RAPID PROTOTYPING CENTRE

FACULTY OF MECHANICAL ENGINEERING
KOSZALIN UNIVERSITY OF TECHNOLOGY

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FACULTY OF MECHANICAL ENGINEERING
KOSZALIN UNIVERSITY OF TECHNOLOGY

SCIENCE AND RESEARCH
WITH KOSZALIN UNIVERSITY
OF TECHNOLOGY

CATALOG - PRESENTATION OF THE RAPID PROTOTYPING CENTER

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CENTRE

Vice-Rector for Science at KUT, prof. Błażej Bałasz, PhD. DSc

Ladies and Gentlemen,

I present to you the following publication, which is a showcase and at the same time a presentation of the Rapid Prototyping Centre (RPC) of the Faculty of Mechanical Engineering of Koszalin University of Technology, which I manage. Four years of the laboratory's operation is a good time for the first summary. We are entering the fifth anniversary year with the hope that we will reach the widest possible audience and potential partners from the business community with the RPC offer.

At the time of its design and creation, the Centre was a pioneering project in this region of the country. Even now, it continues to be a source of innovative changes in production and a reflection of the practical use of new technologies. I am glad that our research and experience support entities that focus on innovative solutions and look for new forms of cost optimisation. We meet them with an offer tailored to the needs of dynamically developing companies.

The following publication consists of two parts. The first is informative and journalistic and contains all the information necessary for a closer and more complete understanding of additive production. The second part is an offer of services provided by the Rapid Prototyping Centre. It is worth reading both parts to find out what, in the case of metal 3D printing, the combination of evolution and revolution is all about.

I invite you to read.

Vice-Rector for Science at Koszalin University of Technology, prof. Błażej Bałasz, PhD. DSc

Coordinator of the Rapid Prototyping Centre of the Faculty of Mechanical Engineering

RAPID PROTOTYPING CENTRE

FIND OUT THE POTENTIAL OF ADDITIVE MANUFACTURING

The Rapid Prototyping Centre, which deals with 3D metal printing, has been operating at the Faculty of Mechanical Engineering since 2018. One of the initiators of its creation, and currently the coordinator of the laboratory's work is Vice-Rector for Science at KUT, prof. Błażej Bałasz, PhD, DSc.

The centre where metal three-dimensional components are made is the only centre of this type in Pomerania. In addition to developing students' skills, its offer is also addressed to entrepreneurs interested in the rapid creation of elements necessary for production, replacement of parts, introduction of innovations and development of the most progressive branches of industry.

Prof. Błażej Bałasz is a graduate of the Koszalin University of Technology, associated with the Faculty of Mechanical Engineering from the beginning. Before becoming a Vice-Rector for Science for a four-year term in 2020, he was the Vice-Dean for Science of the Faculty of Mechanical Engineering (in 2012-2016), and later the Dean (in the years 2016-2020).

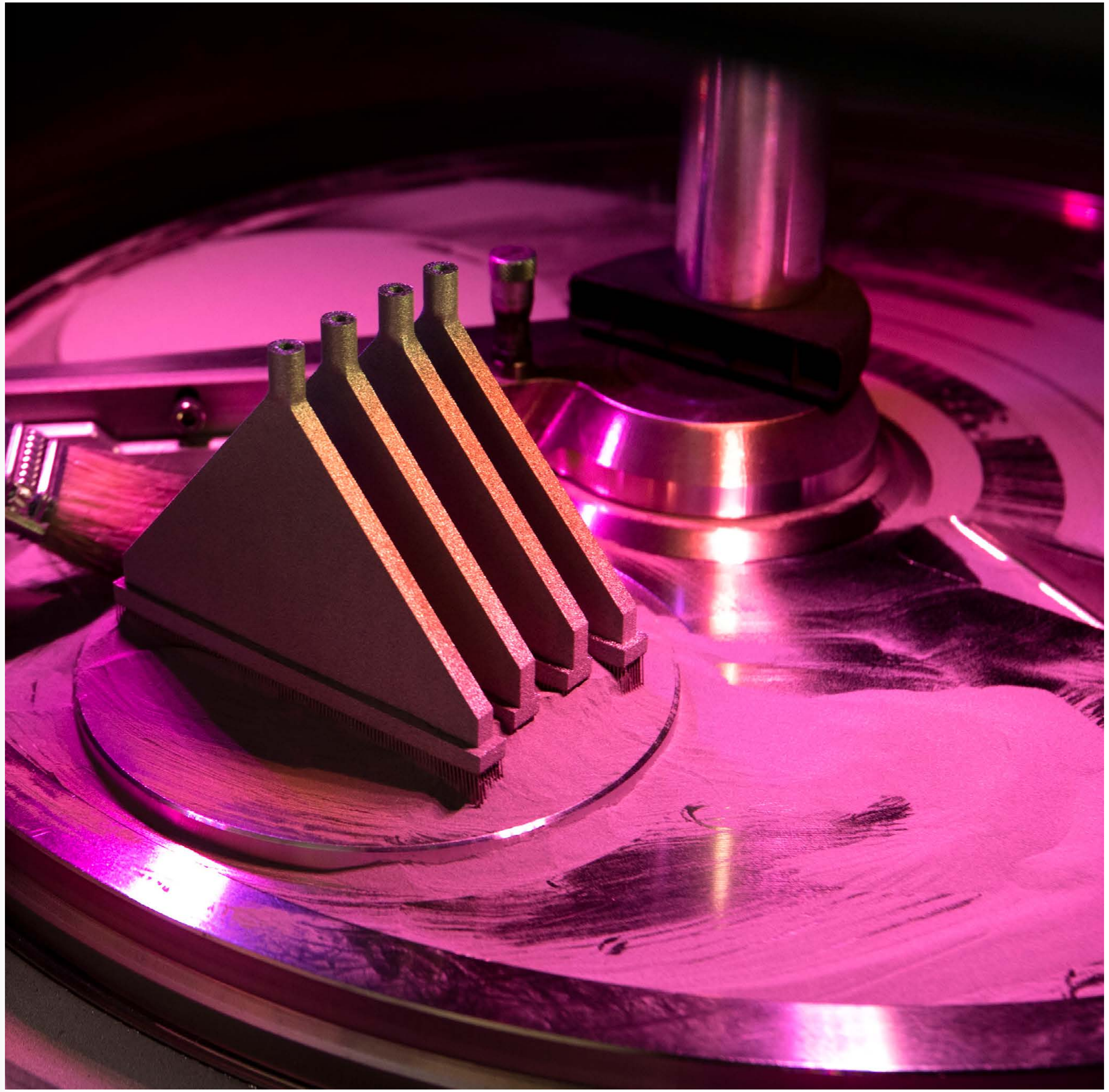
From a student to a Vice-Rector

He completed his master's degree in Mechanical Engineering and Machine Design in 1994. He started work as an assistant, conducting research for his doctoral dissertation defended in 2003. The following years of Błażej Bałasz's research activity were crowned with obtaining the degree of habilitated doctor in discipline: construction and operation of machines. In the years 2003-2006, he was the director of the Knowledge Transfer Centre at the Science and Technology Park in Koszalin. In the years 2003-2007, he was the manager of postgraduate studies: Computer Networks - Design and Management. On a daily basis, he is associated with the Department of Technical and IT Systems Engineering of the Faculty of Mechanical Engineering. Research interests of prof. Błażej Bałasz focuses on issues related to Industry 4.0, in particular: the use of large data sets for diagnostics of machines and devices, modelling and simulation of industrial processes and designing technological processes. The scientist's achievements include over 100 publica-

tions. In addition, he has been a manager or executor in 12 research projects. At the Rapid Prototyping Centre (RPC), together with a team of experienced specialists, he conducts research and development work on the development of technology for additive manufacturing of machine parts from metal powders, applicable in machine building, energy and biomedical engineering.

Great potential and enormous opportunities

The primary mission of the Faculty of Mechanical Engineering, the oldest didactic unit of the University, is to lead in the development of technology in the fields of: mechanical engineering, automatics, robotics, mechatronics and cybernetics, power engineering, investments and industrial implementations, management and production engineering, agricultural technology and food engineering through scientific research, academic education, knowledge dissemination and technology transfer. The mission of the faculty is also international, national and regional cooperation in accordance with international standards and the level of modern civilization. In addition to his involvement in RPC, prof. Błażej Bałasz is the coordinator of another important project, that is the Knowledge Constellation - a portal containing and presenting information about the scientific activities of the Koszalin University of Technology. The Knowledge Constellation is a promotion of the successes of scientists representing the academic community and the university itself, an element motivating students and graduates to work and act, and an inspiring presentation of the school's potential, addressed to entrepreneurs. Prof. Błażej Bałasz admits that for a long time he has perceived 3D metal printing as, not even the technology of the future, but of the present and contemporary engineering idea, understood as an algorithm of knowledge, imagination and technical capabilities of already available devices for additive production. The establishment of the centre was actually a matter of time, and not of vision, assumption or access to financing sources.



Support from ministries and the European Union

Prof. Błażej Bałasz recalls the beginnings of the RPC in the following way: - At our faculty, the idea emerged to acquire specialized equipment for research on the development of additive manufacturing technology, using powders of various types of metals, ranging from surgical steel, through titanium, to aluminium alloys. Having such an excellent base as the facilities of the Koszalin University of Technology, we decided to give it a try and, as you can see, we managed to do everything we had wanted to achieve.

This is how was created the project to launch a new laboratory at the Faculty of Mechanical Engineering - Rapid Prototyping Centre - enabling research in the field of additive technologies and the production of machine parts from metal powders. The idea of scientists found fertile ground and received financial support from EU funds and from the then-Ministry of Science and Higher Education (now: Ministry of Education and Science). The purchase of the equipment was possible thanks to the project: "Rapid Prototyping Centre", the total cost of which was PLN 3.6 million. A significant part of this value, i.e. nearly PLN 2.2 million, was co-financed by the European Union from the European Regional Development Fund, under the Regional Operational Program of the West Pomeranian Voivodeship 2014-2020. The ministerial funding amounted to PLN 288,000.

Nothing is impossible!

Thanks to the implementation of the project, a modern research and implementation centre was created in one of the Faculty of Mechanical Engineering buildings, enabling - as we read in the assumptions of its construction - "research in the field of additive technologies, modelling and simulation of deformation mechanisms and processes, strength testing and reverse engineering with the use of a 3D laser scanner ".

Additive manufacturing is the process of creating three-dimensional metal parts based on a digital file.

In practice, it looks analogous to 3D printing from other materials, like filaments. It is illustratively called additive manufacturing because it involves applying thin layers of material on top of the other.

Additive manufacturing technology is closely related to the technology of producing machine parts, that has been known for several decades, by pressing metal powders and making castings. It allows for the production of metal parts that are as functional as those produced by other traditional methods, such as: milling, casting or machining.

This innovative technology, becoming more and more popular, and which, above all, performs very well in situations of breakdowns, faults and damage to small and larger parts for machines and devices, allows for obtaining elements of complex shape, the production of which using traditional methods of casting, machining or subtractive machining/cavity treatment would be very difficult, and in some situations even impossible.

The layer-by-layer production

The Rapid Prototyping Centre has, above all, measuring and technological equipment that is unique in the entire region.

- Nobody from Szczecin to Gdańsk or Piła City has such, or even similar, devices - says prof. Błażej Bałasz. - The facility is equipped with the most modern devices for additive manufacturing, including: a 3D scanner and two machines for 3D printing from metal. Thanks to the scanner, digitisation of objects takes place quickly and precisely, and a digital design can be created even in several dozen minutes.

The new technology offers the possibility to give the manufactured parts any shape - this is an advantage of additive manufacturing, which was previously known thanks to the dissemination of 3D printing technology for the production of plastic elements. This idea was successfully applied to the manufacture of metal elements.

How is the production process going? In the device that prints, a small layer of metal powder is distributed, which undergoes melting in the right places. The process needs to be repeated. In this way, the production of the product proceeds layer by layer. Hence the term - additive technology.

Device for the production of powders

In the case of 3D printing from metal, we are dealing with an extremely flexible production method. The detail is produced in short series and can be upgraded as required. It takes a long time to manufacture parts by additive manufacturing. However, if we take into account the fact that there is no need to carry out tedious preparation and logistics work, such as preparing moulds, the manufacturing process may turn out to be short. In addition, there is no loss of material, which can be a problem in the case of subtractive manufacturing (turning, machining, milling).

It is worth emphasizing that the centre has been equipped with a device for the production of metal powder - this is a unique piece of equipment which, in laboratory conditions, allows for the transformation of metal, for example in the form of a wire, into a powder, from which, in subsequent manufacturing stages, a finished product can be prepared.

- Thanks to this, we can carry out research in the field of new materials and check the possibility of their use in the production of specific products - says Prof. Błażej Bałasz. - We can modify the parameters: the power of the laser, the speed of its movement, the spatial arrangement of products during printing. All of this is of great importance, as it affects the final result.

Converting the real into a digital model

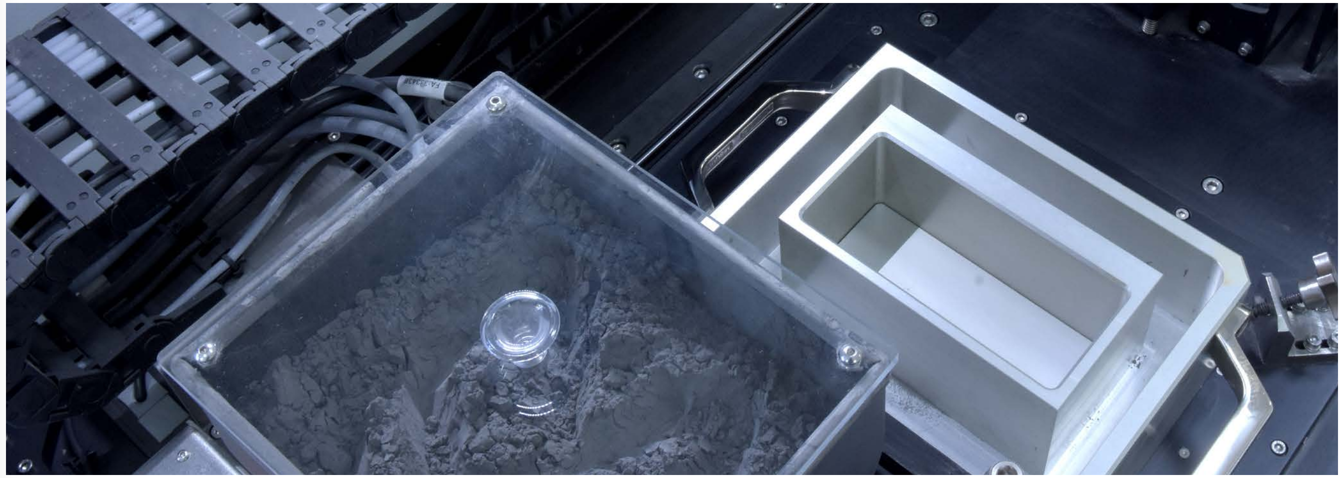
Additive technology has almost unlimited application possibilities. The only barrier may, but doesn't have to, be the cost. Manufacturing objects using this method enables a completely new approach to the design of machine parts.

- So far, our capabilities were limited by the shape of the knife, the milling cutter, or the shape of the injection mould, used in the production of parts - explains the Rapid Prototyping Centre coordinator. - But with additive manufacturing, we do not face such limitations. Additive manufacturing allows us to avoid many different difficulties.

Why? Because with new technology, a new method has emerged: generative design. It consists of the fact that the shape and features of the product determined at the beginning are transformed as a result of subsequent interactions so that the product exactly meets the expectations.

This allows obtaining complex shapes with variable properties. Analogies for such optimisations can be found in the structure of the human body. In those places where the bone should fulfil specific functions, it is thicker, in others - thinner and has a different internal structure.

The first step to production, as we mentioned, is to prepare a digital model of the object which is created through CAD modelling or reverse engineering. That is why a laser scanner has become such an important part of the centre's equipment, which enables very accurate and quick digitization of objects and their conversion into a digital model.



Two Additive Manufacturing Methods

The laboratory has two Additive Manufacturing Machines that use two different technologies. The first is based on selective laser melting technology. The powder layer is precisely distributed in the machine. The laser beam melts the powder in the right places, creating the desired shape.

The second technology uses the binder jetting method. In order to obtain a finished product, metal powder is bonded together, layer by layer, using a specialised binder. The model prepared in this way, after removing the excess binder, is sintered at a high temperature in the metallurgical furnace, which gives it the required strength and mechanical properties.

- Each of these methods has a different purpose - adds prof. Błażej Bałasz. - We wanted entrepreneurs to be able to choose the most suitable one for their applications. The most important for us in contact with company representatives is the possibility to learn what their needs are exactly, then to adapt our capabilities to them, and finally to establish permanent cooperation based on mutual development signals.

The Centre also has a machine for testing strength and resistance, thanks to which it is possible to thoroughly examine the properties of products - resistance to compression, stretching or bending as well as processes related to fatigue wear.

Technology doomed to success

The manufactured object, just like models prepared on the basis of traditional methods, can be later subjected to additional processes, including abrasive or mechanical processing. If surfaces of better quality and smoothness are needed, it is possible to apply abrasive treatment, if it is necessary to change the mechanical properties, heat treatment should be used.

What can be considered an added value in this project? The Rapid Prototyping Centre offers a chance not only to learn about additive technology, but also to undertake research collaboration with companies on, among other things, practical research projects. This involves designing and manufacturing advanced components with a complicated and complex shapes. The new method enables a completely new approach to the design of machine parts, providing complete freedom compared to traditional manufacturing methods.

Innovation and new technologies are one thing, but their proper application in production and other manufacturing processes is something completely different. It can happen that a solution that is one hundred percent innovative, resulting from long, tedious, thorough research, is not applicable in practice, and therefore cannot be commercialised. In the case of metal 3D printing, impracticality was out of the question from the beginning.

Decreasing costs in the market turnover

Additive manufacturing was initially used almost only in the space and aerospace industries, because the components produced in this way were very expensive to prepare, and therefore expensive to market. But over time, the technology has become more accessible and today it is more and more often used, for example, in the aviation, automotive and consumer goods industries. Increasingly, manufacturers use it as a complementary technology and an integral part of production processes.

Interestingly, the jewellery industry is a large, regular customer and partner of 3D printing centres. The additive manufacturing technology enables the individual design and the production of jewellery with the use of precious metal powders. The furniture industry has thus gained access to the production of unique, individual decorative elements.

- The entrepreneur must assess whether the use of this method can bring him benefits - believes prof. Błażej Bałasz. - The product itself, as a final element, may be more expensive, than even previously assumed. However, if you take into account the entire cost calculation and the fact that non-standard customer expectations are satisfied in a much shorter time, the profit may turn out to be higher than with the use of traditional technologies.

FAST PROTOTYPING CENTER / Koszalin University of Technology / Faculty of Mechanical Engineering / csp.tu.koszalin.pl / 15-17 Racławicka Street, 75-620 Koszalin / contact: phone: 94 34 78 341, 609 313 610 / csp@tu.koszalin.pl

THE RAPID PROTOTYPING CENTRE OFFER INCLUDES:

• Additive manufacturing of advanced metal products and tools with complex geometry and spatial structure;

• Testing of static, dynamic and fatigue strength of prototypes of metal products with geometry and spatial structure;

• Testing and design of new products in the automotive industry that meet the highest strength standards in accordance with EU requirements;

• Testing and design of new construction elements in agricultural and road transport, and in agricultural machinery and equipment, as well as in the furniture industry;

• Testing and design of heating systems with increased efficiency with the use of additive technology.

>> The coordinator of the Rapid Prototyping Centre of the Faculty of Mechanical Engineering, KUT, prof. Błażej Bałasz, PhD. DSc: - In order to best and fully illustrate the features of 3D printing from metal, I will use a quote from Theodore von Karman [1881-1963 – the pioneer of modern aerodynamics and the scientific approach to aviation – editor's note]: "Scientists study the world as it is; engineers create the world that has never been".

3D METAL PRINTING, FUTURE ENGINEERING

An interview with Vice-Rector for Science at Koszalin University of Technology, the coordinator of Rapid Prototyping Centre of the Faculty of Mechanical Engineering prof. Błażej Bałasz, PhD. DSc

What is additive manufacturing?

- Additive Manufacturing (AM), also known as 3D printing, is a technology that enables the production of three-dimensional parts, layer by layer, from a material, based on a polymer or metal.

What is this method about?

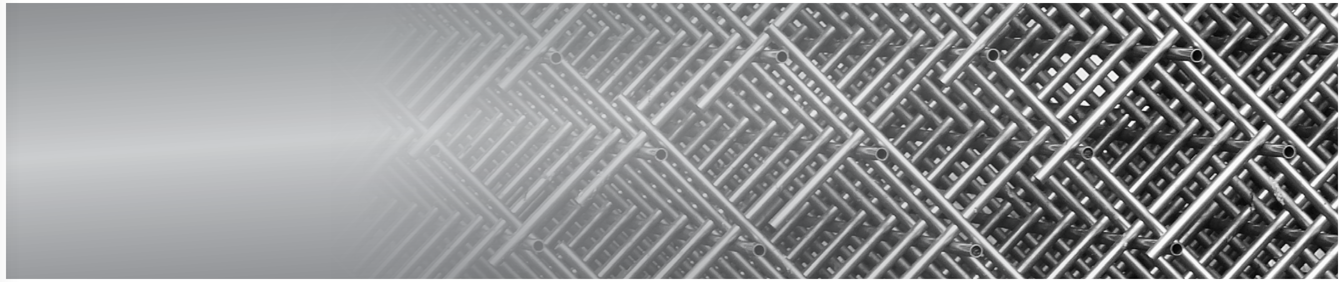
- In fact, the production process is extremely simple. It consists in sending a digital data file to a computer which generates the codes that control the 3D printer. The printer then builds the component in its rhythm of movement frequency.

Is it possible to mass-produce components?

- Yes, of course. Components that would not have been obtained by this method a few years ago are now successfully manufactured to high standards using a wide range of metal powders. It is no longer just a prototype technology. We use it to produce series components for the most demanding applications.

What is the main feature of Additive Manufacturing?

- It is difficult to select the main feature, all the elements of this production method are of great and separate importance. In my opinion, we are talking about a kind of evolution, although perhaps a revolution in technological significance would be a more appropriate term. 3D printing, by the way not only for metal, offers many different advantages in the production of parts, offering absolutely exceptional design freedom,



with the possibility, as I have mentioned, of producing one or more components.

What were the beginnings of AM?

- The early processes and projects related to Additive Manufacturing date back to the 80s' of the twentieth century. It was about adopting the most effective solutions for faster product development. It is known that the speed of production is crucial because it determines the pace of sales, the changes and, in the case of 3D printing, also how quickly a fault holding up production can be removed.

What were the first experiences with additive manufacturing?

"At that time, all the practices initiated were called Rapid Prototyping because it was really about creating three dimensional models or mock-ups to check form, fit and function.

When did the commercialisation process of the new technology begin?

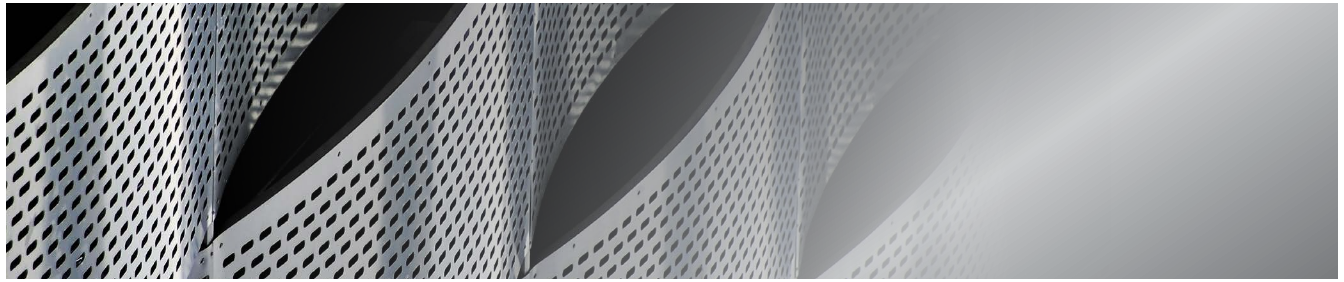
- In 1987 - that is the date we assume. 3D Systems company began commercialising the plastics processing technique known as Stereolithography (SL), offering completely new opportunities for designers and engineers and supporting a rapidly growing market for short-life products. The process involved solidifying thin layers of a UV light-sensitive liquid polymer by means of a laser and was the first commercially available AM system in the world.

Was this the beginning of 3D technology as we know it today?

- In the early 90s' of the twentieth century, commercialisation of other polymer-based AM technologies began, including fused deposition (FDM) from Stratasys, ground curing (SGC) from Cubital and Laminated Object Manufacturing (LOM) from Helisys. At that time, DTM Selective Laser Sintering (SLS) was also introduced, consisting in bonding powder materials together using a laser. So to answer the question: yes, it was the beginning of something that we are starting to use today and that will have the greatest impact on the engineering and technology of the future.

Was Additive Manufacturing already related to metal then?

- Not immediately, but it was obvious that it would quickly involve metal. Metal-based Additive Manufac-



turing processes of an advanced nature were developed in the 1990s and were soon introduced to the market. During that time, several companies implemented laser sintering systems that could directly produce metal parts. It was an alternative to direct multi-stage processes.

When did prototypes of metal 3D printing machines appear?

- In 1984, EOS demonstrated EOSINT M160 prototype machine based on direct metal laser sintering technology. A year later, EOSINT M250 was launched, enabling the production of metal tools. These systems were able to produce metal parts by sintering the powder, but in many cases the mechanical properties of the materials were comparable to composites rather than metal alloys.

Why?

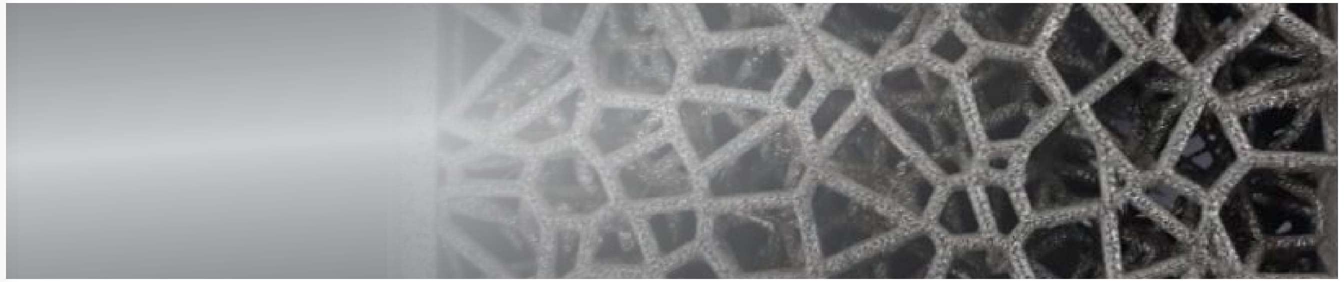
- Because of the combination of a material with a low melting point, such as a bronze-based structure, with a material with very high resistance, such as stainless steel or tool steel. In 2002, Precision Optical Manufacturing began selling its systems for laser direct metal deposition (DMD), a process that produces and repairs parts using metal powder.

What is the current situation with the availability of technology?

- There are currently many different technologies available for metal additive manufacturing systems. The systems can be classified according to the source of energy or the method of joining the material, such as by a binder, laser, or heated nozzle. Classification is also possible according to the group of materials being processed, such as plastics, metals, and ceramics, for example. The states of the raw material, which most often are solids such as powder, wire or sheet, or liquid, are also used to define the process.

What is the powder bed system?

- Almost every powder bed-based system uses a powder deposition method, consisting of a coating mechanism to spread a layer of powder on the substrate plate and powder hopper. The layers can range in thickness from twenty to around a hundred micrometres. Once the powder layer is spread, the 2D slice is bonded together and known as 3D printing or fused using a beam of energy applied to the powder bed.



What is the source of energy in the latter case?

– A high power laser, but the most modern systems can use two or more lasers of different power, in an inert gas atmosphere. Systems with a direct powder bed process are known as "laser melting processes" and are commercially available under various names, for example: selective laser melting (SLM), laser developing, and direct metal laser sintering (DMLS). The exception is electron beam melting (EBM). This process uses an electron beam in full vacuum.

What materials are used in the binder spraying process?

- There are generally two materials: powder-based and binder-based. The binder acts like the adhesive between the layers of powder. The binder is usually in liquid form and the building material is in powder form. The print head moves horizontally along the X and Y axes of the machine and deposits alternating layers of construction and bonding agents. After each, the printed object is lowered onto the work plate.

What is the last part of printing?

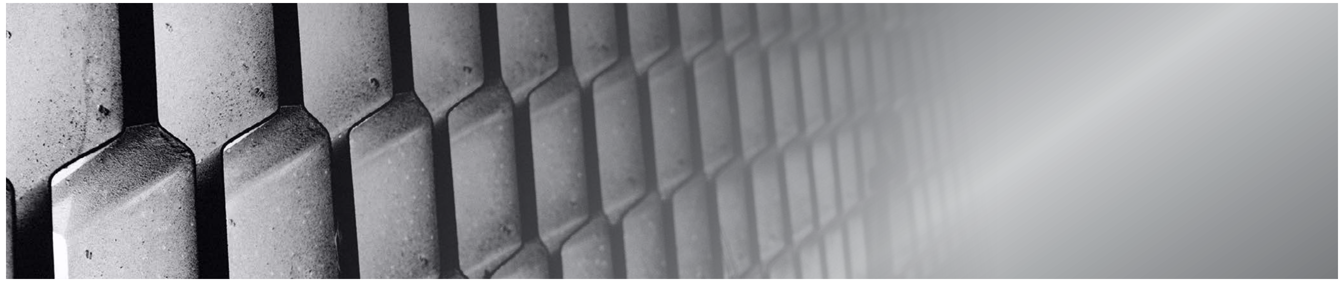
- It proceeds in the same way as the previous ones, printing is a constant and unchanging process, keeping the rhythm of methodical head movements. Until the element is created, we wait for what is happening behind the safety glass. Once printing is complete, the parts are dug out, i.e. extracted from the powder using compressed air. Subsequently, they are subjected to a hardening process, followed by a sintering process at high temperature in a metallurgical furnace.

How thick is the layer of material deposited?

- The process is very precise and based on the automated application of a layer of material from one-tenth of a millimetre to several centimetres thick. Powder fed systems are also known as laser cladding, targeted energy deposition, and laser metal deposition. The metallurgical bonding of the facing material to the base material and the absence of an undercutting are some of the features of this process.

How does it differ from, for example, welding techniques?

– It differs in many features, including the fact that a small amount of heat penetrates into the substrate. The variety of materials available for metal AM systems is constantly and systematically increasing, which bodes well for the future and the development of this



technology. Today, according to our experience, the most commonly used materials are: aluminium, stainless steels, nickel, cobalt-chrome and titanium alloys, but many machine manufacturers offer their own materials.

What is the importance of the quality and properties of the material used for printing?

- The characteristics of the material are of fundamental importance. Material properties such as tensile strength, hardness and elongation are often used as reference points when making important decisions, including the use of a specific material that is best for a given situation. Common specifications of metal powders suitable for AM are: spherical particle geometry resulting from gas atomisation and particle size distribution depending on layer thickness. Research and efforts to standardise processes and materials are ongoing, which is an important step for better product comparison and faster incorporation into existing process chains.

Do components still require any additional adjustments after printing?

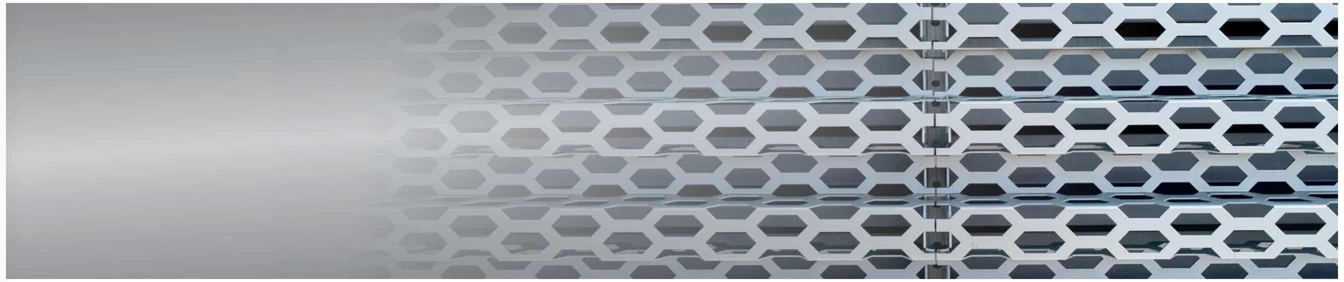
– In order to achieve the necessary specifications or to improve properties such as surface quality, geometric accuracy and mechanical properties, it is often necessary to post-process and finish components produced by additive manufacturing techniques. Surface roughness values for selectively laser melted metal parts are typically between fifteen to forty micrometres. Most of the physical characteristics of components can be improved by adding well-established manufacturing processes to the end of the AM process chain.

Can already printed elements be further processed?

- Yes. This is another advantage of Additive Manufacturing. Once the support structures are removed to separate the parts from the work platform, the products can be milled, drilled, polished and so on. Therefore, they can be customised exactly to the needs of clients. Internal surfaces, such as those located in internal channels, can be polished by abrasive blasting. Heat treatment is often included in the process chain as well as shot blasting/peening which is used to improve the mechanical and tactile properties of the surfaces of AM parts.

What is the importance of AM printing for an engineer?

- AM printing complements a wide range of manufacturing processes, enabling engineers, but also designers, for example, to improve existing process chains and offer new product possibilities. Metal 3D printing belongs to the class of disruptive technologies that fundamentally change our way of thinking about design and production. Most importantly: from consumer goods produced in small batches to large-scale production, the uses of AM are vast.



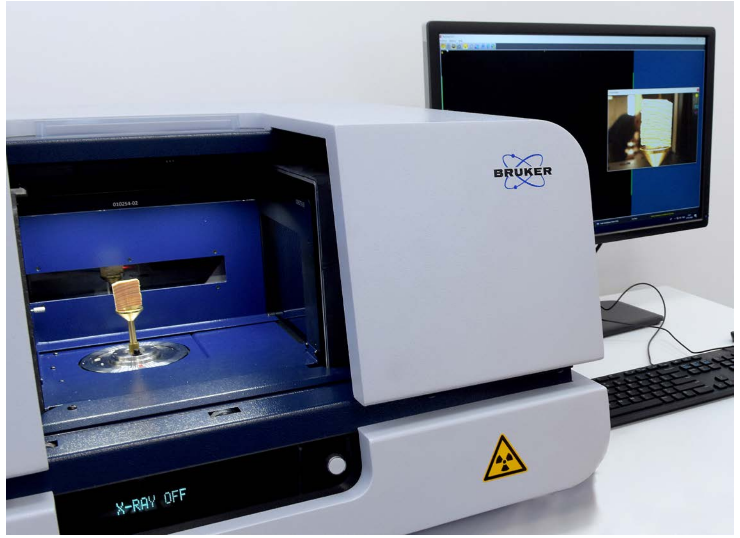
Today, after almost thirty years of experimenting and developing this technology, what are the greatest advantages of 3D printing from metal?

- The most important and valued advantages result from the high flexibility of this technology, as the product is manufactured directly from the CAD model, and therefore without the need for tooling. It also allows to produce almost any geometry that can be designed. Until recently, the external geometry of a part and its function or strength were a matter of the user's concern, but AM enables the integration of additional functions and new areas of application for technical parts.

Interviewer:
Mateusz Stankiewicz

THE OFFER

BRUKER SKYSCAN 1275: STATIONARY SYSTEM FOR COMPUTER MICROTOMOGRAPHY MICROTOMOGRAPH



MAIN SYSTEM PARAMETERS:

- maximum sample scanning diameter 96 mm, maximum sample height 120 mm,
- radiation source with a continuous energy peak change in the range of 20-100 kV,
- voxel size: <4 µm,
- squeezing attachment, maximum pressure of 4400 N.

|SCOPE OF RESEARCH WORK:

- 3D morphology analysis of materials and composites,
- imaging the structure of matter,
- imaging of sample cross-sections in any plane,
- identification of the internal structure of the porous material, particle distribution, pore fibers, etc. and determining its density,
- identification of the shape and size of structural elements and their distribution in the volume of the tested material,
- identification of the geometrical parameters of the composite materials layers.

EMPYREAN: PANALYTICAL X-RAY DIFRAECTOMETER

SCOPE OF RESEARCH WORK:

- qualitative and quantitative phase analysis,
- structure analysis of materials,
- crystallographic analysis of materials,
- analysis of stress states in PVD coatings,
- phase analysis and structural testing of powder samples.

DIFRAECTOMETER SOFTWARE:

- software controlling the operation of the diffractometer and data collection,
- Software for phase identification and Rietveld's phase analysis cooperating with the ICDD and ICSD database,
- stress analysis programme,
- texture analysis programme,
- software for the analysis of thin layers (reflectometry),
- SAXS small-angle scattering analysis software,
- ICDD / PDF-4 + crystallographic database


CREATOR
CAUTION
BURN HAZARD

3D PRINTER FOR SELECTIVE LASER MELTING OF METALLIC POWDERS **COHERENT CREATOR**

MAIN SYSTEM PARAMETERS:

- working area (diameter x height): 100 mm x 110 mm,
- laser power: 250 W,
- directly builds metal parts and components of very complex geometries,
- handling and processing of print data is carried out directly via a CAD file,
- high resolution ensures excellent surface quality.

POSSIBILITY OF PRINTING FROM THE FOLLOWING MATERIALS:

- 316L stainless steel,
- cobalt-chrome,
- titanium.

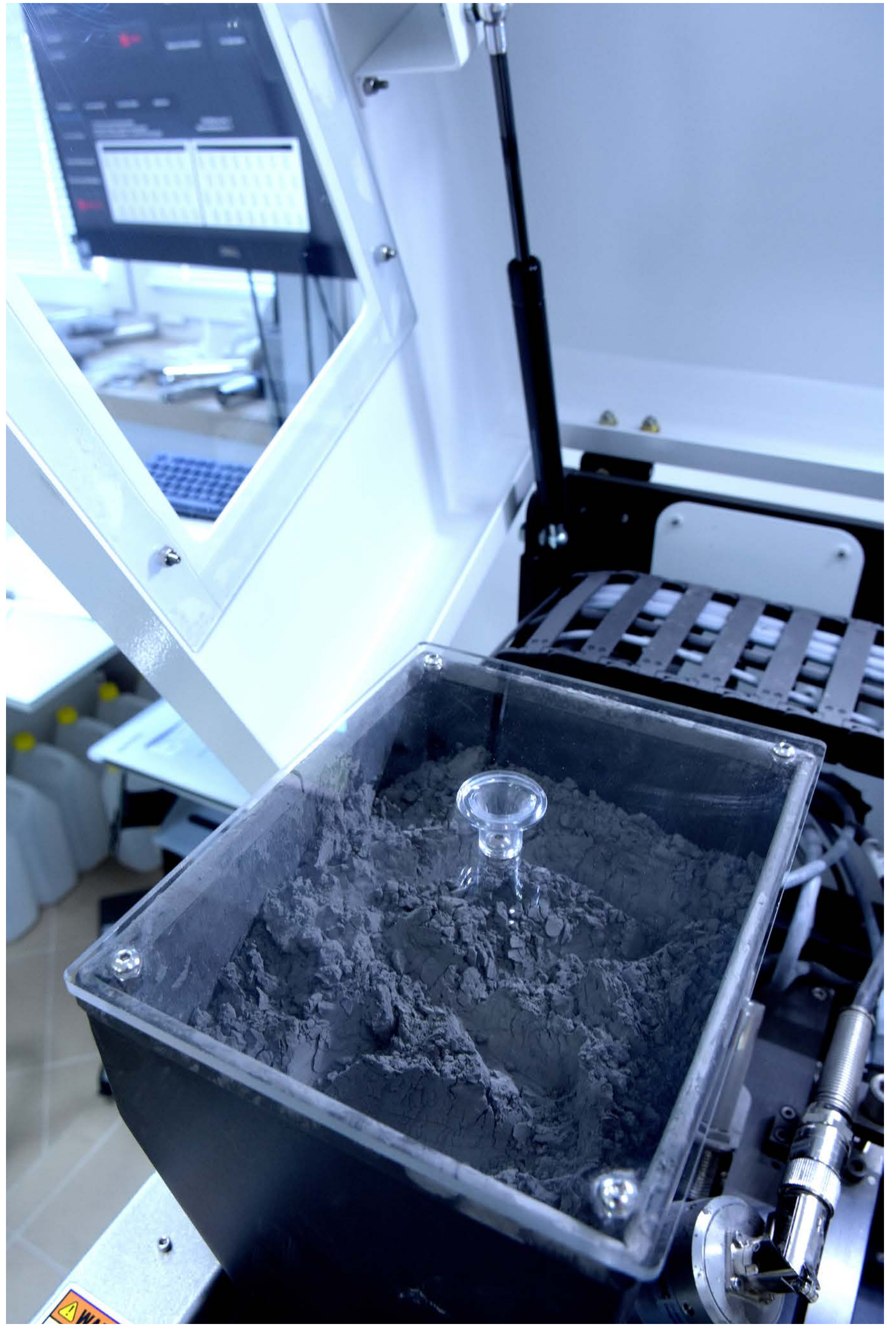
EXONE INNOVENT+: 3D PRINTER FOR SINTERED POWDER MANUFACTURING OF PARTS

MAIN SYSTEM PARAMETERS:

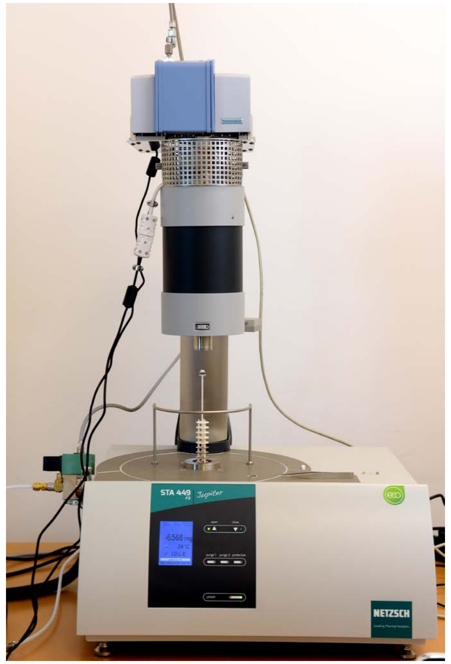
- printing in Binder Jetting technology,
- no need to create supports for the printed part,
- working area: 160 x 65 x 65 mm,
- working box volume: 0.676 l,
- layer height: 30-200 µm.

POSSIBILITY OF PRINTING FROM THE FOLLOWING MATERIALS:

- 316L stainless steel,
- 304L stainless steel,
- 420 stainless steel,
- 17-4PH stainless steel.



THERMAL ANALYZER **NETZSCH STA 449 F3 JUPITER FTIR PERSEUS**



SCOPE OF RESEARCH WORK:

- identification of the chemical composition of the analysed material,
- examination of changes in selected physical properties of a material under the influence of temperature changes in a given way, in an oxidising or inert atmosphere (e.g. thermal stability, humidity, corrosion resistance),
- assessment of the course of chemical processes and phase transitions occurring in a specific material under heating,
- identification of thermodynamic parameters of reactions occurring during material heating,
- determination of specific heat, determination of substance purity,
- determination of the melting and decomposition point of substances,
- determination of the lifetime setting of polymer resins in polymer-wood composites,
- tests carried out in laboratory conditions.

ZWICK Z400E: MULTIFUNCTIONAL STRENGTH TESING MACHINE WITH ELECTROMECHANICAL DRIVE

MAIN SYSTEM PARAMETERS:

- working area (diameter x height): 100 mm x 110 mm,
- laser power: 250 W,
- directly builds metal parts and components of very complex geometries,
- handling and processing of data for printing is carried out directly via a CAD file,
- high resolution ensures excellent surface quality.

POSSIBILITY OF PRINTING FROM THE FOLLOWING MATERIALS:

- 316L stainless steel,
- cobalt-chrome,
- titanium.


Zwick / Roell
Z400
F max = 400 kN
F max = 400 kN

MODELMAKER **H120 AND MCAX S**

MAIN SYSTEM PARAMETERS:

- printing in Binder Jetting technology,
- no need to create supports for the printed part,
- working area: 160 x 65 x 65 mm,
- working box volume: 0.676 l,
- layer height: 30-200 µm.

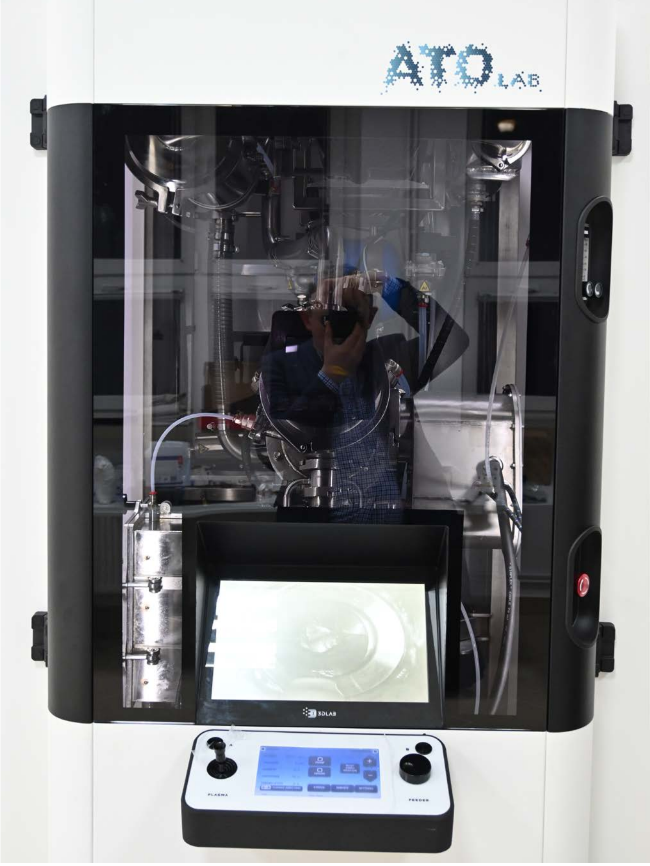
POSSIBILITY OF PRINTING FROM THE FOLLOWING MATERIALS:

- 316L stainless steel,
- 304L stainless steel,
- 420 stainless steel,
- 17-4PH stainless steel.


Nikon
MCAx25+


Nikon

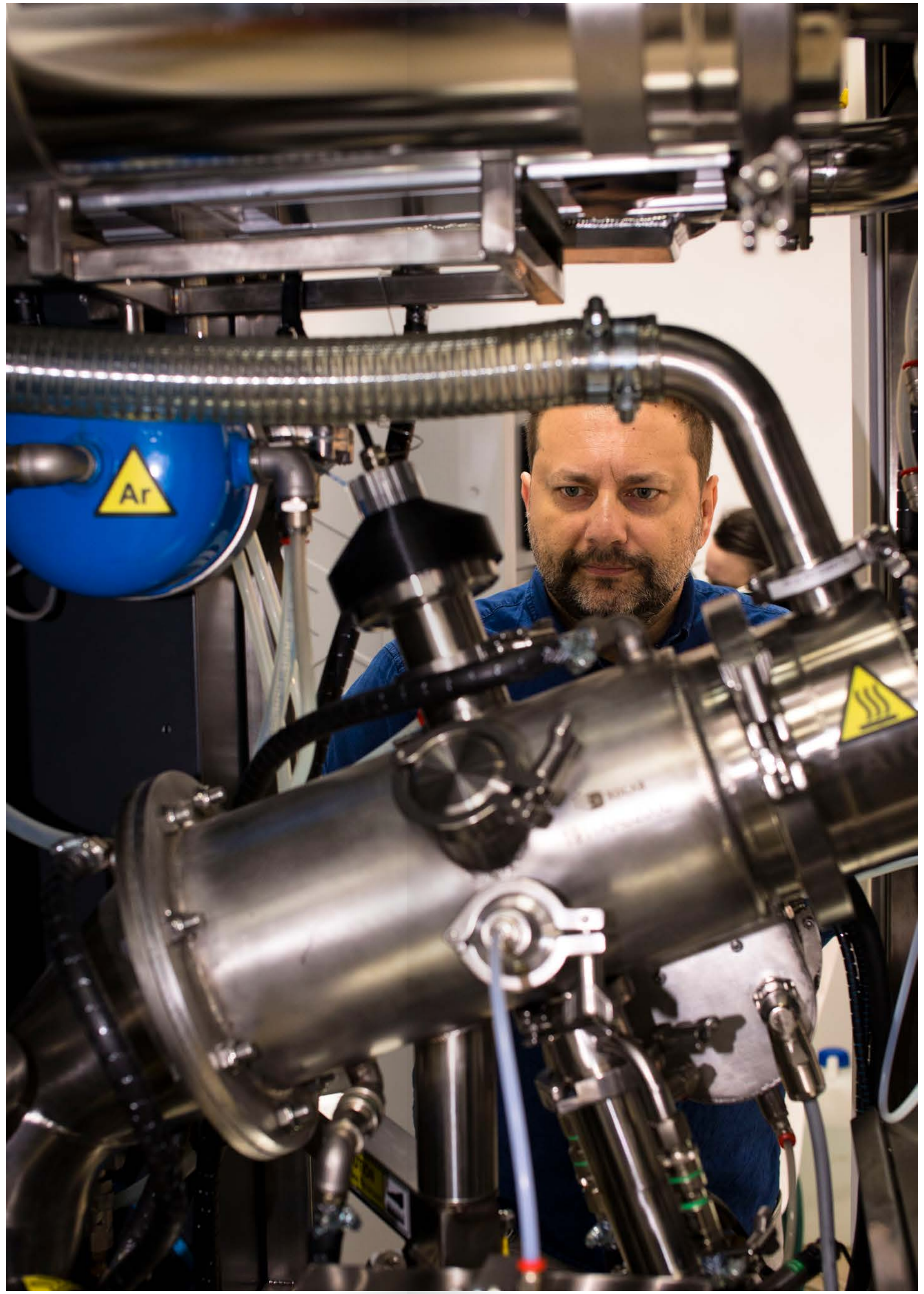
ATO LAB:
ATOMISER FOR THE PRODUCTION OF METAL POWDERS



THE MAIN PARAMETERS OF THE SYSTEM ARE:

- Process: production of metal powders
- Technology: ultrasonic atomisation
- Melting method: plasma burner
- Inert gas: argon
- Type of sonotrode: nano-alloy sonotrode
- Type of powder produced: spherical shaped powder
- The form of the material processed: wire, rod
- Possibility to be processed into powder: Fe, Al, Ti, basic alloys


ATOLAB
TIG
GENERAL


Ar


3DLAB
TORCH
FEEDER


Air 20°C
15
10
5
3
Air 20°C
15
10
5
3

GOM ARAMIS ADJUSTABLE BASE 12M ESSENTIONAL 3D SCANNER

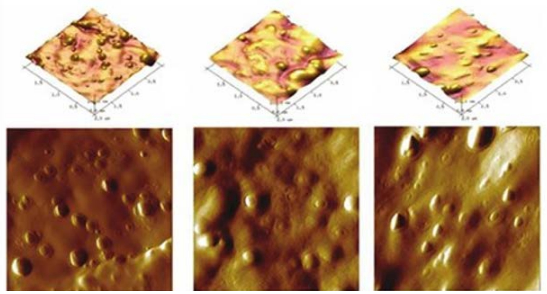
THE MAIN PARAMETERS OF THE SYSTEM ARE:

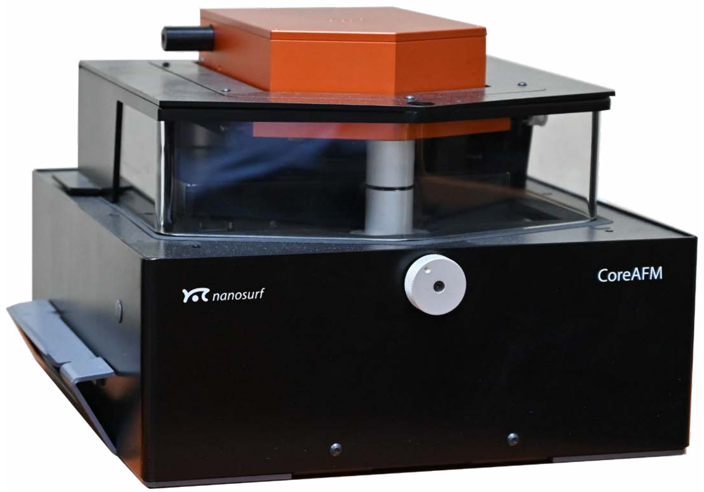
- Resolution up to 4096 x 3000 pixels,
- Image capture frequency: up to 100 Hz,
- Recording of analogue signals from sensors up to 8 channels.

SCOPE OF RESEARCH WORK:

- non-contact measurement of spatial displacements of characteristic points of a component subjected to external forces,
- registration of phenomena occurring during the destruction of material subjected to external forces at a frequency of up to several hundred images per second,
- determining of material strength parameters on the basis of its deformation under the influence of external forces,
- the possibility of carrying out tests outside the laboratory

MICROSCOPIC MEASUREMENTS OF ATOMIC FORCES



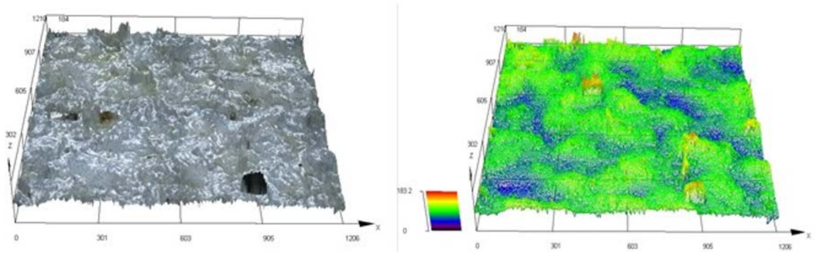


MAIN SYSTEM PARAMETERS:

- Measuring range (XY): 100 µm <5 nm of Flatness
- Height range (Z): 12 µm close loop
- Detector noise (RMS): typ. 60 pm max. 100 pm
- Sensor Noise (RMS): typ. 180 pm max. 250 pm
- Dynamic Noise (RMS): typ. 40 pm max. 70 pm
- Static noise (RMS): type 100 pm max 200 pm


HGS 5,5
hertz

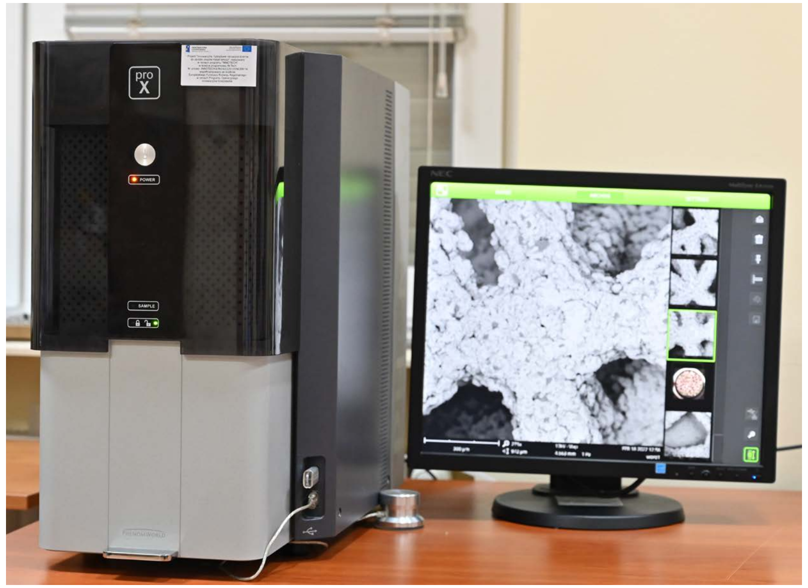
MEASUREMENTS WITH A **CONFOCAL MICROSCOPE**



MAIN SYSTEM PARAMETERS:

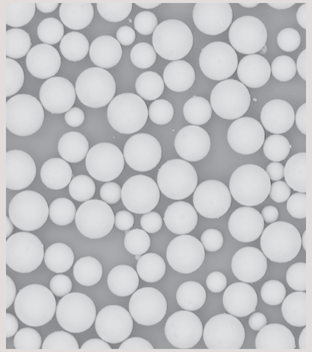
- Magnification range: 108x to 17 280x
- Slope measurement: max 85 deg
- Repeatability in plane measurements: 0.02 µm for 100 measurements
- Accuracy in plane measurement: 2%
- Height measurement repeatability: 0.012 µm for 50 measurements
- Accuracy in height measurement: (0.2 + L) / 100 µm
- Stitching: from 1 x 25 to 5 x 5
- Built-in anti-vibration system: yes
- Device type: confocal microscope

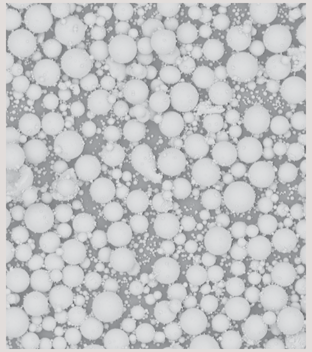
MEASUREMENT WITH SCANNING **ELECTRON MICROSCOPE**



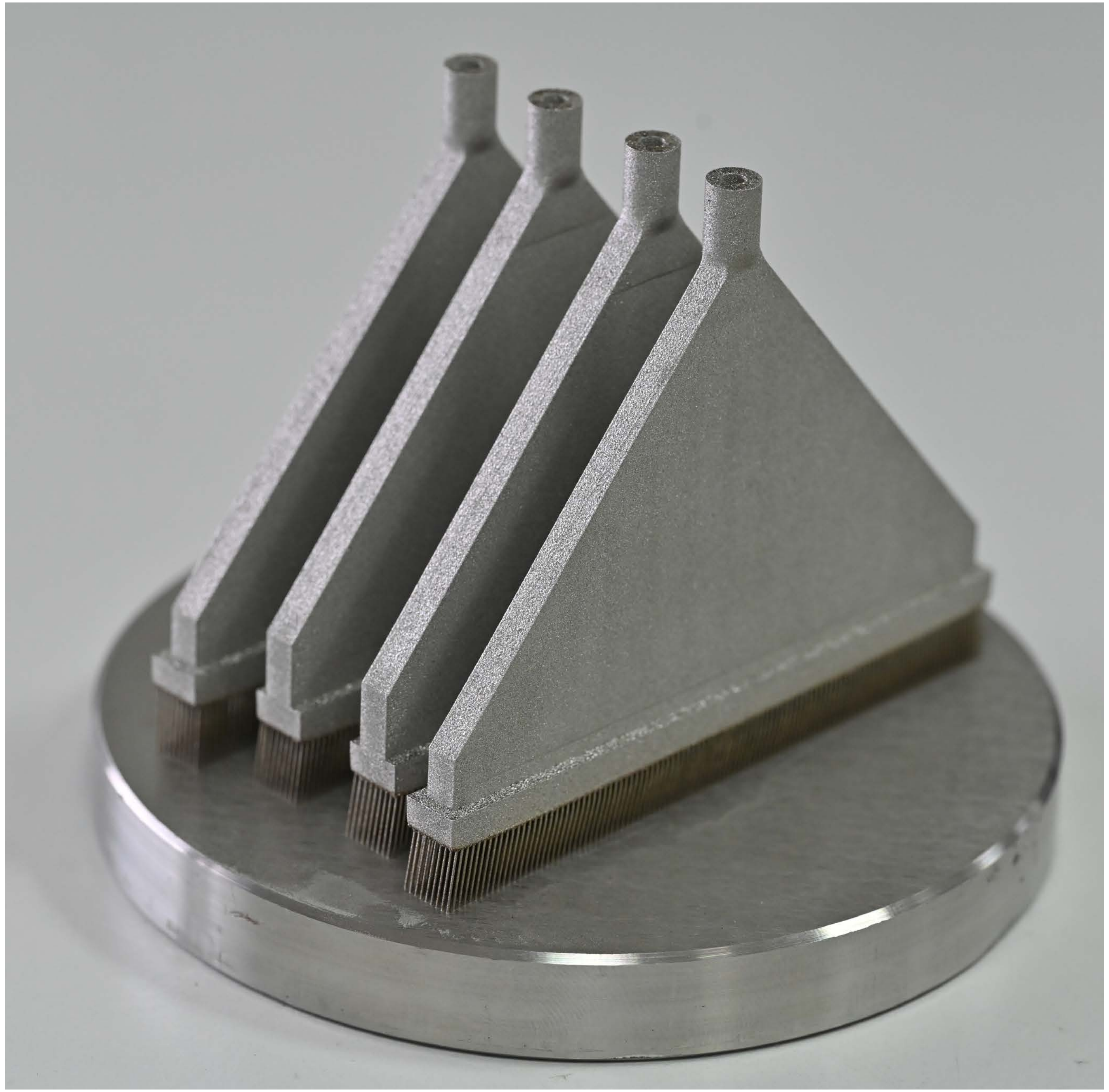
MAIN SYSTEM PARAMETERS:

- Measuring range (XY): 100 µm <5 nm of Flatness
- Height range (Z): 12 µm close loop
- Detector noise (RMS): typ. 60 pm max. 100 pm
- Sensor Noise (RMS): typ. 180 pm max. 250 pm
- Dynamic Noise (RMS): typ. 40 pm max. 70 pm
- Static noise (RMS): type 100 pm max 200 pm






Nabertherm



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