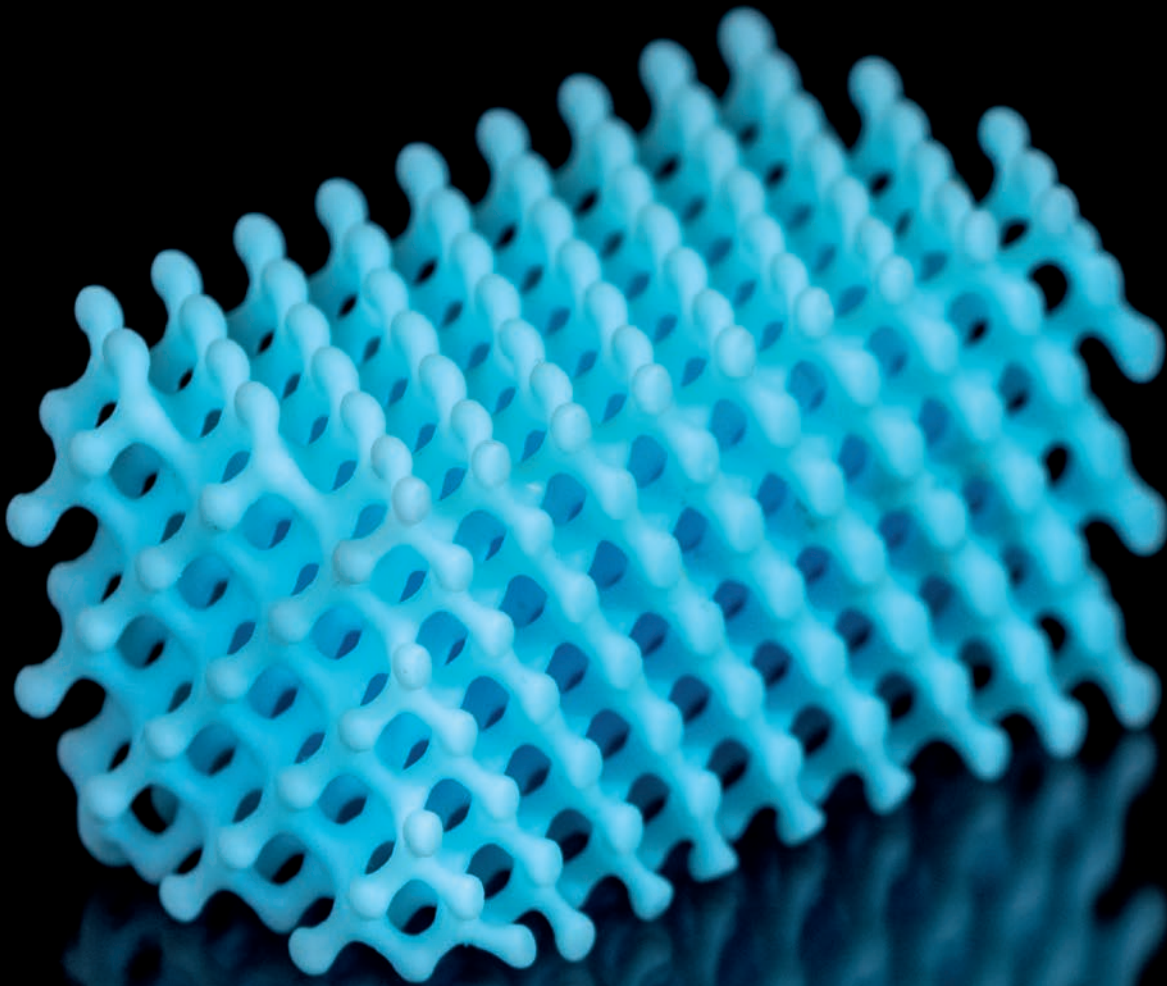


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formnext magazine



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by **formnext**

In three years,  
every product my company makes  
will be obsolete. The only question is  
whether we will make them obsolete  
or somebody else will.

[ William »Bill« Henry Gates III, founder Microsoft ]

## EDITORIAL

**T**he fAMily meets again! This has been the theme of the various events that have taken place since the beginning of the year. People from the additive community have been coming together face-to-face to share their ideas and opinions – and perhaps make some new contacts during the coffee breaks, as well.

We ourselves have been frequenting a number of gatherings and networking events in France, the official partner country of Formnext 2022. Such things normally wouldn't be all that newsworthy, but we haven't put the COVID-19 pandemic behind us entirely, and gathering in person was anything but routine over the past two years.

As a result, we've learned to appreciate how valuable these interpersonal exchanges are. Formnext 2021 demonstrated this to impressive effect, which is part of the reason why we're looking forward to the current event year with so much optimism. We've already registered more than 500 exhibitors, and well over half of them are from outside of Germany. Meanwhile, the amount of space they have booked has already surpassed last year's total.

On almost a weekly (or daily!) basis, we're getting information on new machines, procedures and areas of use; the latest company foundations and mergers; and the challenges

industrial AM applications are facing – some new, and some long-standing. To discuss these matters and come up with corresponding solutions together, it's more important than ever that we meet in person. That's why we're all the more excited to see the fAMily again at Formnext in Frankfurt on 15–18 November.



Sincerely, Sascha F. Wenzler  
Vice President Formnext

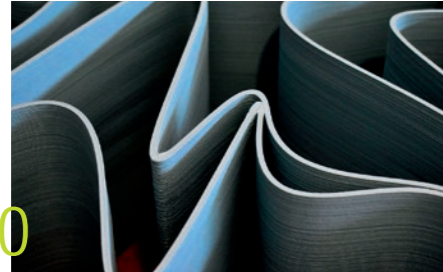


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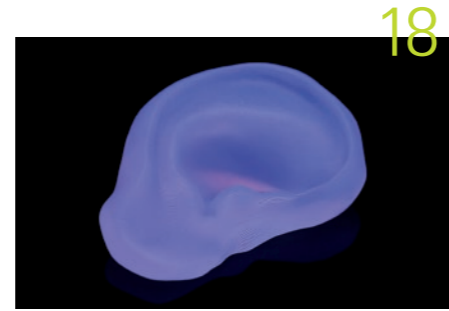


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# FORMNEXT NEWS

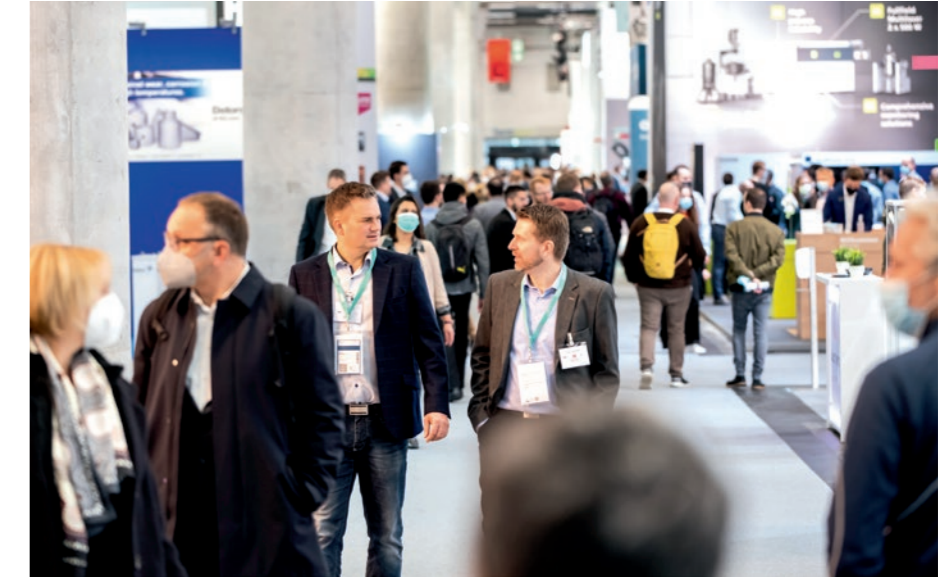
## NEW EVENT YEAR KICKS OFF WITH SIGNIFICANT GROWTH

Formnext started off the trade fair year with a very strong response from its exhibitors. By the end of April, some 500 companies had already registered for the 2022 event, representing an increase of 74 percent compared to the same time last year. Meanwhile, the 50,000 square meters that have been booked for Formnext 2022 have already blown past the amount of gross exhibition space reserved in 2021 by more than 30 percent. Formnext will also have plenty of international character once again this year, with 56 percent of its exhibitors coming from outside of Germany.

Those that have already signed up represent a who's-who of the global AM industry, including 3D Systems, ACAM, Additive Industries, AddUp, Arburg, BigRep, Carbon, Chiron Group, Desktop Metal, DMG Mori, DyeMansion, EOS, 3D Tech, Farsoon, GE Additive, GF Machining Solutions, GKN, Hage 3D, HP, Keyence, Lincotek, Lithoz, Markforged, Materialise, Oerlikon, Prima Additive, Renishaw, Roboze, Shining 3D, Sinterit, Sisma, SLM Solutions, Stratasys, Trumpf, Voxeljet, Xjet, and Xerox.

In addition, numerous young and innovative companies will be showing off products and services all along the process chain alongside established corporations that have developed special solutions for additive manufacturing. These companies include the likes of BASF, Bosch, Covestro, Evonik, Hexagon, Höganäs, Ingersoll, Sandvik, SMS Group, and Voestalpine.

»After a difficult 2020, the overall AM market has returned to its usual very positive development,« says Sascha F. Wenzler, Vice President for Formnext at event organizer Mesago Messe Frankfurt GmbH. »That makes it all the more important for companies from all over the world to present their new business ideas and innovations and discuss them in person with an international audience of experts.«



### THIS YEAR'S PARTNER COUNTRY: FRANCE

Formnext's most important countries in terms of its participants are the United States (14.3 percent of international exhibitors); the United Kingdom and Italy (both 8.4 percent); the Netherlands and France (both 7.7 percent); and Spain, Poland, Austria, and China.

With the support of a prominent AM community that includes both globally established companies and highly innovative start-ups, France – the trade fair's partner country this year – is set to lend Formnext 2022 its own special flair. This will also be reflected in the surrounding program and other adjacent events. Among other highlights, a partner country event is to be held in advance of Formnext in Grenoble in cooperation with the organizations CIMES (Creating Integrated Mechanical Systems) and Polymeris, Competitiveness Cluster for Rubbers, Plastics and Composites on 22 September 2022.

### EXHIBITION HALLS WITH EXCELLENT AIR CIRCULATION

Even though most of the measures implemented to combat COVID-19 are no longer required, Formnext and Messe Frankfurt are continuing to make the health of exhibitors, attendees, and employees a top priority. To that end, a study was conducted to examine the content and hygienic quality of the ambient air in typical exhibition halls. In the second

half of 2021, corresponding measurements were taken at Formnext and two other events.

»We now have the results of the study, and they show that all the halls analyzed were well ventilated at all three events; no local accumulations of aerosols were detected,« reports Uwe Behm, executive board member at Messe Frankfurt. »There were only slight differences in the concentrations of CO<sub>2</sub> in the outgoing air and the individual locations where measurements were taken, which means the mixing ventilation was almost ideal.«

CO<sub>2</sub> concentration was chosen as the indicator of air contamination because people exhale CO<sub>2</sub> in the same way as aerosols, which took on importance as potential carriers of COVID-19 during the pandemic. »You want to make sure that the CO<sub>2</sub> level doesn't exceed 1,000 parts per million,« Behm explains. »Ambient air with more than 2,000 ppm is considered unacceptable in terms of hygiene.« All the measured levels of CO<sub>2</sub> concentration were continually and significantly below 1,000 ppm. In fact, some of the measurements came in at just over 400 ppm, which is close to the quality of outdoor air.

**+ FURTHER INFORMATION:**  
» [formnext.com](https://formnext.com)

## NEWS

## BACK IN THE DOUBLE DIGITS

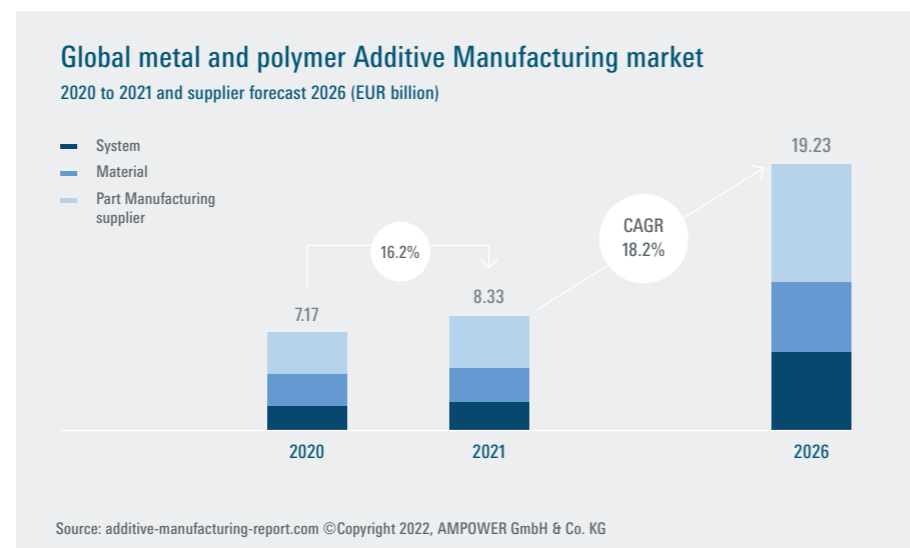
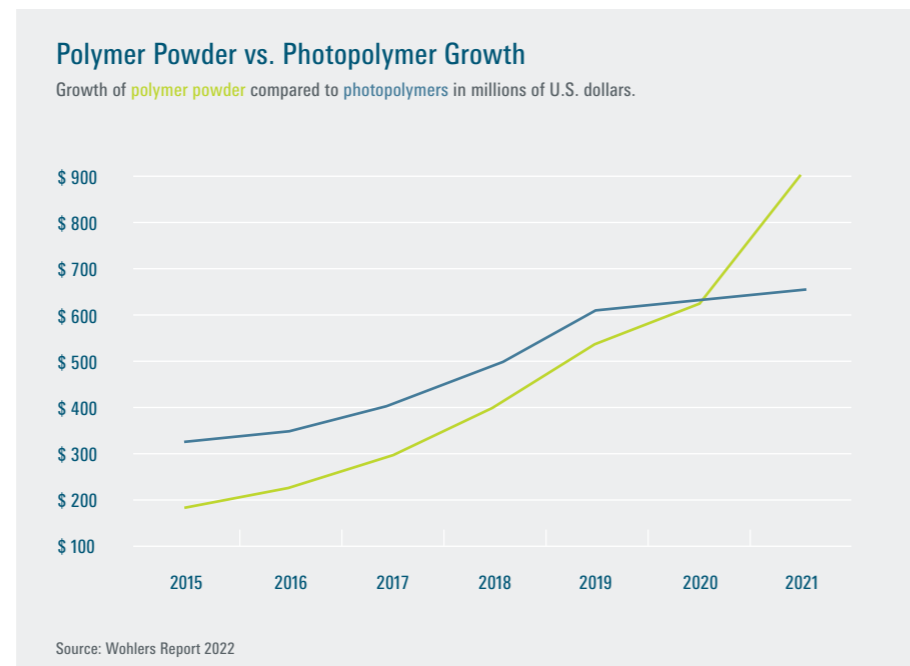
After the Covid-related difficulties of 2020, the AM sector is now back on track and growing as strongly as it had in previous years. The analyses performed for Wohlers Report 2022 have the industry expanding by 19.5 percent in 2021, while the Ampower Report 2022 estimates 16 percent growth.

»As expected, the industry has returned to a period of advancement and investment,« said Terry Wohlers, head of advisory services and market intelligence at Wohlers Associates, powered by ASTM International. »This expansion cuts across aerospace, healthcare, automotive, consumer products, energy, and other sectors.«

This was a significant improvement on 2020, when the global AM industry grew by 7.5 percent according to Wohlers Report. Polymer powders in particular enjoyed a real boom, expanding by 43.3 percent in 2021. »These powders have thus overtaken photopolymers as the most commonly used AM material,« Wohlers Report states. »As the technology and industry mature, a growing number of companies are using AM for custom products and series production.«

Meanwhile, the Hamburg-based consultancy Ampower was already observing a rebound in incoming orders all along the value chain just before 2020 came to a close. The printer facilities of part manufacturers were back to run at full capacity after a desolate year and supplier were able to make up the lost business in the first year of the pandemic. This upward trend continued well into 2021, despite the continuous economic challenges existing all around the world. The only downer: Ongoing supply chain disruptions prevented an even stronger growth. However, the system suppliers faced with increasing demand suffered from shortages of certain critical parts and the lead times of some machines increased significantly.

Ampower now projects that the volume of the worldwide AM industry will grow from €8.33 billion at present to €19.23 billion by 2026. The key drivers of this expansion will include the variety and perspectives offered by innovative AM technologies, some of which



are still in their nascency. »Today, powder bed fusion machines make the majority of sales but in the coming 5-10 years, new technologies are growing at a faster pace, promising significant productivity increases«, explains Dr. Maximilian Munsch, Co-Author of the Report and Managing Partner of Ampower. According to Timo Führer, Polymer Expert at Ampower, polymer

shows »significant productivity increases in new disruptive liquid and powder AM technologies. This has the potential to bring the technology to mass products across industries in the next decade. This development will not only push consumer goods but open the door for upcoming applications with high volume potential.«

Infographic: feedbackmedia.de / Wohlers Report 2022 (1), additive-manufacturing-report.com (2)

Photo: Aubert & Duval

## NEWS

## SECURING THE STRATEGIC SUPPLY CHAIN AND DEVELOPING NEW MATERIAL

Airbus, Safran and Tikehau Ace Capital have signed a Memorandum of Understanding with the mining and metallurgical group Eramet for the acquisition of its subsidiary Aubert & Duval. The three partners intend to acquire 100% of Aubert & Duval through a new joint holding company that would be specifically set up for this transaction and in which they would have equal ownership rights.

With annual revenues of approximately €500 million and a workforce of around 3,600 employees based mostly in France, Aubert & Duval is a strategic supplier of critical parts and materials for a number of demanding industry sectors, notably the aerospace, defence and nuclear industries. The company has end-to-end capabilities in special materials and super-alloys which are critical to aerospace, transportation, energy and defence applications.

This acquisition would allow Airbus and Safran to secure the strategic supply chain, for themselves as well as other customers, and new material development for current and future civil and military aircraft and engine programmes.

»Aubert & Duval is a historical supplier of Safran with unique technical expertise in Europe«, said Olivier Andriès, Safran's CEO. He also stressed out that the planned acquisition



will »ensure national sovereignty for our most strategic programmes for disruptive civil and military aircraft engines«.

Guillaume Faury, CEO of Airbus, emphasized the industry sector's need for a »solid partner to ramp up production while preparing next-generation technologies in aerospace. With this acquisition and an ambitious transformation plan, we aim to restore the operational excellence and market confidence in Aubert & Duval to create, in the mid- to long-term, a leading European player able to face global competition

as well as to reduce geopolitical risk of supply.« »This joint acquisition sends a strong and very encouraging message about the acceleration of the restructuring, the transformation and the consolidation of the supply chain in the aerospace industry«, added Marwan Lahoud, Executive Chairman of Tikehau Ace Capital.

The proposed transaction is subject to consultation with relevant employee representative bodies and all necessary regulatory approvals. The closing is expected in the fourth quarter of 2022.

## FLATTENED SCREW PAVES THE WAY TO AM

Seiko Epson Corporation has developed an industrial 3D printer that can use commonly available third-party materials. 3D printers with these features will have uses in a far wider range of applications, including in the production of parts for final products.

Epson's newly developed 3D printer employs a new material extrusion method that is achieved using a flat screw (an inline screw with a flattened configuration) like that found in Epson's injection molding machines. This

extrusion method enables the printer to be used with a variety of common third-party materials, such as resin or metal pellets, which are generally available at lower cost than other materials, environmentally considerate biomass pellets, and PEEK materials, which can provide high heat resistance. The amount of material injected is controlled by regulating the pressure within the head and by regulating the action of a valve in concert with the modeling speed.

The temperature at the surface of a piece being printed must also be controlled in order to obtain the required strength. To achieve this purpose Epson employs a unique mechanism. Epson is aiming to commercialize the printer after first making needed refinements while utilizing it internally to volume-produce certain parts for commercial and industrial equipment.

## NEWS

## LEAN PRODUCTION FOR THE SPACE INDUSTRY

Boeing unveiled a new high-throughput small satellite production, integration and test facility designed for efficiency and rapid delivery timelines. Housed in the world's largest satellite factory, Boeing's 1-million-square-foot El Segundo facility (92,903 square meters), the small satellite production line will be powered by Boeing subsidiary, Millennium Space Systems.

»Boeing and Millennium are bringing together Boeing's production expertise, domain knowledge, and manufacturing capacity with Millennium's agility and rapid prototyping,« said Jim Chilton, senior vice president of Boeing Space and Launch. »We're scaling and growing to fulfill our customers' vision for multi-orbit constellations with demand across markets and mission sets.«

The companies are applying advanced and additive manufacturing techniques, including 3D printing entire space-qualified satellite buses, to offer faster cycle times while improving performance.

»Our customers need satellites on-orbit faster than ever,« Chilton said. »Much like an airplane or auto production line, we're employing lean production principles and advanced manufacturing techniques to accelerate delivery and pass on cost savings to our customers.«

Boeing will provide access to extensive environmental and specialty testing capabilities that have qualified some of the most iconic spacecraft, including the first vehicle to make a fully controlled soft landing on the moon and more than 300 satellites.

Designed to build small satellites for different security levels on the same assembly line, the digitally-defined small satellite factory incorporates model-based systems engineering, digital design engineering, and design for manufacturability.

Initial operating capability took place in September 2021, and the small sat factory's full operational capability is expected in late 2022.

## MERGER TO ACCELERATE GROWTH



Prima Industrie S.p.A. completed the spin-off operation of the Business Unit dedicated to additive manufacturing and the consequent capital increase in the company 3D New Technologies Srl, which was already collaborating with the group for the development of innovative systems based on Powder Bed Fusion technology. At the same time as the capital increase, the change of the company name of 3D New Technologies Srl to Prima Additive Srl was approved.

Prima Additive Srl will maintain close collaborative relationships with Prima Industrie S.p.A., which will be majority shareholder of the new company, with a stake of 50.01%. Paolo Calefati has been appointed Chief Executive Officer.

»The merger between the spin-off Prima Additive and 3D New Technologies represents growth and an investment in this sector by Prima Industrie,« Calefati said. »Furthermore, this operation is a first step in attracting both financial and industrial investors who are already leaders in this market.«

The purpose of this merger is to make synergistic the activities of the two units involved in the operation to accelerate the development and commercialization process of the products and the growth plans of the new company that will operate in a market with great development prospects.



Photos: Boeing, Prima Industrie S.p.A

## NEWS

## TO ANALYZE HUNDREDS OF COMBINATIONS

Linde announced it is developing a new, dedicated laboratory to advance the understanding of the parameters and behavior of atmospheric gases used in the manufacture of metal powders. As innovative additive manufacturing technologies have made significant advances to the process itself, the demand for novel metal powders has grown significantly. The new laboratory is due to become operational mid-2022.

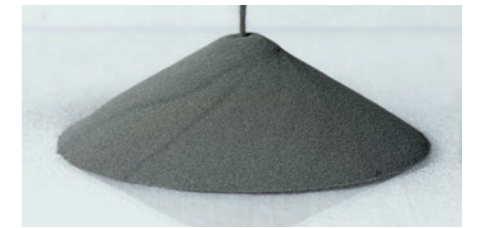
While being vast in size, and requiring multi-million-dollar investments, standard metal powder atomizers are unsuitable for the observation and analysis of gas behavior as parameters are adapted.

The focal point of Linde's new laboratory will be a much smaller scale version (1.60 meters high) of a typical atomizer with specially adapted windows, lighting, high-speed cameras and schlieren imaging allowing for surveillance and data capture of each change of gas parameter. It will not rely on the introduction of

molten metal, instead using data from the simulated process to provide evidence of gas behavior under certain conditions. The different parameters to be assessed include gas type, volume of gas, pressure and temperature, with the miniature atomizer able to rapidly switch over to analyze hundreds of combinations within minutes.

The laboratory will enable Linde to develop new technologies to improve the atomization process – particularly increasing yield and process stability. Linde will also collaborate with powder manufacturers and OEMs to help them test specific gas behaviors on the test bench, allowing them to then scale up the results on their large atomizers.

»As demand grows for new metal powders, more research into the parameters of the gases which are integral to their manufacture is needed to ensure their role is optimized,« said Pierre Forêt, Associate Director Additive Manufacturing, Linde.



For the atomization of metals to create powders for additive manufacturing, a key challenge is to maintain a large volume of gas (2,000 cubic meters per hour), under high pressure (60 bar or higher) and temperature (up to 400°C), even for a short period of time. When adding in factors such as metal type and gas composition, the variable parameters are immense.

A further key variable is the nozzle design. Linde will offer powder manufacturers testing services to ensure optimal nozzle designs by 3D printing prototypes and testing them in the new lab.

## WEAR-RESISTANT AND TOUGH

With 160 years of materials expertise Sandvik has been working with cemented carbide since 1932. The company is providing for instance metal cutting- and mining tools such as turning inserts, end-mills, and drill bits. Now, Sandvik is broadening its offering to also include 3D printed components in cemented carbide.

Cemented carbides have a unique character as a result of their composite structure – a wear-resistant phase bonded together by a ductile binder metal. They are widely used across multiple industries such as metal cutting, agriculture, food, and oil and gas. As Sandvik reports, due to its inherent hardness, cemented carbides can be challenging to machine, not least in complex geometries. Sandvik can now offer 3D printed cemented carbide on a commercial scale – based on a



tailor-made powder attained through a proprietary process. »Cemented carbide is one of the very hardest, if not the hardest material available in 3D printed shape as of today,« says Anders Ohlsson, Lead Product Manager at Sandvik Additive Manufacturing. A key



differentiator compared to other hard materials is the fact that these alloys are often brittle, to some extent – while cemented carbide, with its matrix structure consisting mainly of cobalt and tungsten carbide, is uniquely tough.

Photos: Linde, Sandvik

# HIGH DEMAND FOR A FULLY AUTOMATED PRODUCTION LINE

Is it possible to automate Additive Manufacturing processes? This question has been one of the most discussed in the industry since AM first made its appearance as a manufacturing technology. Especially during the Covid19 crisis and the associated supply bottlenecks, there were many calls for a realignment of the supply chain. Additive manufacturing also often came into play here, although it requires a greater degree of automation for the production of higher volumes. This was already a hotly discussed topic at Formnext 2021 – but what is the current situation of automation technologies and how are they implemented in the AM-plastic industry?



**P**ilot projects for testing automation technologies within an industrial production line have been run by industry leaders to try and break through the current limitations and technological barriers.

For example, the Polyline project, begun in March 2020 and scheduled to run for the duration of three years, was devised with the intention of automating single processes in the AM production line and connecting them from part design to the final product. The technology shall be qualified for larger series in general and the automation shall further increase the quality of the products. The objective is to bring this to market as an end-to-end solution, within what is referred to as a »holistic view« of the automated AM workflow. »You can't only develop one thing or the other«, says Martin Friedrich, former Project Lead Series Projects Additive Manufacturing at BMW Group, »Everything should be interconnected and fully automated.«

A BMBF (Federal Ministry of Education and Research)-funded consortium of 15 industrial and research partners from Germany has been

At the BMW Group Additive Manufacturing Campus (AMC), Oberschleifheim: Automated unpacking, post-processing, part identification and separation cell

Text: Luca van der Heide

Photos: BMW



brought together by EOS to contribute their individual competences to try covering all of the aspects of software and hardware know-how required to overcome the many technological hurdles of automating every step of the production line.

## »SO FAR, EVERYTHING IS LABOR-INTENSIVE«

»From the point of view of the supplier, we can see that there's a high interest in scaling polymer 3D printing technology«, said Marcus Andrä, Product Line Manager Polymer Periphery and Automation at EOS. »The demand for a fully integrated automated production line is very high.«

The reasons why a big OEM like BMW Group would approach the automation of AM processes are very clear. »Currently, everything is labor-intensive«, says Martin Friedrich, Project Lead AM Series Products at BMW Group. »A great share in the production of AM parts today is invested for repetitive processes, such as unpacking the parts. As an automotive manufacturer, we want to be as efficient as we can, and give our employee's capabilities the best way.«

»A lot of it has to do with costs as well«, adds Paul Osswald, Project Lead R&D for Non-metal Additive Manufacturing at BMW Group. »If AM wants to take the next step and increase production volume the cost needs to decrease, and automation is one way to do it. There's downtime, you're dependent on employees to be there. Being able to run the machines productively without anyone being present increases the efficiency which then in turn reduces the final cost per part, and reducing costs is crucial to be able to scale up.«

Automation is implemented in the production line through a combination of software, hardware, AI and robotics. In particular, automating a whole production line means to automate the individual machines as well as to automate the communication between them. Machines like the EOS P 500 are fully automated polymer systems able to perform a series of operations such as loading and unloading exchange frames and cooling off the part without any human intervention. Automated powder handling, unpacking, cleaning and post-processing stations all work autonomously, while also being connected by automated transport systems. »

EOS P 500 AM system, including Grenzebach Exchange EOS P500 and EOS closed-loop powder management



Automated post-processing  
at Protolabs

### ALGORITHMS TO MAKE THE OVERALL PROCESS MORE EFFICIENT

Software is another crucial aspect. Data are collected from the work stations via real-time monitoring and used to develop algorithms to make the overall process more efficient. The part is followed in every stage and can be checked at any time thanks to thermal cameras and sensor data from the machines. As a result of this, quality inspection and monitoring is established throughout the process, rather than at the end.

At the same time, having all the data of all the processes recorded also enables greater traceability. »If a customer from BMW wants to know where all the information of a part that's been produced is, they can just click the button and get the information right away«, says Andr .

However, there are still limitations to how the technology can work independently of human operators. This is evident especially in the phase of post-production, where operators still have to set up the machines according to the different structural and design require-

ments of each specific job. »Currently we can't adjust to complex geometries and new materials automatically«, says Julius Legenmayer, Senior Product Engineer at DyeMansion. »This means that the process has to be adapted by our experts to the almost limitless variety of 3D printed part geometries and specifications. What we need as a next step would be to have smart machines that can adjust dynamically to changing input parameters and adapting to the limitlessness of AM designs.«

Making this particularly problematic is the fact that the issue seems to be inherent to the nature of automation. »Automation is about repeatability«, commented Oliver Elbert, Head of Additive Manufacturing at Grenzebach. »One of the things that makes AM so attractive as a manufacturing technology, which is that parts can have very specific, customized layouts, is also what makes it so difficult to automate.« What the Polyline project aims to do is therefore to overcome these limitations and have processes that are standardized and repeatable along the entire production line.

### INCREASING THE EFFICIENCY AND RELIABILITY OF INDIVIDUAL OPERATIONS

While pilot projects like Polyline are focused on achieving end-to-end automation, automation technology is already used in the industry to increase the efficiency and reliability of individual operations with wide applicability. Andrea Landoni, Product Manager 3D Printing EMEA at Protolabs, explains how as a 3D printing services provider, Protolabs has automated post-processing steps with the intention to cater to a range of different sectors, and for this reason, their main interest for automation lies in the possibility to apply the same processes to many products simultaneously.

Certain post-processing steps, Landoni says, apply to every product. For example, parts produced via SLA or Polyjet processes, which are processes usually employed for prototyping, all need support removal. Parts made with SLS or Multijet Fusion, instead, which are used for finished products as well as small serial production, all need powder removal. On the other hand, some products need more specific parameters and post-processing steps. »For us, it

Photos: Protolabs

wouldn't make a lot of sense to spend hours setting the parameters for jobs with very specific requirements«, Landoni said. »What we need is to enhance reproducibility, and reduce time and costs; and the best way to do this is to automate those processes that every part needs to go through.«

Right now, Protolabs has automated machines for depowdering and vapor smoothing. Before this, the cleaning and smoothing of the part was done manually, and it was therefore a much more fallible process. With an automated machine, efficiency is greatly increased, especially in regards to times, that are always consistent, and quality reproducibility, which doesn't have to depend on the accuracy of the operator.

But at the same time, Protolab's R&D teams are always on the lookout to include new technologies for automation in their facilities. In Munich, they recently moved to a new, bigger facility, with a view to remodeling their produc-

tion streams and integrating, step-by-step, upcoming automation technologies. »Although right now, the value of automation for us resides mostly in its application to standard post-processing steps«, Landoni concluded, »there's no reason why we can't upgrade our automation technology so as to include a broader spectrum of cases in the future.«



**Powder Bed Fusion**  
For further information on this procedure, check out the AM Field Guide at [formnext.com/amfieldguide](https://formnext.com/amfieldguide)



**Vat Photopolymerization**  
For further information on this procedure, check out the AM Field Guide at [formnext.com/amfieldguide](https://formnext.com/amfieldguide)



Typical orthopedic application built in MJF TPU, before and after vapor smoothing (including optimized design)

**+ FURTHER INFORMATION:**  
[formnext.com/fonmag](https://formnext.com/fonmag)

## ROCKING OUT ON A GREEN AXE



Additive manufacturing has also given the guitar industry new momentum, though less in an economic direction and more in an artistic and creative one. Olaf Diegel and his company, ODD Guitars, have been producing and selling 3D-printed guitars for over 10 years. Diegel, who also teaches product development as a professor at the University of Auckland (New Zealand), has designed more than a dozen different models and built a total of 92 guitars, and five more are in the planning stage. The prices range from \$3,500 to \$4,000.

In particular, Diegel is making use of the design possibilities afforded by 3D printing. »In the case of guitars, the only real advantage of 3D printing over traditional production is the incredible aesthetics you can achieve that would just not be possible with traditional manufacturing,« Diegel told FON magazine. »That's why my guitars are all designed to be incredibly complex inside the guitar body. If I was making a conventional guitar in the style of a Fender Stratocaster or a Gibson Les Paul, 3D printing would probably be the worst choice of method.« After all, he says, CNC machining or hand-rout-

ing with a template is infinitely more cost-effective for simple geometries. »But, if you're trying to make a guitar with the skyline of New York City – with 3D buildings, cars, bridges, and so on – it's impossible with traditional tools; 3D printing is the way to go.« Diegel's creativity is evident in the wide variety of his different creations. They range from the flame design of »American Graffiti« to the stars and stripes of »Americana« and the barbed wire and roses of the »Heavy Metal« model. For his »Beatlemania« bass guitar, Diegel – who primarily plays bass himself and

studied jazz for a few years in his youth – drew inspiration from his favorite English band. »This bass guitar plays great and is borderline kitsch, so I just love it,« he admits. In addition, he has a fondness for rockabilly and the rock 'n' roll of the '50s and '60s.

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Text: Thomas Masuch



Photo, p. 14:  
Diegel's latest model, »Green Axe«, was made from wood-based materials using a binder jetting procedure.  
This page:  
Olaf Diegel has found a way to combine his passions for music and 3D printing, including in the bass guitar »Beatlemania«

Photos: Olaf Diegel



**Powder Bed Fusion**  
For further information on this procedure, check out the AM Field Guide at [formnext.com/amfieldguide](https://formnext.com/amfieldguide)

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### 3D PRINTING SERVICES AND HAND-PAINTED FINISHES

ODD's guitar bodies are printed from nylon using the SLS (polymer powder bed fusion) process. Diegel's workshop is very well-equipped with 3D printers, but the build spaces of its machines are not sufficient for the size of the guitars. Diegel thus uses 3D printing services from i.materialise or Shapeways, or from Xylloc in Belgium (for aluminum guitars). He takes care of the finishing, assembly, and simple paint jobs himself. For more complicated color work, he works with his airbrush artist friend Ron van Dam. Hand-painted finishes are done by Diegel's wife, Akiko, who is also an artist.

Diegel uses top-quality pickups and hardware that promise the same tonal quality as other high-end electric guitars. However, there is »a kind of religious argument among guitar enthusiasts about the merit of tone woods versus other materials,« as he puts it, and this argument cannot be won.

At the same time, Diegel has also added new materials to his production portfolio. For his latest »Green Axe« model, he used a fairly new additive manufacturing technology that processes wood-based materials. For this, the binder jetting process from Forust was used (see our previous report). The procedure designed by this young U.S. company, which was acquired by Desktop Metal last year, uses wood sawdust and bio-epoxy resin.

### + FURTHER INFORMATION:

» [formnext.com/fonmag](https://formnext.com/fonmag)  
» [oddguitars.com](https://oddguitars.com)



## FORMNEXT START-UP CHALLENGE

# University start-up acquired by 3D Systems

3D-printed metal implants have been a well-established application in the world of additive manufacturing for many years. Back in 2017, five graduates from the Technical University of Munich set their sights on printing implants for human use – cranial plates made of plastic, for instance – in founding the start-up Kumovis. Five years on, the young company has become so successful that it now employs 26 people and has been purchased by 3D Systems, an AM industry giant based in the U.S.

Kumovis' 3D printing lab and post-processing station



Photos: Kumovis

Text: Thomas Masuch



Left:  
A cage with an absorbable fill structure, a cranial implant, and an osteosynthesis plate with a corresponding test implant  
Right:  
Dr. Miriam Haerst, co-founder of Kumovis

The main engine of Kumovis' growth has been its R1 printer, which it launched in 2019. Since then, multiple advancements have been made in the unit, and it remains the company's main product. According to its manufacturer, the Kumovis R1 combines a clean-room environment with component mechanics in a unique way that makes it particularly good at turning PEEK materials into implants and medical technology products. Its printing process is based on specially developed fused layer manufacturing (FLM) technology. Besides selling the R1, Kumovis also helps its customers deal with important issues related to post-processing, the requirements medical implants have to meet, and the provision of regulatory data. Meanwhile, the company's customer base has grown considerably, as well. Along with manufacturers of medical products, three hospitals have now procured their own R1 printers.

For co-founder and CEO Miriam Haerst, however, Kumovis' technology isn't the only reason why the company has been so successful. »It's actually been a lot of different factors,« she says. For example, her company first attended Formnext as an exhibitor not long after its foundation in 2017. The following year, it moved from its initial home at TUM to its own office, acquired two investors (a family office in Bavaria and High-Tech Gründerfonds), and promptly won the Formnext Start-up Challenge. »All this helped us expand our network further,« Haerst reveals.

Based on her five years of experience as a successful entrepreneur, Haerst underscores how crucial it is for young companies to be present at events like Formnext, even if they don't take home an award in the process. »Having a market-ready product to exhibit can

be a big challenge for start-ups, but at the end of the day, there are so many advantages,« the 35-year-old continues. »Achieving a certain level of visibility is extremely helpful. You also get feedback from the market – along with criticism, of course, which isn't always easy to hear. Ultimately, though, it gives you the chance to fine-tune your product and make further improvements.«

Kumovis is now an established player in the market, but maintains a clear focus on medical technology customers when attending exhibitions. »That said, we interact with other attendees in different ways these days,« Haerst says. »It used to be about testing out our business idea and building a network. Today, customers already know us, and many of them stop by to see the latest innovations we've come up with.«

Over time, Kumovis has also had more and more dealings with material manufacturers, which was why it only made sense for two experts in plastic – Solvay (through its investment subsidiary Solvay Ventures) and Renolit – to purchase stakes in the young company in a round of series A funding in 2019. The topic of materials is an important one for a hardware manufacturer, after all. »There's such a wide range of plastics out there,« Haerst points out. »Even with the established types, there are still exciting developments – for the production of implants that fuse better to bone, for example.«

In 2021, Kumovis took another key step in its development by establishing a subsidiary in the United States. Its acquisition by 3D Systems, which was completed in April of this year, promises to be at least as significant a milestone.

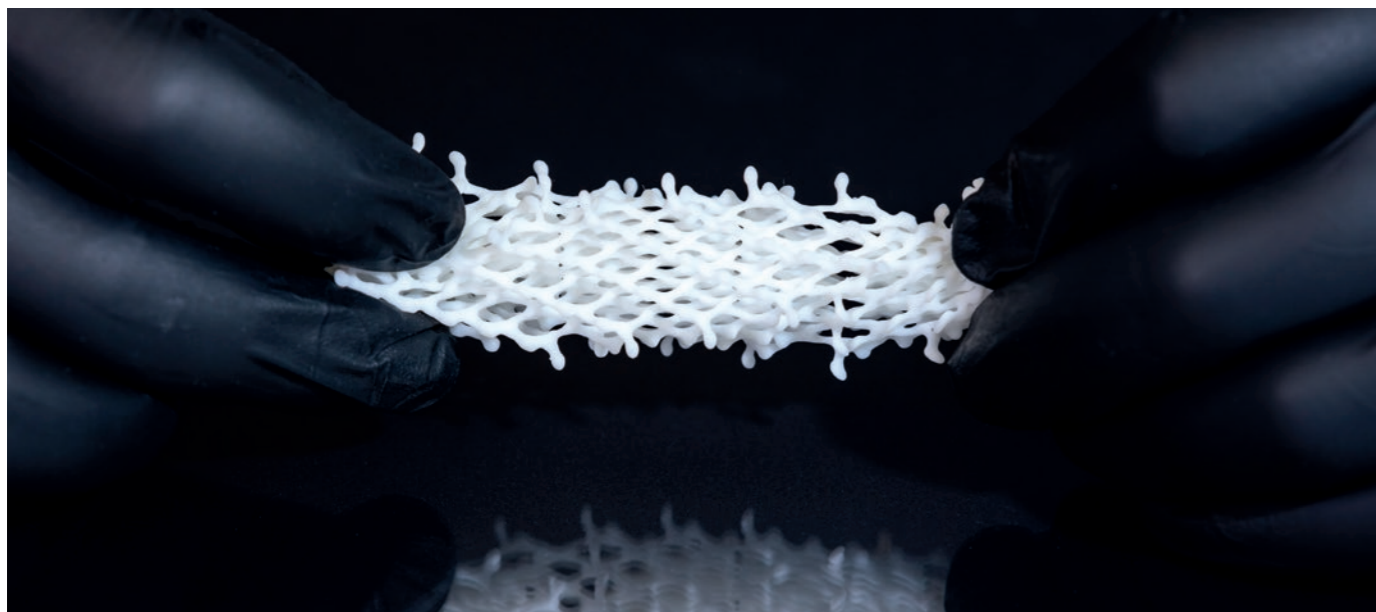
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- » [kumovis.com](https://kumovis.com)

## FORMNEXT START-UP CHALLENGE

# Special silicone sounding like success

The new type of 3D silicone printing developed by Spectroplast AG has been music to quite a few ears. This young Swiss company, whose customers include audiology customers all around the world, has written a compelling success story over the past four years – and several of its pages have featured Formnext.



Text: Thomas Masuch

Photos: Spectroplast



In 2019, just a year after it was founded as a spin-off of ETH Zürich, Spectroplast took home first prize in the Formnext Start-up Challenge. »That definitely gave us a boost. For one thing, it raised our profile,« recalls founder and CEO Dr. Manuel Schaffner. »For another, being known as the winner of the challenge helped us gain the trust of our customers even more – they all know Formnext, after all.«

When it attended Formnext 2019, Spectroplast had a grand total of three employees; today, it has 20. »Our staff numbers aren't the only thing that has really grown. We now have over a thousand customers across the globe,« reports Schaffner, who's also proud of the fact that his company has brought its own 3D printer to market.

Manuel Schaffner, founder and CEO of Spectroplast



Spectroplast's customers mainly hail from the fields of audio, medicine, and consumer products. Its 3D-printed silicone components are built into things like headphones and hearing devices.

For Schaffner, Spectroplast owes part of its rise from start-up to international player to its biocompatible silicone, TrueSil, which the company offers in four different levels of hardness (20 A to 60 A). »We've revolutionized the industry with this material, and even after four years on the market, we're still the only provider capable of 3D-printing silicone with the same level of quality as injection molding.« It was Schaffner who already had corresponding expertise upon founding Spectroplast. He had previously spent around four and a half years performing researching for this new material and developing suitable hardware for it while working toward his Ph.D. at ETH Zürich.

To quickly expand its customer base as a service provider, Spectroplast is working with many other leading service organizations in 3D printing. These firms offer the Spectroplast's services along with their own and pass the corresponding orders they receive on to the Swiss company.

Another key factor in Spectroplast's rapid growth was its first round of seed financing, which was handled by AM Ventures GmbH. Schaffner sees this as an important part of his

company's success story – and it wasn't only the money that helped. »As a member of the AM Ventures ›family‹, we also benefited from a big network and market expertise you can't find anywhere else,« he points out. Spectroplast was thus able to leverage synergies and customer contacts, among other advantages.

For the first few years, the company used its hardware only in its own lab, but continued making related advancements. The printers Spectroplast now offers enable its customers to accommodate the very short delivery times in the audiology industry, for example. »It's a sector that was one of the early adopters of additive manufacturing,« Schaffner explains. »As a result, the companies in it have come to expect their deliveries in just a few days.«

Meanwhile, the CEO and his team have set some ambitious goals for the future. They include having both its material and facilities in which it is produced certified in line with medical criteria. »We'll definitely be launching some more hardware, as well,« Schaffner reveals.

#### + FURTHER INFORMATION:

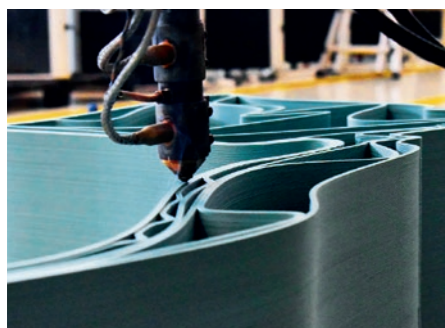
- » [formnext.com/fonmag](http://formnext.com/fonmag)
- » [spectroplast.com](http://spectroplast.com)

## Formnext Start-up Challenge

The call for entries for the Formnext Start-up Challenge 2022 has started already. Write the next success story and apply now at [formnext.com/startup](http://formnext.com/startup).

## TRENDS

## LUXURY FURNITURE 3D-PRINTED FROM SEASHELLS



included furnishings and other interior elements that were 3D-printed from renewable resources. These fresh trappings are to be part of Torre Capitolare's new life as exclusive and luxurious lodgings.

The suite's interior design was created by Federica Cristaudo in cooperation with the Italian 3D-printing specialists at Caracol. In its colors, materials, and forms, the motion of the sea is a recurring theme. Another unique aspect of this restoration relates to the synergies that have resulted from combining 3D printing with artistic methods that date back to the 12th century.

The designers' search for new materials led them to use the remains of seashells and recycled material in a closed production process that generates almost no emissions. In this specific case, they opted for recycled polypropylene that is 20-percent fiberglass-reinforced.



The village of Porto Venere lies on the Ligurian coast of northwestern Italy, where it was defended for centuries by the Torre Capitolare – a stone tower that was built all the way back in the year 1161. It is now enjoying its well-deserved retirement as a local landmark that draws curious travelers from all over the world. The tower has also undergone a very special restoration for this purpose, which has

## EYEWEAR FROM SUSTAINABLY FARMED CASTOR BEANS



Materialise paves the way towards a sustainable eyewear industry by expanding its range of materials to include Polyamide 11 (PA11). The 100% bio-based polymer is made from sustainably farmed castor beans and offers excellent properties for eyewear as the company says.

3D printing, with PA11, is the driving force behind a brand-new collection of 3D-printed eyewear by leading Belgian eyewear brand Odette Lunettes. The collection is the result of a collaboration that brings together the creative designs of Odette Lunettes, the 3D printing expertise of Materialise and the sporting background of former cycling world champion Tom Boonen.

»3D printing is ideal to create a technical sports frame without compromising on the design we had in mind«, says Eline De Munck, Co-founder of Odette Lunettes. »On top of that

you can personalise the design. With our »Odette Lunettes X Tom Boonen« collection, consumers can choose the colour and the size of their frame.« The glasses are produced in Ultrasint PA11 by Forward AM, the brand of BASF 3D Printing Solutions.

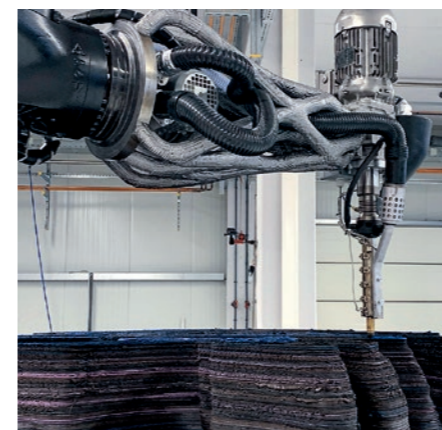
With fast fashion based on forecasts and anticipated demand, overproduction has become the fashion industry's biggest environmental challenge. According to Materialise, for eyewear, this leads to 20 – 30 % of unsold stock. »Eyewear doesn't just need to look good, it needs to be produced in a way that reflects the brand and the consumer's sustainability mindfulness«, says Alireza Parandian, Business Development Director at Materialise.



Photos: Capitolare S.R.L., Materialise

## TRENDS

## SCULPTED BY ROBOTS



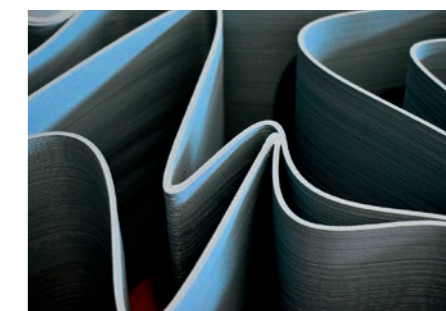
At Hanover's renowned Sprengel Museum, artist Peter Lang is creating Sker – a 2.5-ton, 7.5-meter »cyber sculpture« he designed in an on-site virtual space in collaboration with Additive Tectonics.

In this process, Sker's virtual twin is tracing the jagged, untamed rock formations of an Icelandic island based on cross-sections that are similar to contour lines. Two manufacturing robots from the FIT Additive Manufacturing

Group (of which Additive Tectonics is a subsidiary) will then transform this digital information into real, tangible objects – layer by 3D-printed layer – while operating in precise synchronization. One of them will melt down a granulate and use its extruder to apply layers of material at a speed of 13 centimeters per second. The other will be tasked with supplying the material. This aspect prompted the development of what has been dubbed the »color organ«, which is a series of upright pipes that contain the base material and various pigments for the sculpture. The second robot will move to the individual pipes as instructed and activate a slide feed to extract a predefined amount of material and color. The base material being used is the biopolymer compound Arboblend, which comes entirely from renewable sources.

The technical realization of Sker is being overseen by FIT AG and Additive Tectonics, which specializes in architecture and art projects. The robot control system, the interaction between the material and the production process, and all the surrounding infrastructure were specially designed by FIT for this exhibition.

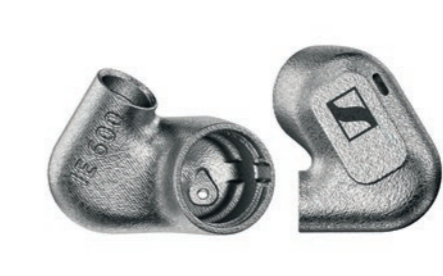
The finished sculpture will be presented once more – minus the 3D-printing robots – at the Sprengel Museum from mid-September to mid-October 2022.



## ENJOYING SOUND WITH SPACE TECHNOLOGY



For its latest IE 600 audiophiles, Sennheiser not only uses 3D printing as a manufacturing technology, but also uses a very special material. Through a patented 3D printing process, the housings of the IE 600 have been crafted from ZR01 amorphous zirconium, a metal



with a glass-like atomic structure that gives it triple the hardness and bend resistance of high-performance steel. According to Sennheiser, one of the only other places the Zirconium alloy from Heraeus Amloy Technologies is used is in the aerospace industry, such as in

the drilling head of the NASA Mars Rover, where ultimate toughness in extreme conditions is required.

Through multiple elaborate treatment processes, a beautiful surface finish is achieved that is extraordinarily resistant against corrosion and scratches. That's why Sennheiser promises poetically that »the IE 600 can be enjoyed for many years while its distinctive great looks remain undiminished«.

The IE 600 also benefits from the meticulous manufacturing process that is the hallmark of Sennheiser's IE audiophile earphone family. Designed in Germany, they are manufactured at Sonova Consumer Hearing's transducer production facilities in Ireland.

Photos: FIT, Sennheiser

## »OUTSIDE THE BOX«



## Fantastic Truths

From an early age, I always liked biographies. The first one I ever read was about Julius Caesar, who rather famously witnessed his own fair share of ups and downs. Much more recently, celebrities seem to have been feeling more of a need to record their own exploits of varying import and immortalize them – not by etching them in stone at the Forum like a Roman statesman, but by publishing a book.

Bastian Schweinsteiger, a former captain of Germany's national soccer team, was one such star who felt compelled to share the various episodes of his life with the general public. To aid this undertaking, he engaged the services of the Swiss writer Martin Suter, who reported spending two years on related research and evidently came to the conclusion that the midfielder's actual experiences on and off the field didn't quite have the drama that makes for a good read. In the 192-page *Einer von euch* (»One of You«), Suter thus put one of Schwein-

steiger's grass-stained cleats in the realm of biography and the other closer to fiction to tell tales that are »true – or almost true«, as the book's dust jacket reveals.

Unfortunately, embellishing the truth with a bit of imagination still wasn't enough to produce a quality book in this case. The method, however, is common enough in the world of business as well, and sometimes even a prerequisite of success – at least when it's applied in the right doses. As Erna Lackner astutely puts in in the book *Phantasie in Kultur und Wirtschaft* (»Imagination in Culture and Business«), »The imagination can conceive of any desire, but it can't fulfill any of them.«

At times, up-and-coming industry sectors like additive manufacturing are also borne by propositions that aren't based entirely in reality. Without them, many innovations and business ideas wouldn't have even gotten off the ground. And it's not just start-ups, either: Think back to

Formnext 2021, where plenty of well-established companies showed how they're letting their imagination (and not just their latest figures) guide their actions. For example, big-name manufacturers of AM machines have made sustainability the focal point of some of their business in order to take on current and future challenges in industry and society at large. The emphasis here is on »some«, of course. »If our machines were more sustainable, but also more expensive, we wouldn't sell any,« explained a manager from another manufacturer, who was somewhat less euphoric about the supposedly endless possibilities in this regard.

Still, the skyrocketing prices we've seen in energy and raw materials in the last few months have made it even clearer that the topic of sustainability (and resource conservation) is more crucial than ever. And with the real world moving so quickly, who needs fantasy?

Illustration: feedbackmedia.de, iStock / id-work

# AM4U

Technical and economic changes are setting a rapid pace, especially in our industry. Exchange, knowledge transfer and inspiration is therefore also our mission before and after Formnext. Throughout the year, you'll find exciting AM-related content.

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IMPRINT fon | formnext magazine Issue 02 / 2022

PUBLISHER

**mesago**

Messe Frankfurt Group  
Mesago Messe Frankfurt GmbH  
Rotebühlstraße 83–85  
70178 Stuttgart, Germany  
Phone +49 711 61946-0  
Fax +49 711 61946-91  
[mesago.com](https://mesago.com)

Responsible for content under German Press Law:  
Bernhard Ruess

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DESIGN  
[feedbackmedia.de](https://feedbackmedia.de)

PRINTING  
Druckhaus Stil + Find, Leutenbach-Nellmersbach

PUBLICATION FREQUENCY  
Published four times per year

ADVERTISING  
Mesago Messe Frankfurt GmbH  
Phone +49 711 61946-501  
[Stefan.Rapp@mesago.com](mailto:Stefan.Rapp@mesago.com)

CIRCULATION  
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