AM Network
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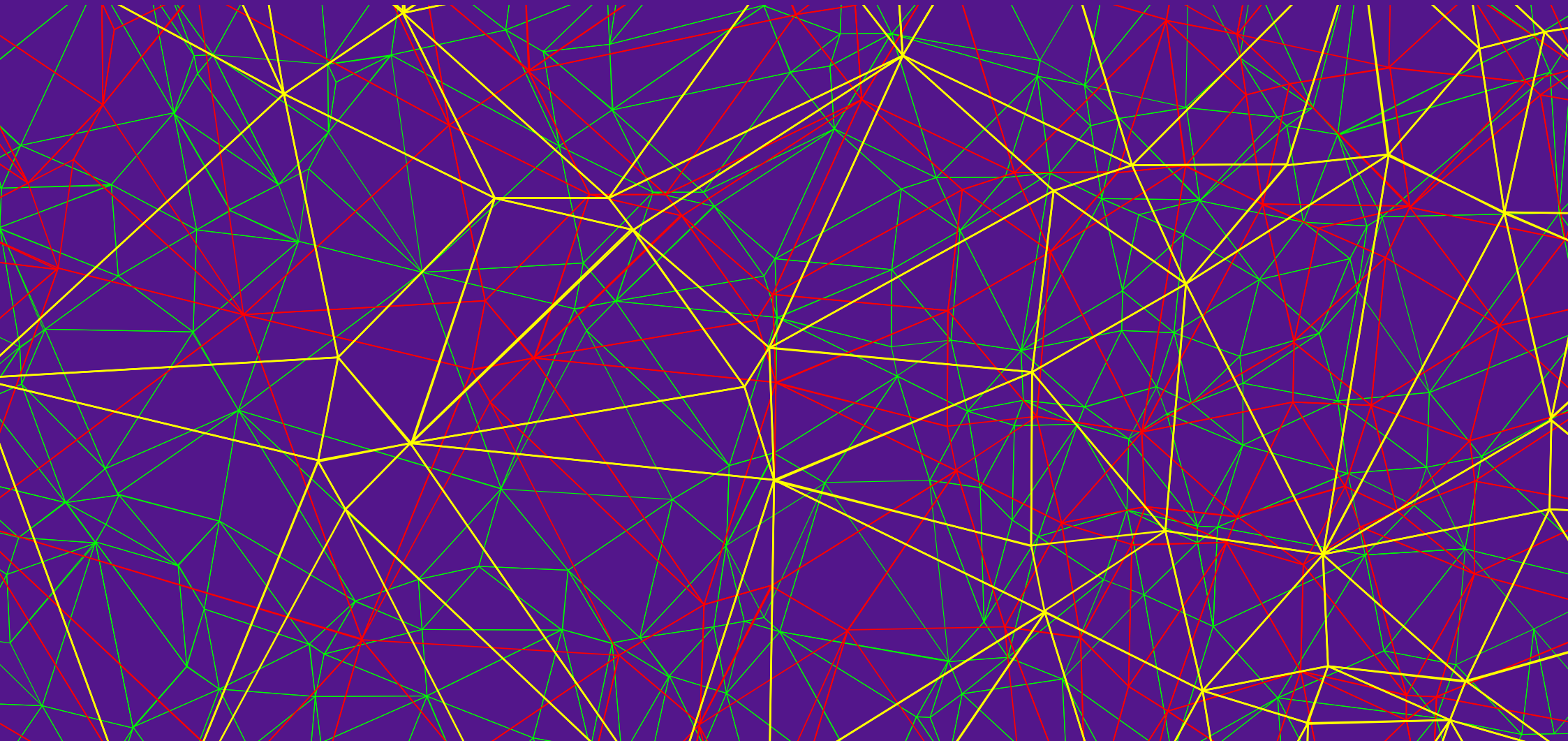
Swiss AM Guide 2020
Exploring new applications in additive manufacturing



Swiss AM Guide 2020

Editor:

AM Network
Additive Manufacturing

Partner:

AMX
Additive Manufacturing Expo

additively
your access to 3D printing

Note:
The new AM Guide is an interactive document. You can access it via the normal PDF navigation or by using the navigation on the right side of the page. In addition, the blue terms are programmed as links to get to the institute or project.

What does the economic efficiency look like.

Prof. Markus Baertschi

Dear readers,

The NTN AM-Network started its activities in January 2017. For four years, Innosuisse supported us to promote 3D technology and additive manufacturing in Swiss industry, especially in the SME world. Where are the areas of application, which materials should you print with, which tolerances could be maintained, what does the economic efficiency look like, which sizes of series are possible and which are sensible. There are still many open questions.

The AM-Network has held many events in the last three years in order to provide answers to these questions. The research organizations in Switzerland, namely the two Federal Institutes of Technology, the Universities of Applied Sciences, the Swiss Federal Laboratories for Material Siences and Technology (Empa), the Swiss Research and Technology Organization (CSEM) and Inspire – together with the industry - have initiated and supported various Innosuisse projects.

We have encountered great interest from industry, science and society. At this point I would like to take the opportunity to thank all those involved, be it as organizers or participants!

At the end of this year, the support of Innosuisse will come to an end.

In 2020 we will go ahead with creating an eventful year with many interesting activities. The Board of Directors has decided that the AM-Network association will participate in Innosuisse's tender for the new NTN Innovation Booster programme.

We will submit the participation application for the funding period 2021-2024 in the field of additive manufacturing by the end of February 2020 and are confident that we will be able to continue our work on this fascinating technology.

On this note, I wish you a good time reading this report.

Prof. Markus Baertschi
President AM Network

AM Network

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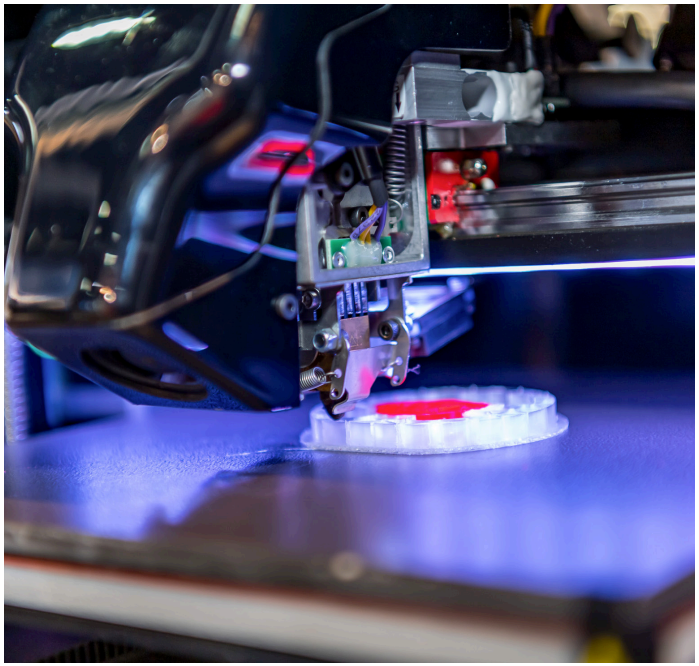
AM Network
Additive Manufacturing

The AM Network is the national thematic network for additive manufacturing and 3D printing in Switzerland.

The AM Network is an initiative supported by Innosuisse, the former Commission of Technology and Innovation (CTI), in the National Thematic Networks (NTNs) program. Goal of the network is to connect companies and research institutes to foster innovation in joint research projects.

- **We enable the Swiss industry to realize the full potential of additive manufacturing through collaboration with Swiss research institutes.**
- **We organize symposiums and workshops with the goal of transferring know-how between research and industry.**
- **Our AM Guide gives an annual update on additive manufacturing and provides inspiration for the Swiss additive manufacturing community.**
- **We ensure that the additive manufacturing community has access to international networks in order to make know-how available.**



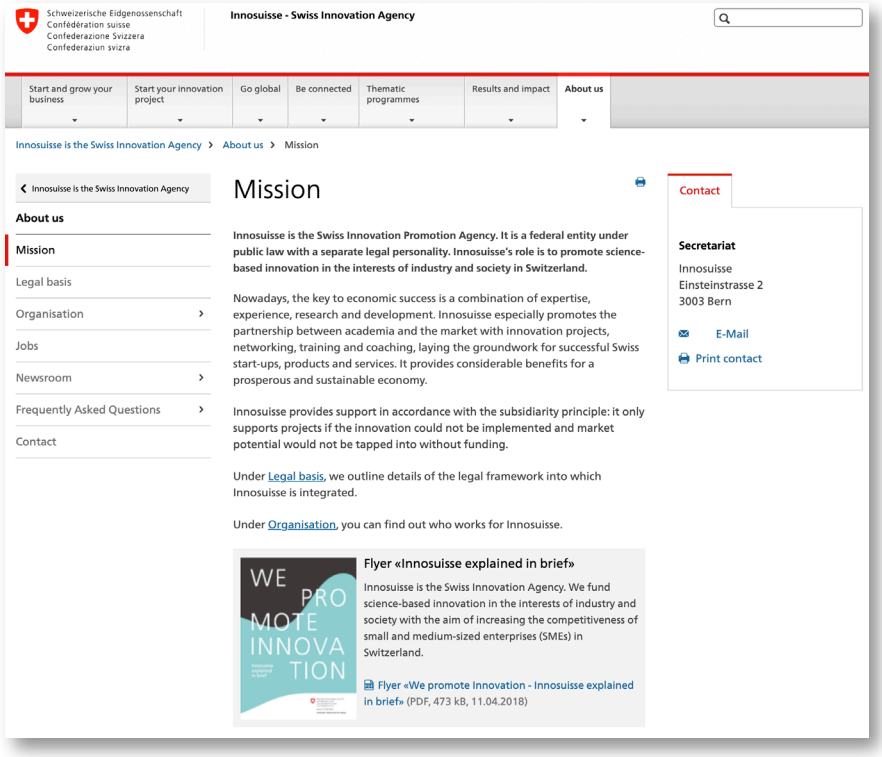
Find the right partner for your innovation project

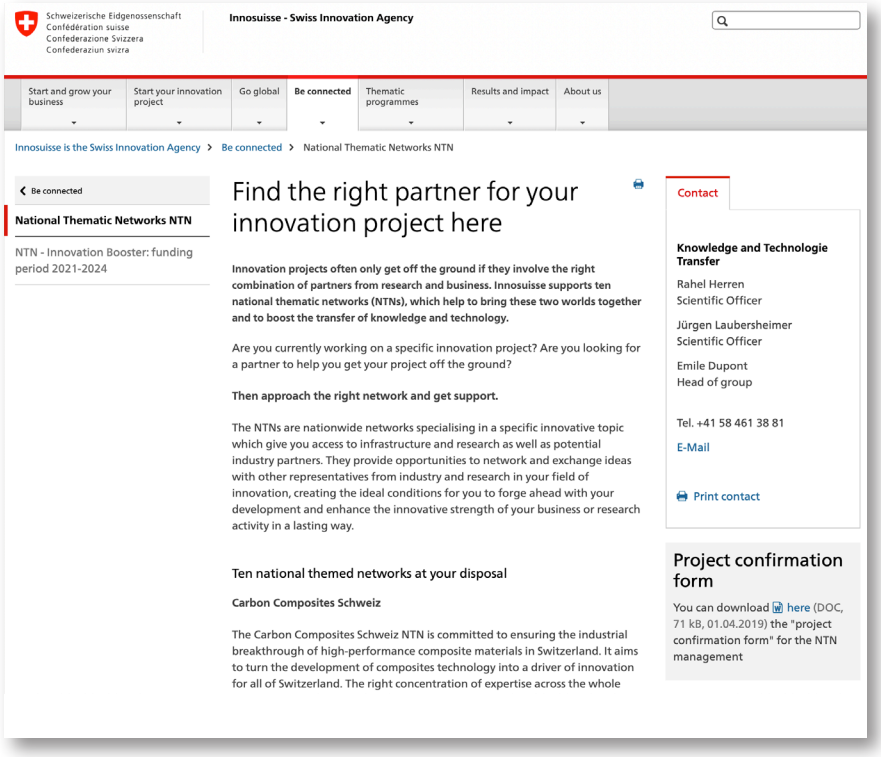
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Innosuisse – Swiss Innovation Agency

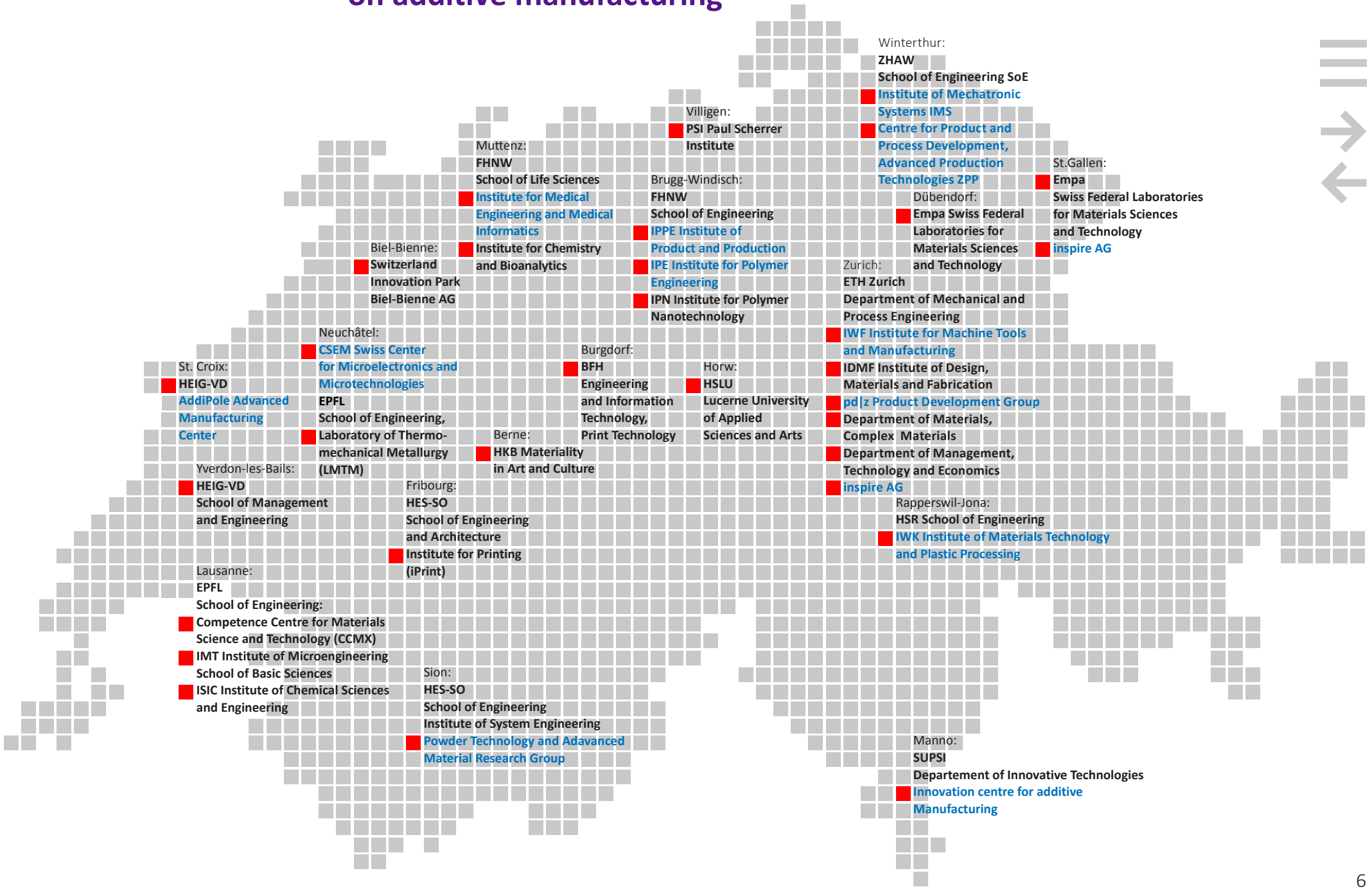
This National Thematic Network (NTN) supported by Innosuisse promotes the introduction of additive manufacturing (AM) in Swiss industry.

The technology, which is also known as professional 3D printing, allows components to be manufactured directly from digital 3D models. Because of the way it differs from traditional production processes, it opens up new applications that have not been available until now. The AM-Network's objective is to make the major innovation and differentiation potential of professional 3D printing available to Swiss businesses.





Swiss Institutes with a research focus on additive manufacturing



Institutes specialized in additive manufacturing research

BFH Bern University of Applied Sciences:
- Engineering and Information Technology, Print Technology
- HKB Bern University of Arts, Materiality in Art and Culture

CSEM Swiss Center for Microelectronics and Microtechnologies

EPFL Swiss Federal Institutes of Technology Lausanne:
School of Engineering:
- Competence Centre for Materials Science and Technology (CCMX)
- IMT Institute of Microengineering
- Laboratory of Thermomechanical Metallurgy (LMTM)

School of Basic Sciences:
- ISIC Institute of Chemical Sciences and Engineering

Empa Swiss Federal Laboratories for Materials:
- Sciences and Technology

ETH Swiss Federal Institutes of Technology Zurich:
Department of Mechanical and Process Engineering D-MAVT:
- IWF Institute for Machine Tools and Manufacturing
- pd|z Product Development Group Zurich
- IDMF Institute of Design, Materials and Fabrication

Department of Materials, Complex Materials D-MATL
Department of Management, Technology and Economics D-MTEC

FHNW University of Applied Sciences Northwestern Switzerland:
School of Engineering:
- IPPE Institute of Product and Production Engineering
- IPE Institute for Polymer Engineering
- IPN Institute of Polymer Nanotechnology

School of Life Sciences:
- Institute for Medical Engineering and Medical Informatics
- Institute for Chemistry and Bioanalytics

Institutes specialized in additive manufacturing research

HEIG Vaud, The School of Management and Engineering
- AddiPole Advanced Manufacturing Center

HES-SO University of Applied Sciences and Arts Western Switzerland
School of Engineering and Architecture of Fribourg:
- Institute for Printing (iPrint)

HES-SO Valais/Wallis University of Applied Sciences and Arts Western Switzerland:
School of Engineering:
- Institute of Systems Engineering
- Powder Technology and Advanced Materials Research Group

FHO University of Applied Sciences of Eastern Switzerland:
HSR School of Engineering,
- IWK Institute of Materials Technology and Plastics Processing

HSLU Lucerne University of Applied Sciences and Arts:
- Lucerne School of Engineering and Architecture

inspire AG:
- inspire icams Innovation Center for Additive Manufacturing Switzerland
- inspire Design for New Technologies

PSI Paul Scherrer Institute

SUPSI University of Applied Sciences and Arts of Southern Switzerland:
Department of Innovative Technologies
- Innovation centre for additive manufacuring (icams)

Switzerland Innovation Park Biel-Bienne AG

UZH University of Zurich:
- Department of Informatics

ZHAW Zurich University of Applied Sciences:
School of Engineering SoE:
- Institute of Mechatronic Systems IMS
- Centre for Product and Process Development, Advanced Production Technologies ZPP

AddiPole
Advanced Manufacturing Center

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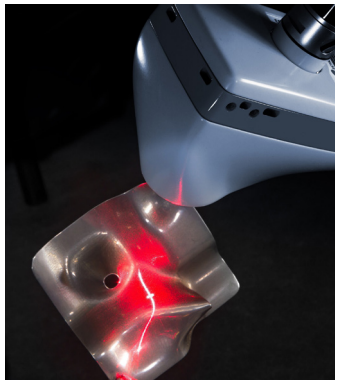

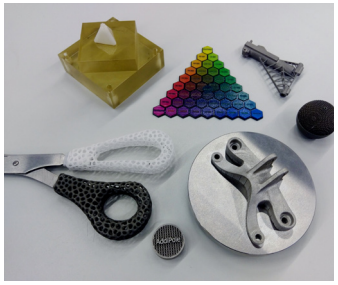

AddiPole - Scanning
AddiPole - Additive

Institute

AddiPole is a comptence center and a reference in French-speaking Switzerland. We offer a unique position from design ideas to market success including post-processing operations and reverse engineering.

Our missions:

- to help technicians, engineeers, companies in product and process development
- to developp skills related to advanced manufacturing (additive and scanning)
- to enpower industrial and research applications for tech-transfer

Research focus

We focus on high precision printing in metals and polymers:

- Functionnal analysis, new design rules, dynamic and topology optimization
- Design for manufacturing (DFM), value analysis, cost to design
- Research into additive manufacturing processes for parameters optimization and monitoring
- Powders improvement and development
- Development of new 3D printing systems for metals and polymers

Offers

With our industrial partnership with Nikon, Trumpf Sisma and Prodways, we offer a complete range of services in advanced manufacturing:

- Reverse enginnering in high resolution scanning including 3D post-treatment
- Adapted product development including process
- Economical and technical feasibility studies
- Development of 3D printer and components
- Supporting companies with workshops and education (possibility of on-site residence service)
- Common and customized teaching and training

We are a public institution and eligible to be your scientific partner for Innosuisse projects.

Technologies

- FDM Fused Deposite Modelling
- SLS Selective Laser Sintering
- SLM Selective Laser Melting
- PolyJet™ technology
- Autodesk's DLP SLA

CSEM Swiss Center for Microelectronics and Microtechnologies

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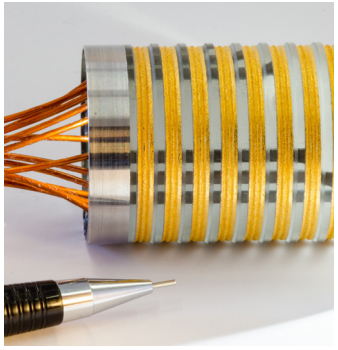

The picture above illustrates the re-design of the rotor of a SlipRing Assembly (a flagship product of RUAG Slip Rings SA), leading to drastic product simplifications. CSEM and RUAG were awarded the innovation prize by AMX in 2018. The concept developed enables the development of parts featuring built-in electrical wires (patent pending)

Institute

CSEM is a national innovation accelerator – a catalyst for the transfer of technologies and know-how from fundamental research to industry. This role involves four principal tasks: we develop and maintain technology platforms, we integrate and combine technologies into workable systems, we mature those technologies which are used, we add value to our industrial clients, and we also support the process of transferring those technologies to industry.

Research focus

- Optimized redesign of existing customer products and design of new products, based on AM technologies
- Advanced manufacturing of high-precision components with embedded functionalities (sensors and actuators) by combining manufacturing technologies
- Optimization of SLM process parameters and quality control
- Qualification of the raw material (initial powders) and SLM-fabricated parts

Offers

- Combination of AM technologies with micro-fabrication, surface treatment/grafting and functional printing
- Characterization and optimization of material properties based on the developed protocol (applying post-processing such as HIP). Selection of the initial materials based on the developed characterization protocol (particle size, flowability, residual humidity, crystalline phase, microstructure, chemical composition …)
- Integration of electrical connections, sensors (resistive, capacitive, piezoelectric) and/or actuators on 3D objects, by combining various AM technologies
- Technology transfer and licensing

Product development offer:

- Customer products in-depth system analysis to identify potential improvement areas based on AM
- Product design, multiphysics simulation and multi-objective optimization (Solidworks, Comsol, Optistruct)
- Prototyping and production of high-precision components
- Product performances and metrological characterization

Technologies

Selective laser melting (SLM),
UV stereolithography (SLA),
UV micro stereolithography (uSLA),
multimaterial platform: combination of different technologies within 1 system with up to 24 materials
Inkjet printing (single and multi-nozzle), aerosol jet printing, screenprinting, gravure printing, photonic sintering, characterization systems

ETH Zurich
Institute of Machine Tools and Manufacturing IWF

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Institut für Werkzeugmaschinen und Fertigung
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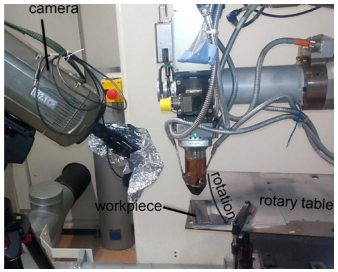

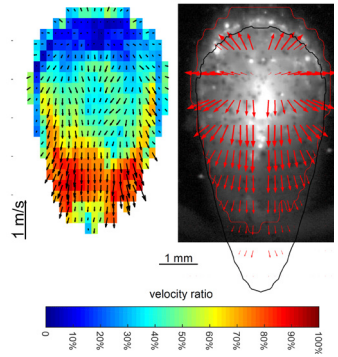

Institute

IWF conducts research in the field of Additive Manufacturing (AM) in three technologies: SLM, DMD and WAAM. In these technologies the institute covers research in materials and material behavior, research on the process and process chains for and with AM, research in machines and special applications as for instance lightweight parts and functionalized parts. IWF works with metals and ceramics materials and conducts research on simulation on different scales like melt pool analysis, micro structure development and internal stresses. IWF is well equipped with different machines for experimentation and experimental validation and cooperates closely with inspire icams in St. Gallen. IWF is especially researching synergies between AM and other process technologies.

Research focus

SLM (Selective Laser Melting): The main research fields are the solidification process and the resulting metallurgic microstructure generated by the rapid solidification following laser-material interaction, measures to influence the cool-down process and advanced control processes Two laser strategies are researched with respect to stress relief and avoidance of hot cracking in Ni based alloys on a self made SLM machine. One step processing of ceramics is researched together with EMPA so to align material and process development. DMD (Direct Material Deposition). The main focus is on the rapid build-up of large structures and quality issues, e.g. for laser-cladding of turbine blades and wear resistant coatings. A Computer-Aided Manufacturing tool (CAM) with a feature based approach and for the combination of DMD and milling is setup and designed for growing with machine learning abilities. High speed and hard cladding provide the basis for all DMD endeavours.

Offers

Development support for companies in the following topics:

- simulation and experimental analysis of the melt pool (including laser-material interaction)
- simulation and measurement of warpage and surface tension
- analysis of the microstructure analysis regarding the risks for micropores and splatters
- analysis regarding the risks for hot and cold cracking
- quality improvements and quality management - in cooperation with inspire icams, St. Gallen
- postprocessing technologies (cleaning, machining, sandblasting …) in cooperation with pdz I ETHZ

Technologies

- SLM (Selective Laser Melting, powder bed fusion with metal and ceramic powders)
- DMD: (Direct Material Deposition, material build-up with feed of metal powder and wire)
- WAAM: (Wire Arc Additive Manufacturing as fast buildup strategy for large structures)
- Simulation of AM Processes with FEM, cellular automates, finite differences and meshfree methods like SPH
- Artificial Intelligence in combination with model approaches for the setup of learning expert systems
- CAM tools for DMD
- Material anaysis and testing

ETH Zurich
Product Development Group Zurich pd|z

Eidgenössische Technische Hochschule Zürich
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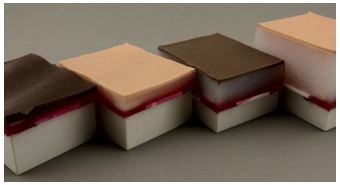
Additive manufactured spring for Adjustable Stiffness Element



Design automation for additive manufacturing of diversified medical training environments

Institute

The Product Development Group Zurich pd|z focuses on human-centered product development and regard the link between research and education as the key to excellence in training. We see ourselves as a partner for industry and promote the continuous transfer of knowledge through cooperation, as well as the training and further education of students and graduates to boost the competitiveness of the mechanical engineering industry.

Research focus

The research of pd|z addresses three main areas: Biomedical Systems, Human Behavior and Design for New Technologies. The first two groups apply additive manufacturing as tool for prototyping and testing. The group Design for New Technologies develops tools and methods for engineers to benefit from the advantages of new technologies.

Offers

Implementing new technologies into a company requires a change process to build up knowledge and trust. We assist in these processes by transferring knowledge and supporting engineers in gaining initial experience in a learning-by-doing approach:

- R&D projects to identify and validate parts and business models
- Exploration of design automation opportunities
- Technology transfer through workshops, trainings and publication

Technologies

Various AM technologies for metal and plastic parts for prototyping and validation.
CAD and simulations programs to investigate part performance and AM processes.
Measurement equipment for qualitative and quantitative testing.

Project:
Automated design of additive manufactured multi-flow nozzles

Customer:
Technology demonstrator of pd|z

Manufacturer:
–

Problem definition:
Additive manufacturing (AM) enables highly complex parts such as nozzles with multiple integrated flow channels. However, to fully exploit this potential the manual effort required for the CAD model creation and design adaption is usually very time-consuming and must be reduced to obtain cost-efficient process chains for AM.

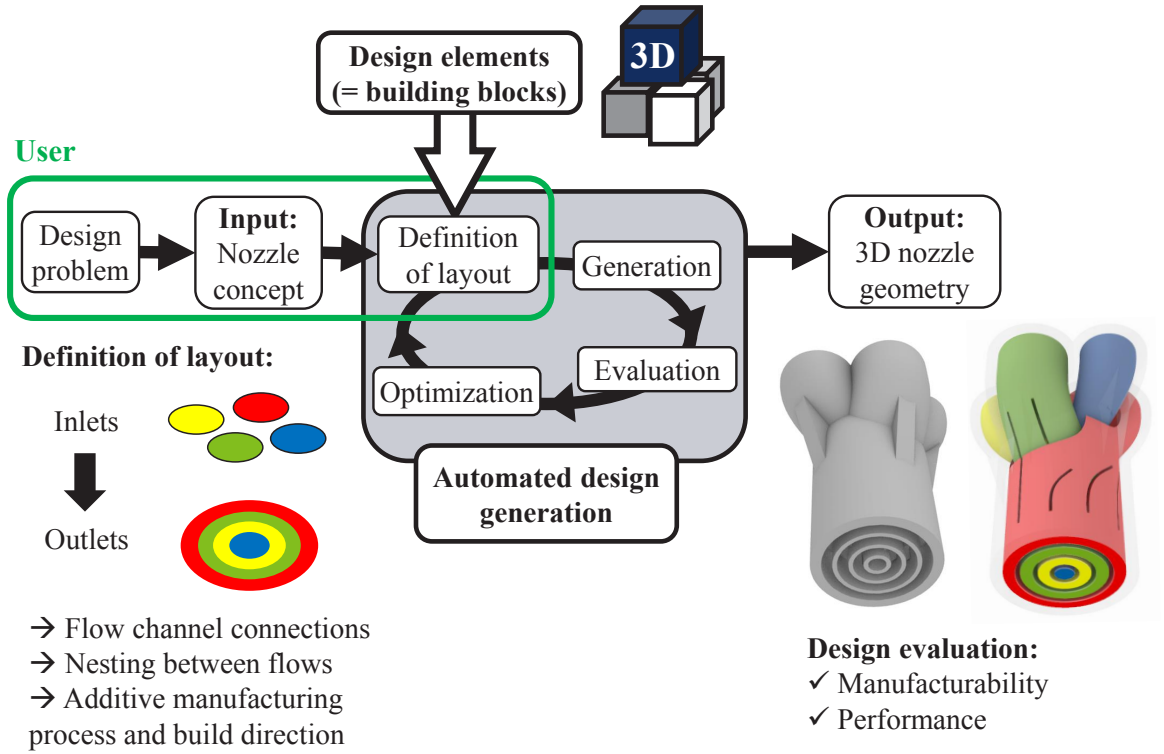
Solution approach:
The approach is to provide users a design toolbox with a set of design elements, which represent import functionalities for the design of AM parts such as nozzles. The design elements function as high-level building blocks and are used to specify the layout of a part meaning the arrangement of cross-sections of inlets and outlets, connections between sections, guiding vanes and stiffening ribs, and the nesting between different flows. This layout serves as an input for a software-based toolbox that automatically translates it into the corresponding 3D part geometry. This allows to quickly generate different design concepts, enable iterative design changes, and customize parts at reduced effort and time.

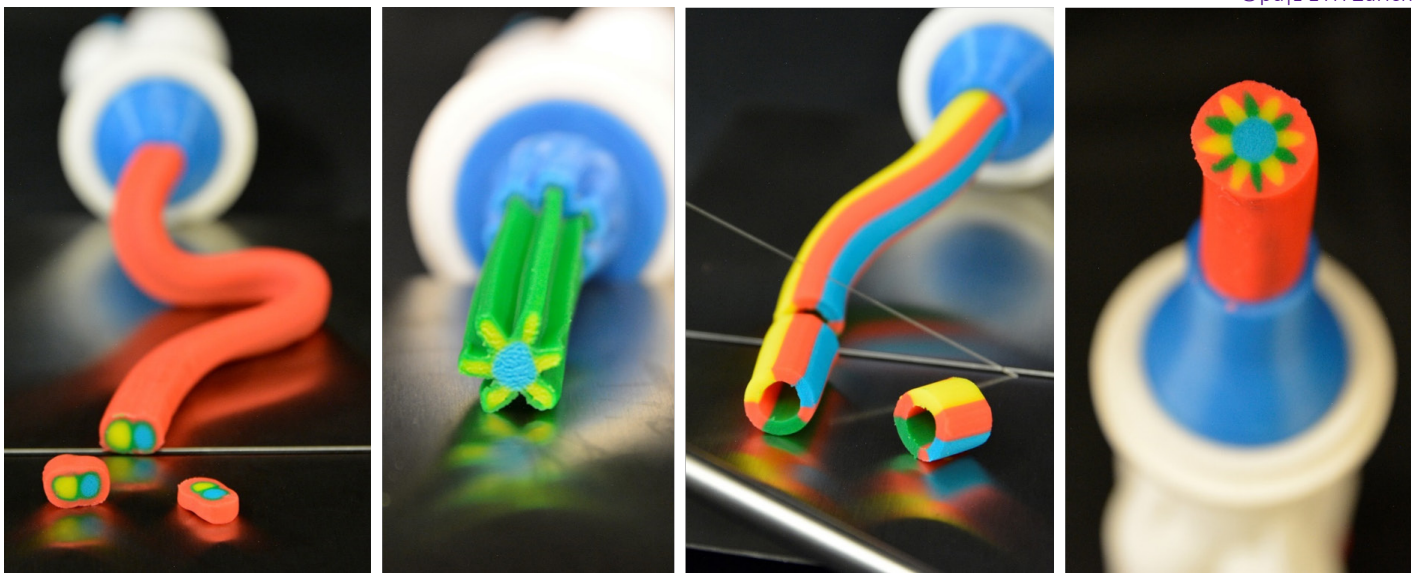
Technology:
Applicable to all AM processes

Material:
Applicable to all AM materials

Machine/Equipment:
–

Produced quantity:
–





FHNW Institute for Medical Engineering and Medical Informatics

University of Applied Sciences and Arts Northwestern Switzerland

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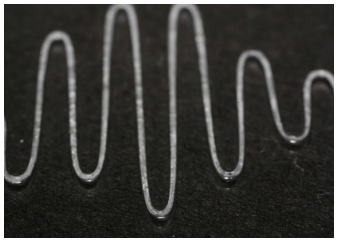
Implants from the 3D printer made of titanium and hydroxyapatite



Bioprinted fugitive ink for vascularization

Institute

The Institute for Medical Engineering and Medical Informatics at the School of Life Sciences of the University of Applied Sciences Northwestern Switzerland in Muttenz has long-standing experience in medical additive manufacturing. In the context of applied research and development, the close cooperation between the FHNW and regional, national as well as international commercial enterprises facilitates access of public institutions to state-of-the-art research results and the transforming of ideas into practice-oriented products and processes.

Research focus

The institute has committed to AM for medical application, using various printing technologies and materials. The application of SLM enables us to realize metallic implants and instruments. We have established the planning, modelling, production and characterization of titanium implants. Printing materials such as ceramics, magnesia and shape-memory alloys expand the technology towards novel unique properties. Bioprinting focusing on AM of biological material like extracellular matrices and cells, for medtech and pharma applications.

Offers

- ISO 13485-conform process chain for patient-specific implants from image up to sterile packaging, including planning, modelling, production and characterization, as well as microstructural, surface analytical, static and dynamic mechanical and computational analyses
- Porous structures with anatomically adapted gradients with adjustable lattice type, micro-architecture and porosity to adjust the Young's modulus according to the biomechanical needs
- Patient-specific implants for trauma and oncology patients
- Patient-specific orthosis and prosthesis combined with sensor applications
- Process development and application of AM for novel printed materials like metals, ceramics or plastics
- Process development for vital materials like cells and 3D structures like extracellular matrices

Technologies

Various Selective Laser Melting systems for metallic implant materials; printing system for bioceramic materials; multijet printing system for plastic-like and rubber-like materials; inkjetbased printing platforms; extrusion-based bioprinting for combined avital-vital structures;
complete testing and characterization environment.

FHNW Institut for Polymer Engineering (IPE)

University of Applied Sciences and Arts Northwestern Switzerland

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Institute

Innovation in manufacturing technologies has become a key driver for the success of advanced composites. Our institute is pursuing this mission in a holistic approach to product development with high performance polymers and fibre reinforced composites.

Research focus

Lightweight structures are one important element of sustainable mobility. We focus on developing solutions and bringing them to the market. Our expertise comprises of: Materials modification, Design Processing, Simulation and Testing.

Offers

Polymer Engineering is an inherently inter-disciplinary field. It is therefore, no coincidence that designers, engineers, polymer chemists and processing experts work hand-in-hand to bring innovations to the market to the benefit of our industry partners.

- Product development for reinforced and unreinforced polymer based AM parts
- Material development for new polymer based materials for AM manufacturing
- Advanced manufacturing methods for polymere based AM

Technologies

Polymer analytics and mechanical testing: Rheology, Viscometry, Thermal analytics (TMA, TGA, DSC, DMA), Surface analysis (ATR, contact angle), various mechanical testing methods.

Processing: Compounding, extrusion, coating, fibre melt spinning, pressforming, FDM, SLM, SLA.

FHNW School of Engineering
Institute of Product and Production Engineering (IPPE)

University of Applied Sciences and Arts Northwestern Switzerland

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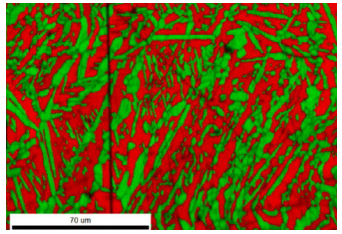
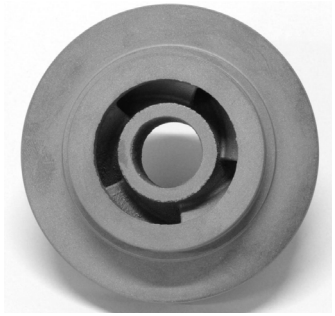


Austenitic-ferritic microstructure of Duplex Stainless Steel processed by SLM at IPPE (project funded by CTI/Innosuisse)



Pump impeller designed and produced by SLM at IPPE (project funded by CTI/Innosuisse)

Institute

The Institute of Product and Production Engineering (IPPE) at the School of Engineering of the FHNW performs research and development in the field of metallic additive manufacturing (AM) with special focus on industrial applications such as, aeronautics and turbomachinery. It features a Selective Laser Melting machine on which parts are 3D printed in aluminum, steel and nickel-based superalloys.

Research focus

The faculty and staff at IPPE have broad expertise in the entire product development cycle from design, simulation, optimization and validation for AM, to the AM process itself where experts in laser physics and materials science ensure the stability and quality of the manufacturing process. Research projects are always collaborations with industrial partners, often co-funded by the Swiss government, and have a typical duration of 1–2 years. The institute, however, is also at the industry's disposal for rendering short-term services.

Offers

- Design for additive manufacturing
- Finite element simulation
- Topology optimization
- Selective laser melting process simulation
- 3D scanning
- Mechanical testing (static, fatigue, random vibration)
- Material characterization (metallography, electron microscopy including EDX)
- Large machine shop

Technologies

- Selective Laser Melting
- Photopolymer Jetting

HES-SO Valais/Wallis
Powder Technology and Advanced Materials Research Group

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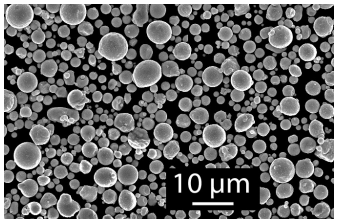
Table-top machine for “Solvent on granule 3D printing” of metals and ceramics

SLM 125 machine (laser power 400W)



Gas atomized powder

Institute

The research group hosts competencies in the manufacturing of metal and ceramic parts from powders by using a number of advanced techniques. It has extensive experience in powder handling, shaping and characterization. Moreover, it has state-of-the-art infrastructure for particulate materials processing, tailoring powders for shaping and consolidation, debinding and sintering and post-processing operations, mechanical testing and materials characterization. It conducts R&D projects in collaboration with the industry, financed by both private and public funds.

Research focus

The research activities focus on the manufacturing of parts from powders, including stainless steels, soft magnetic materials, titanium alloys, copper alloys, aluminum alloys, precious metals, superelastic and shape memory materials and advanced ceramics. In the AM field, the group manages standard binder jetting and laser melting technologies. In addition, it has developed its own technology of solvent jetting on metal- or ceramic-based granule beds. The handling and sintering of reactive metals is also a key competence.

Offers

- Profound know-how on powder technology
- Powder-bed AM facilities: laser melting, binder jetting, solvent jetting
- Powder characterization: size distribution, flowability, cohesive index, apparent and tap density, gas pycnometry, morphology
- Powder preparation: handling under protective atmosphere, sieving, granulation
- Materials characterization, optical and scanning electron microscopy, EDX and XRPD, mechanical tests, heat treatments, C-S and O-N-H element analysis
- Process optimization for AM classical materials
- Development of emerging materials for powder-bed additive manufacturing

Technologies

- Solvent on Granule 3D Printing (SG-3DP)
- Binder jetting 3D printing
- Selective laser melting
- Powder compaction, debinding and sintering
- Powder injection molding (MIM and CIM)
- Tape casting
- Hot isostatic pressing

HSR
HOCHSCHULE FÜR TECHNIK
RAPPERSWIL

FHO Fachhochschule Ostschweiz

HSR IWK Institute for Materials Technology and Plastics Processing

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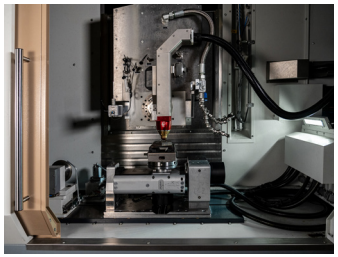
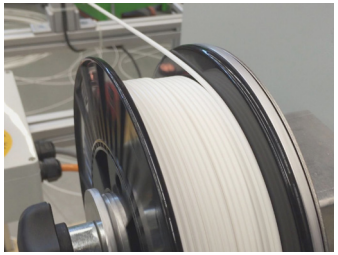
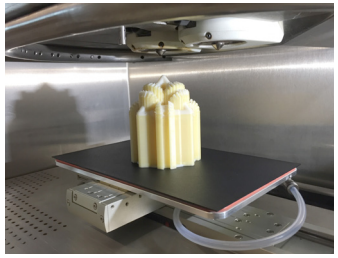


Hybrid machine for Laser Metal Deposition (LMD) and machining



Extrusion of custom specific plastic filaments (FFF)



Development of water-soluble support materials (APF)

Institute

The IWK contributes innovative and application-based research and development in material and part design as well as metal and plastics processing. It combines science and practice to develop modern materials, multilateral technologies and production processes. In the IWK team, experienced specialists and university graduates cooperate in a straight-forward, professional and project-oriented manner to work on industrial tasks in bilateral and publicly funded research projects.

Research focus

One of our research programs at IWK focuses on Additive Manufacturing (AM) which covers a broad variety of interdisciplinary topics including design, manufacturing and materials processing technologies as well as materials science. Our focus is to apply AM in industrial applications both for plastic and metal parts as well as components to create innovative and disruptive products. The two main topics are material extrusion processes like APF and FDM/FFF as well as laser metal deposition LMD in combination with machining.

Offers

- Design and manufacturing of AM parts made from serial thermoplastic resins or metals
- Material selection and experimental material characterization for AM
- Qualification of new materials and development of suitable process windows
- Testing of material and part properties
- Processing, preparation and production of filaments for FDM/FFF according to customer needs/specification
- Material modification by using the compounding process
- Development of water-soluble support materials
- Integration of endless fibers in FFF process
- Coating of metals and abrasives on metals (surface engineering)
- Repair any types of metal components (repair engineering)

Technologies

- Arburg Plastic Freeforming (APF)
- Fused Deposition Modeling (FDM)/Fused Filament Fabrication (FFF)
- Laser Metal Deposition (LMD) together with grinding and milling processes (hybrid machine)

inspire AG
Design for New Technology

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Demonstrator for Smart AM Parts with integrated Sensors

Institute

Inspire Design for New Technologies addresses the challenges of new technologies, like additive manufacturing, impose on the product development process. Engineers in industry need to understand new technologies with their advantages and disadvantages to identify the right applications and design parts with respect to opportunities and restrictions. The group supports the interdisciplinary implementation process for new technologies by bridging product development, manufacturing engineering, value creation and change management.

Research focus

Our research focuses on tools and methods to overcome the implementation barriers of a new technology. To create a series product based on the opportunities of a technology a company needs to adapt its design processes, operations and customer interaction.

An interdisciplinary team develops tools and methods to implement new technologies into industrial applications. The scope includes Additive Manufacturing, design automation, digitalization of products and services in IoT-applications.

Offers

Implementing new technologies into a company requires a change process to build up knowledge and trust. We assist in these processes by transferring knowledge and supporting engineers in gaining initial experience in a learning-by-doing approach:

- Workshops for SMEs and corporations to identify and validate parts and business models
- Agile development of new solutions
- Product development projects from need finding to validated prototype
- Technology transfer through trainings, events and books like “Entwicklung und Konstruktion für die Additive Fertigung” (ISBN: 978-3-8343-3395-7)
  New technologies like Additive Manufacturing, the digitalization of products and services (Internet of Things, Industry 4.0), although based on completely different technologies, bring similar challenges to product development: identifying the right applications and creating additional value for the company and the customer.
  We are therefore able to apply our experience to other new technologies.

Technologies

- Applications of various additive manufacturing in the production of series products
- Post-processing of complex structures
- Digital tools and methods for adopting AM in industry

Project:
Clamping systems for an automated and more economical process chain

Customer:
Gressel

Manufacturer:
AM Kyburz

Problem definition:
Additive Manufacturing enables the production of complex metal parts. However, the part properties such as roughness and tolerances are not sufficient for most end-user applications. Cost-intensive post-processing, often with a high manual effort, hinders the implementation into many series production.

Solution approach:
The challenge of high post-processing efforts is addressed on all stages of the AM process chain.

- Pre-Process: Using Hybrid SLM for a value creation and simplified part removal from base plate
- In-Process: Design Driven Parameter Profiles are developed, that increase the design freedom and reduce the numbers of support structures
- Post-Process: Clamping system for SLM part milling is developed and a AFM surface finishing model is developed for internal SLM channels

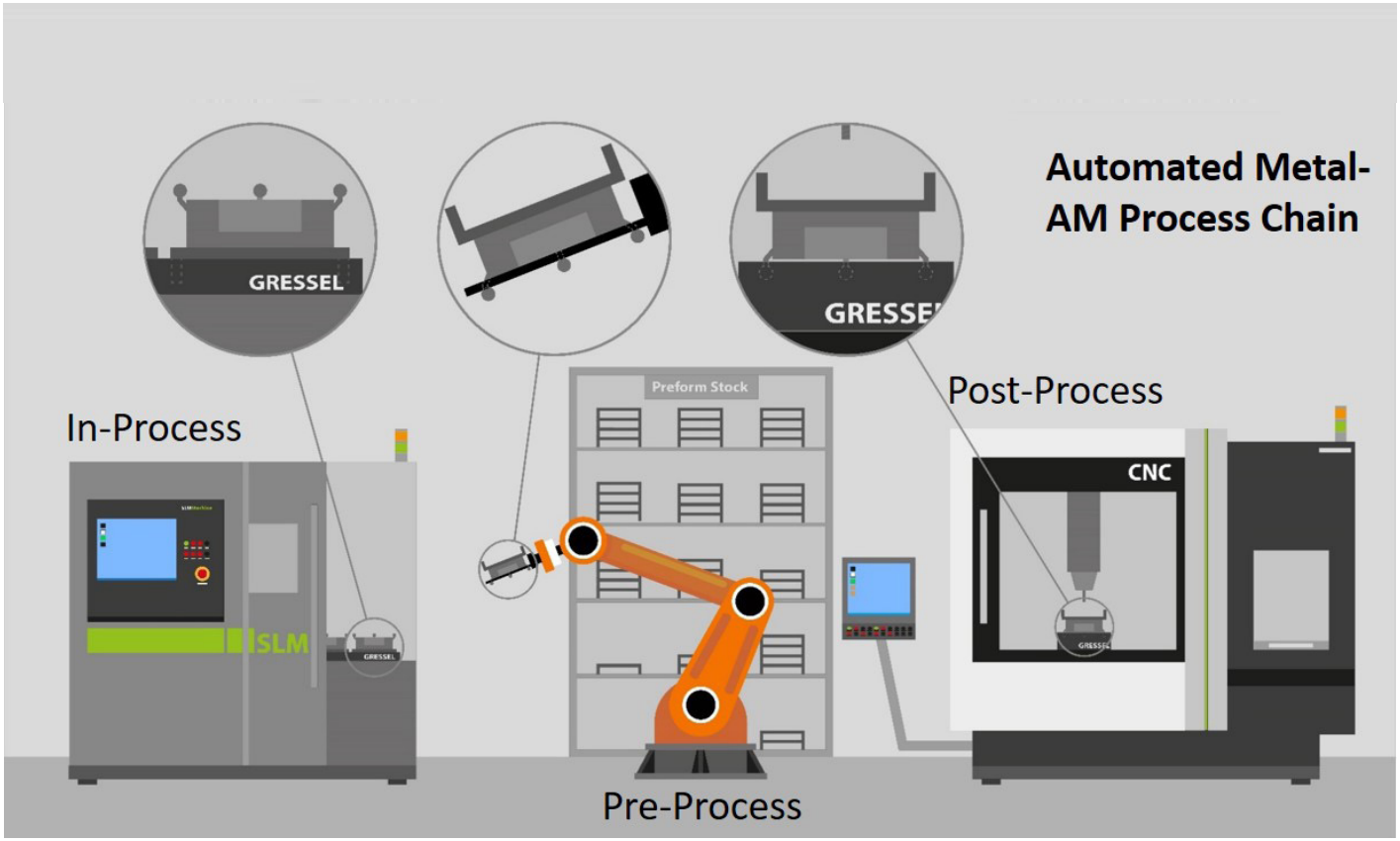
The innosuisse project is conducted by Gressel, AM Kyburz, inspire, ETH Zürich and ZHAW.

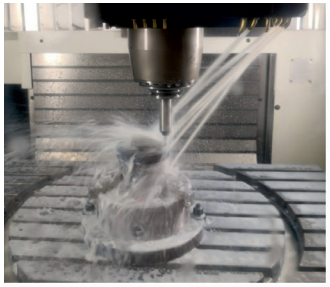
Technology:
Selective Laser Melting

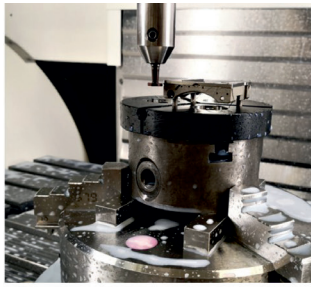
Material:
Unlimited

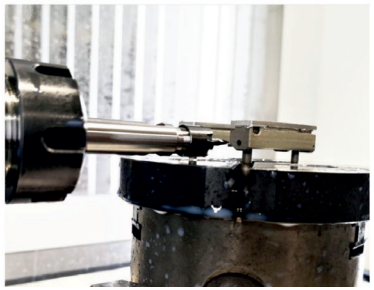
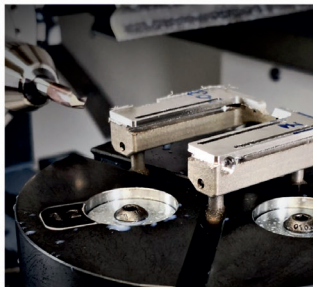
Machine/Equipment:
No restrictions on machine brand

Produced quantity:
Series production







Concept of the Innosuisse Project with Gressel which pursue the goal to automate the SLM process chain

SLM part integrated standardized elements clamped on a Bolt-It system of Gressel

inspire AG
Innovation centre for additive manufacturing (icams)

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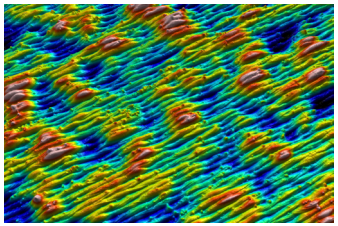


high resolution AM-part surface analysis

SLM scanning

Intelligent H2-valve with integrated sonsors for condition monitoring

Institute

Inspire icams performs basic and applied R&D in AM, focussing on metal and plastic powder bed based technologies (SLM, SLS), next to blow powder technologies such as DMD. We complement the technology portfolio with newer technologies like metal FDM printing.

Inspire covers the whole AM-process chain: We research AM-materials and powders, simulate processes, develop monitoring technologies and optimize machine components, longing for Quality Management Systems. We develop advanced applications, e.g. with integrated sensors and actors.

Research focus

- Quality management in the AM-process chain: From powder qualification to final components
- Alloys (esp. Al) and plastic formulations for AM-processes
- Process simulation, monitoring and process window development for various alloys
- Material qualification and characterization
- Optimization of machine components (re-coater, gas shielding system, …)
- Advanced applications: Integration of sensors into metallic components

Offers

Inspire icams offers all types of collaboration: From B2B projects to Innosuisse and European funded projects.

We offer:

- Powder qualificiation
- Process window development and qualification
- Material characterization (Porosity, in-deep micro structure analysis (SEM, EBSD, …), hardness, static & dynamic mechanical testing,…)
- Part characterization (3D-scanning, surface analysis, mechanical integrity)
- Development of customized, AM-ready applications
- Process chain qualification
- Simulation

Technologies

- Selective Laser Melting (SLM)
- Selective Laser Sintering (SLS)
- Direct Metal Deposition (DMD)
- Desktop Metal Studio Printer (2-step metal FDM-printing)
- Large machine workshop (EDM, cutting, grinding etc)

Project:
Production of a spherical laser sintering powder

Customer:
Geberit AG

Manufacturer:
inspire AG

Problem definition:
Laser sintering (LS) is one of the most advanced and industrialized additive manufacturing (AM) processes. There is however an urgent need for new materials. One of these materials is PBT, used for its dielectric strength and chemical resistance. In this project, a PBT powder with spherical particles was developed for LS.

Solution approach:
To obtain the best part properties in LS, a powder needs to spread easily and have a high packing density. This is best achieved when the particles have a spherical shape. Special methods have to be used to produce such particles, in this case with a process called melt emulsification. Two incompatible polymers are melt blended in an extruder. Under the right circumstances, a droplet-matrix structure is created. After washing, drying, and sieving, a spherical powder remains. The powder spreads very well in the machine, and parts were built successfully. The melt emulsification process was demonstrated to be well suited for the production of spherical polymer powders.

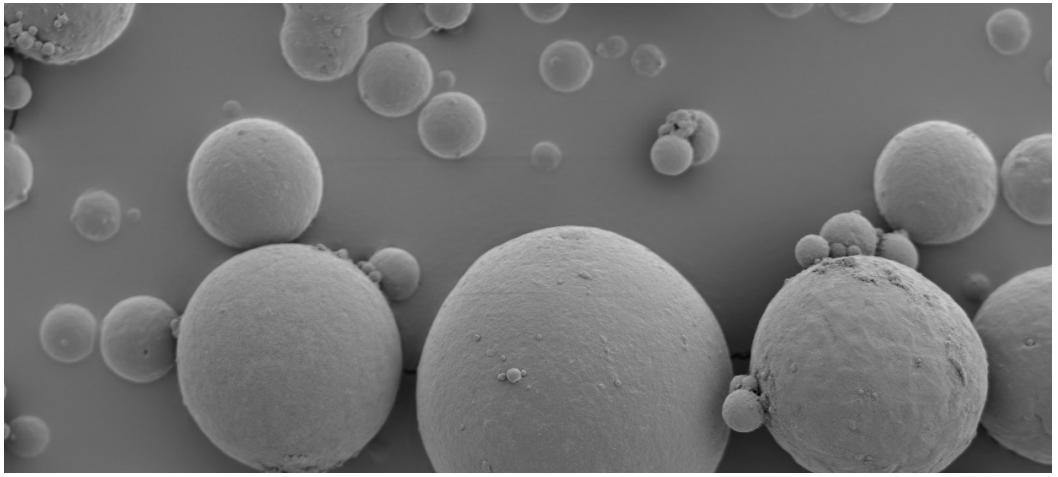
Technology:
Selective Laser Sintering (SLS)

Material:
PBT (polybutylene terephthalate)

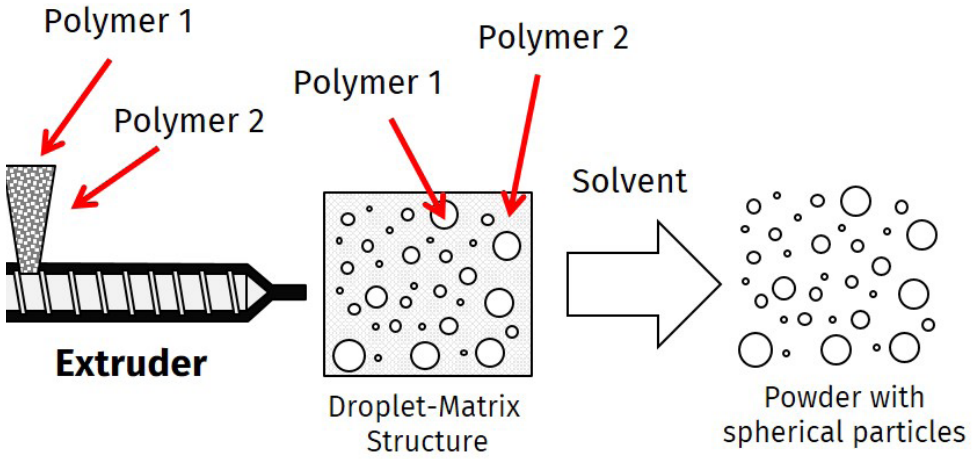
Machine/Equipment:
DTM Sinterstation 2000

Produced quantity:
10 kg

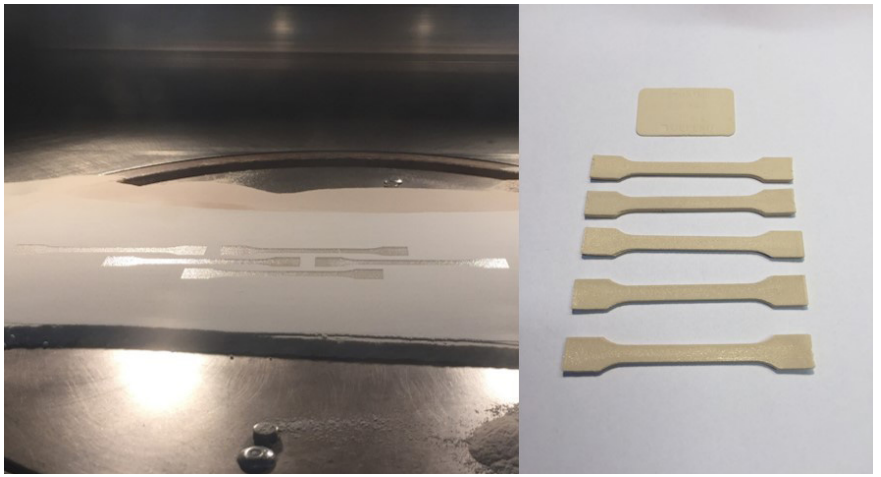
SEM image of the spherical PBT particles



Process schematic of the powder production



Right: parts being produced inside the machine; Left: produced tensile bars



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SUPSI

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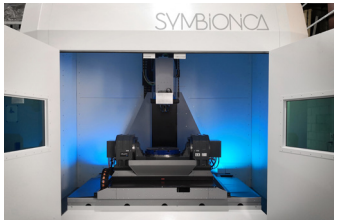

AM 5-axis hybrid machine designed by SUPSI for the EU Project Symbionica (Reconfig-urable Machine for the new Additive and Subtractive Man-ufacturing of fully personalized bionics and smart prosthetics, 2015-2018) for manufacturing medium to large size metal components

Ceramic catalytic support designed and produced by AM at SUPSI

Institute

SUPSI-DTI focusses on engineering sciences for the industrial sector, training and applied research. The Department has been very active in the AM sector for many years, including various applied research projects at national and European level, in the areas of ceramic, polymeric and metallic materials, new processes and machine tools, design of innovative products and services, in particular for the medtech and aerospace sectors as well as for many other industrial applications.

Research focus

Two key activities focus on AM materials, products design, processes and systems:

- integration of multiple subtractive and additive technologies in hybrid solutions; operating by monitoring and adapting the processes, by relying upon a closed automatic in line CAx chain bound to the CNC to select the best processing strategy and machine settings
- design and additive manufacturing of complex ceramic components for high tech applications such as engine exhaust filters, high temperature solar absorbers, water filtering devices

Offers

- AM process design & optimization for metal based alloys (Titanium and Aluminum alloys, Inconel 719, Steel 890, AISI 316 L …)
- Hybrid process implementation based on AM and subtraction of material
- Redundant Machines and Robotic solutions for AM
- Process control and adaptation based on a closed loop monitoring system for AM
- Mechatronic equipment design for multi-material AM (i.e. nozzle, auxiliary gas ejection, gas-powder mix chamber)
- Preparation and characterization of photo-polymeric ceramic pastes for AM
- Design, AM and characterization of complex ceramic components
- Mixing and blending equipment; furnaces for thermal treatments (standard and microwave)
- High temperature equipment for AM porous materials thermo-fluid characterization

Technologies

- Direct energy deposition of small-medium-large parts (up to 800 X 800 X 800 mm envelope)
- Cold spray for coating and repairing of parts
- Laser ablation and texturing with nanosecond laser source
- Femtosecond laser source (soon available)
- Peek deposition
- Stereolithographic devices for ceramic AM

Zurich University of Applied Sciences

School of Engineering

IMS Institute of Mechatronic Systems

ZHAW School of Engineering SoE
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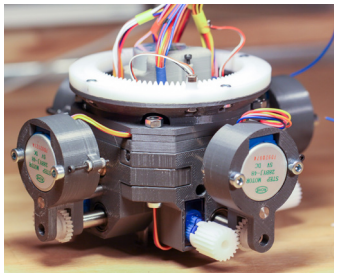

Mechatronic assembly of a medical device manufactured in SLA, FDM and MJP (developed by IMS)

Institute

As a leading national institution for applied research and development in mechatronics, the Institute for Mechatronic Systems (IMS) specializes in projects for innovative products at the interface of mechanics, electronics and computer science. The know-how of over 50 employees from various fields and a modern research infrastructure make us a flexible and efficient partner in the realization of projects in research and development.

Research focus

Our strengths lie especially in the following areas: Robotics & Automation, Control Technology & Advanced Control, Drive Technology & Power Electronics, Medical & Systems Engineering. In the field of additive manufacturing the focus lies on the development of advanced hardware and processes and as well as on optimizing material properties for the FDM and SLA process, to close the gap between 3D printing and injection moulding. This also includes the qualification of material properties itself and the properties of printed parts.

Offers

The activities of the laboratory of rapid prototyping (RapLab@IMS) include the complete development process of functional prototypes:

- Development of specialized devices for 3D-printing (e.g. printers, testing equipment)
- Development of 3D-printed parts with extended, non-mechanical properties
- 3D scanning of parts for geometry capture
- 3D modelling with CAD tools
- Structural analysis of parts and components using state-of-the-art CAE-tools
- Embedding of actuatory and sensory components in SLA and FDM parts
- Manufacturing of parts with various AM-processes

Zürcher Hochschule
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School of
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ZPP Zentrum für Produkt-
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ZHAW School of Engineering Centre for Product and Process Development, Advanced Production Technologies (ZPP)

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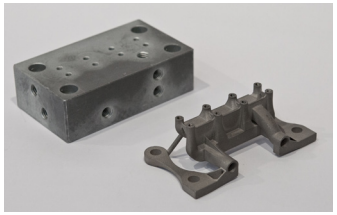
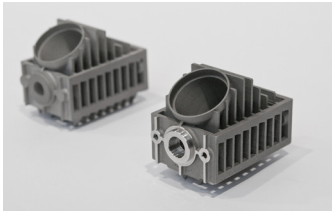




Institute

The ZPP carries out product and process development from the initial idea all the way to realization. We carry out applied R&D in the fields of innovation playground & development, 3D experiences and advanced production technologies, mainly in additive manufacturing.

Research focus

- Research into additive manufacturing (AM) processes
- Analysis and optimization of AM processes for metals, ceramics and sustainable materials
- Implementation of AM technology, e.g., new design rules for product development
- Development of innovative 3D printing systems (e.g., ceramic 3D printer) and components

Offers

- Adapted product development for AM incl. topology optimization
- Economical and technical feasibility studies in AM
- Development of 3D printer and components
- Applied R&D projects for product and process development for AM
- Supporting companies in introduction of AM with workshops and education
- Common and customized teaching and training in AM
- CAS Additive Manufacturing

Technologies

- SLM Selective Laser Melting, powder bed process in metal
- FDM Fused Deposite Modelling
- SLA Stereolithography
- MJP Multijet Printing

Project:
Additive manufacturing of gear components

Customer:
Renk-Maag GmbH

Manufacturer:
ZPP/ZHAW

Problem definition:
Drive systems need to be more and more lightweight and efficient. Smaller mass moments of inertia and optimized design for cooling, lubrication and meshing can significantly increase gear efficiency. Gears manufactured using the LPBF process with typical gear steels such as the 30CrNiMo8 offer great potential.

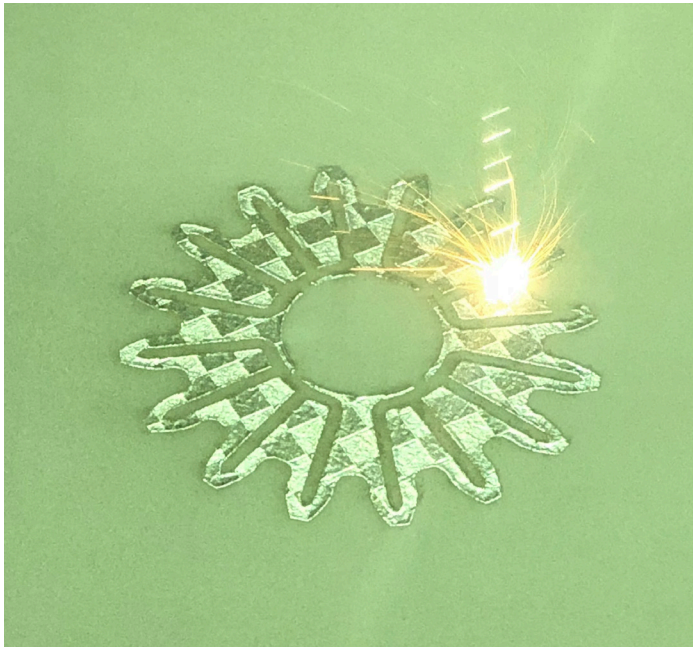
Solution approach:
Within this project supported by Innosuisse, the process parameters for quenched and tempered steel 30CrNiMo8 for the Laser Powder Bed Fusion (LPBF) process were developed and gears manufactured. Various tests showed that the additive manufactured gears are comparable to conventionally manufactured gears with regard to root load capacity and safety against pitting.
In addition, gears with conformal cooling channels were developed and produced as additives, which showed improved cooling behaviour in tests. A gear clutch with integrated lubrication channels at the tooth root was also manufactured using the LPBF process. Further endurance tests are planned.

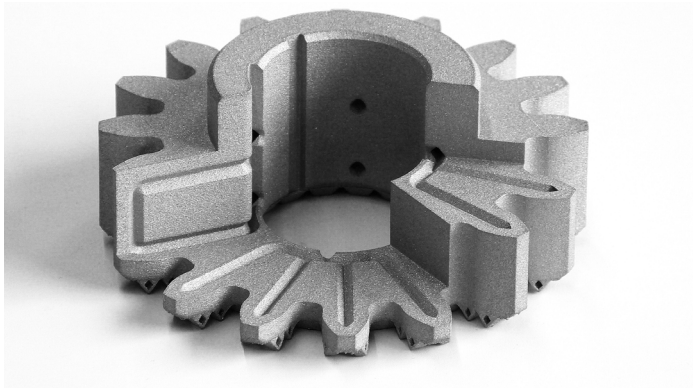
Technology:
Laser Powder Bed Fusion (LPBF)

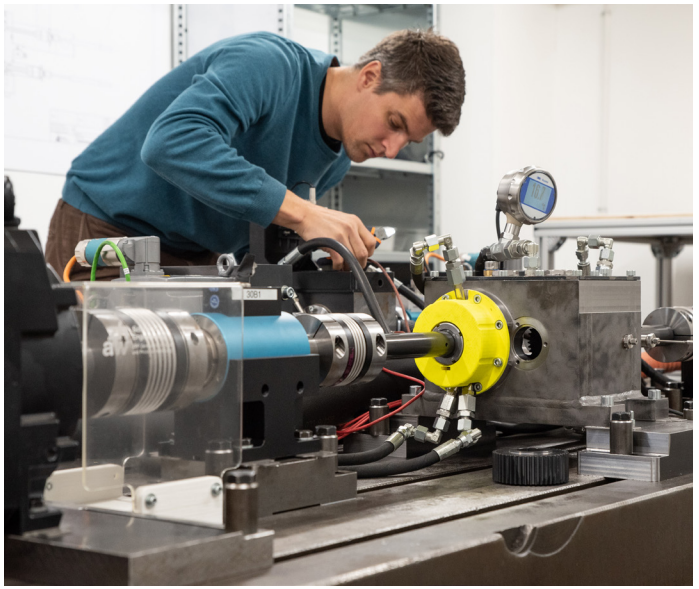
Material:
Quenched and Tempered Steel (30CrNiM8)

Machine/Equipment:
Renishaw AM400HT

Produced quantity:
tbd.







1. gear wheel with intergrated conformal cooling
2. gear wheel lightweight
2. gear test bench at ZPP/ZHAW
3. gear clutch with integrated lubrication at the tooth root