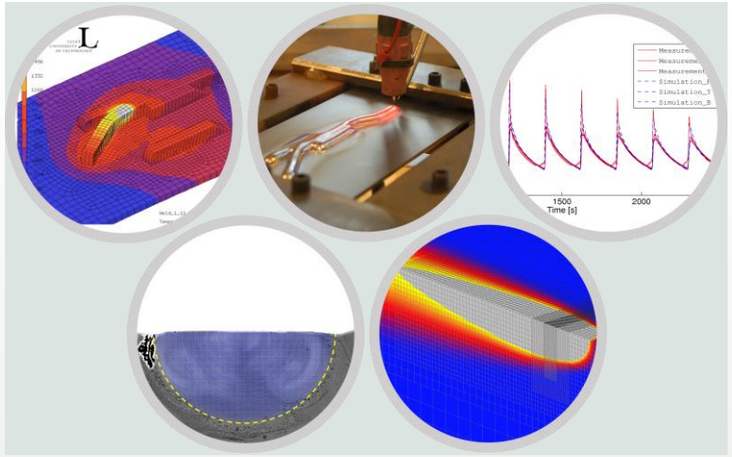
Sinclair, F. (2021). Exploring flexible structures in 3D-printed bio-based materials to closely mimic the properties of foam.

Wadsö, I., & Holmqvist, S. (2020). Additively Manufactured Heat Exchangers-Development and Testing.

Svensson, K., & Laurén, J. (2020). Qualification process development for metal additive manufacturing-A study for the establishment of additive manufacturing at Alfa Laval.

Luleå University of Technology

Jörg Volpp (jorg.volpp@ltu.se)



Courses (www.ltu.se)

Bachelor level:

- Laser Materials Processing (T0018T)
- Manufacturing Methods (T0019T and T7019T)

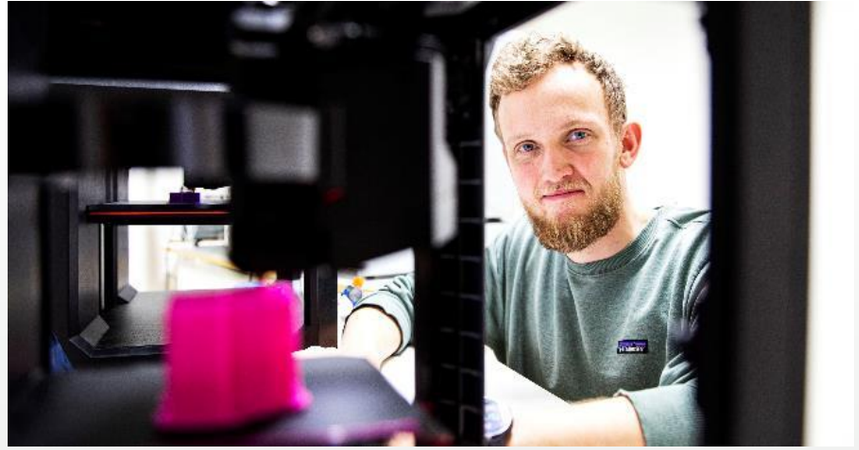
Master level

- Additive Manufacturing – Process, Material, Product (T7027T)
- Advanced processing and CyberLab (T7015T)
- Materials Science and Engineering - project course (T7009T)
- SIRIUS – Creative Product Development (M7017T)
- SIRIUS – Applied Product Simulation (M7029T)
- SIRIUS – Integrated Production Development (T7026T)

Others

LTU continuously supervises Master and PhD projects in the field of Additive Manufacturing in different groups (design, processing, material analysis)

MID SWEDEN UNIVERSITY



Lars-Erik Rännar: lars-erik.rannar@miun.se

Programme:

Bachelor of Science programme, 120 credits, ”*Additiv tillverkning – högskoleingenjör maskinteknik / Additive Manufacturing - Bachelor of Science in Mechanical Engineering, 180 credits*”

Courses:

Includes courses, at basic level, focusing on AM such as:

- Additive Manufacturing Technologies, 7.5 credits
- Materials characterization for Additive Manufacturing in metal, 7.5 credits
- Industrial production, 7.5 credits
- Structural mechanics and thermodynamics, 12 credits
- Design for Additive Manufacturing, 7.5 credits

Others:

Ongoing work to develop master program in Additive Manufacturing, starting fall 2023 in cooperation with two other universities.

Routinely involved in master of science thesis work, tutoring both internal and external students.

Increased activities in the internationalization of second and third level cycles.

University West

Course name

- Additive Manufacturing Processes (ADT610). An advanced course with ~40 students each year. The course is given for three master programs; TAMEA, TATIK and TAPTK. The course is 7.5 credits and covers all the different AM processes, ranging from metals to plastics.
- Post processing in AM (EAT600). Similar course outline as ADT610 but being a 6 credits course. The aim is to increase the knowledge of the students about post processing of AM material.
- Metallurgy of Welding and AM (MTS600). Similar course outline as ADT610. The course covers the materials science behind welding and AM.
- Four so-called Prodex courses (commissioned courses) (2.5 credits). Smaller courses with the objective to educate industrial personnel:

  - Additiv tillverkning grund - Koncept, begrepp och metoder
  - Additiv tillverkning - Metalliska material
  - Additiv tillverkning - Produkt- och tillverkningsaspekter
  - Additiv tillverkning grund - Koncept, begrepp och metoder

Courses with contents of AM

- Advanced Materials Science (AMT601)
- Non-destructive evaluation (K0003901)
- Statistical Process Control & DoE (SPF610)
- Phase Transform (FOM600)

Others

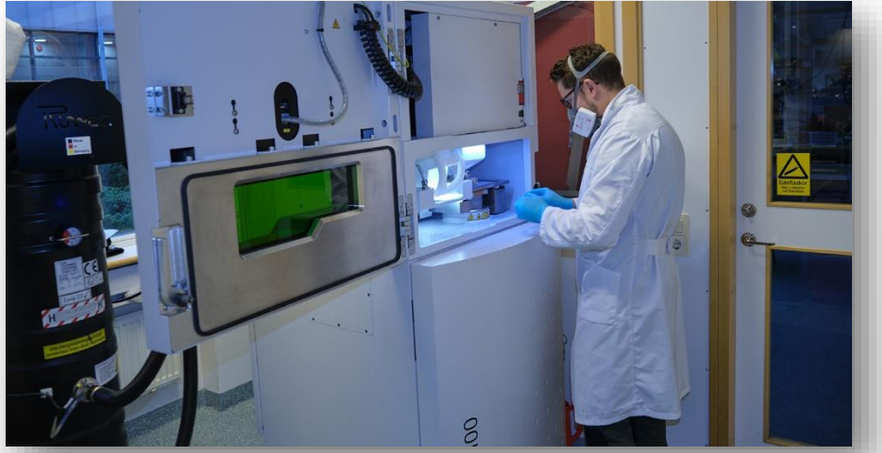
- Each year there are several master and bachelor thesis (and smaller projects) works conducted related to AM, within different processes and alloy systems.
- In end of 2022 a new book will be published by Elsevier, written by UW, covering metal AM.

Contact: Prof. Robert Pederson, robert.pederson@hv.se, tel. +46739013357, page updated 2022-03-22

Uppsala university

Activities coordinated through **The additive manufacturing initiative at the Ångström laboratory**
additive@angstrom.uu.se

Director of initiative: Erik Lewin erik.lewin@kemi.uu.se



UPPSALA UNIVERSITET

Master's program in additive manufacturing

- International masters program on additive manufacturing, started 2020. Presently 10~15 students in both years.
- Program description: https://www.uu.se/en/admissions/master/selma/program/?pKod=TAT2M
- Contact program responsible for more information: Prof. Urban Wiklund urban.wiklund@angstrom.uu.se

BSc, MSc and PhD theses on AM-related topics

- Currently about 15 PhD students at Uppsala university working on AM-related topics. Published PhD theses found through the university's publication database.
- Several master theses per year on engineering masters (Q and K) as well from the dedicated master's programme in AM deal with AM topics. Projects conducted at university, or in industry. Finished Bachelor and Master thesis are published and found through the university's publication database, using the keyword "additive manufacturing".

Under graduate and graduate courses with contents of AM

Many courses within the dedicated master's program, e.g.:

- Introduction to Additive Manufacturing, 5 ct (1TM102)
- Materials Chemistry for Additive Manufacturing, 5 ct (1KB233)
- Manufacturing of Metal Powders, 5 ct (1TM104)
- Additive Manufacturing in Metallic and Ceramic Materials, 10 ct (1TM106)
- Additive Manufacturing in Polymeric Materials, 5 ct(1TM105)
- Structural Optimisation for Additive Manufacturing I, 5 ct (1TM103)
- Post Processing and Surface Engineering, 5 ct (1TM125)
- Additive Manufacturing in Medicine, 5 ct (1TM128)

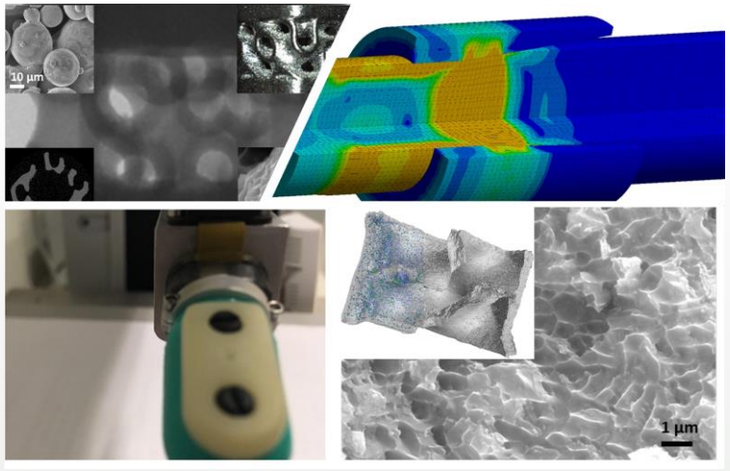
But there is also AM content in courses given at other study programs, e.g. the engineering masters with material focus (Q and K programmes).

Other

- Open seminar series on AM-topics held since spring 2019 https://www.additivemanufacturing.se/seminars/

Örebro University

Patrik Karlsson, patrik.karlsson@oru.se



Courses with contents of AM

- Manufacturing Engineering, MT111G, 7.5 Credits
- Manufacturing Engineering for MSc in Engineering, MT508G, 9 Credits

Others

Anton Jansson, Only a shadow, PhD thesis 2016

Sebastian Hällgren, Some aspects on designing for metal Powder Bed Fusion, Licentiate thesis, 2017

Amir Reza Zekavat, Application of X-ray Computed Tomography for Assessment of Additively Manufactured Products, PhD thesis, 2019