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The next level of
3D Printing

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Hotly contested –
and rife with possibility

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METAL POWDERS



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EDITORIAL

To say that things really hit the ground running this year would be quite the understatement.

It almost feels like we're all trying to catch up on the face-to-face time we missed out on during the pandemic as quickly as we can. In my whole career, I've never seen calendars fill up as fast as they have over the past several weeks.

While Covid-19 may be more or less behind us here, the economic and geopolitical status quo in the world at large is anything but stable. Russia and Ukraine are still at war, and high prices, energy issues, supply chain problems, and labor shortages continue to dominate the headlines.

There's also good news to report, however: More customers have registered for the 2023 edition of Formnext than in any year previous (in terms of exhibitor numbers and reserved space), and the event's international character remains as vibrant as ever. The demand from China and other parts of Asia is back on the rise as well, which makes us very optimistic about this year's November highlight.

Above all, though, it was Formnext 2022 that illustrated how things like automation, the use of robots, post-processing, multi-material printing, and larger components haven't just arrived in Additive Manufacturing; producers are already exploring these topics on a more in-depth level. Plus, industries that use AM are becoming more and more professional and demanding

these innovations for their own manufacturing operations – and thereby driving their advancement.

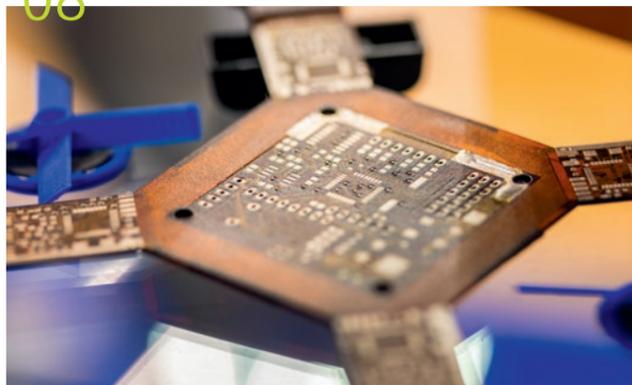
All the more important, then, that Formnext continue to be the international showcase on the yearly event calendar for the »fAMily«. We've got more for you on that and plenty of other interesting subjects in this, the first Formnext Magazine of 2023. Enjoy the read, and may your year be a successful one full of promising encounters!

Sincerely, Sascha F. Wenzler
Vice President Formnext



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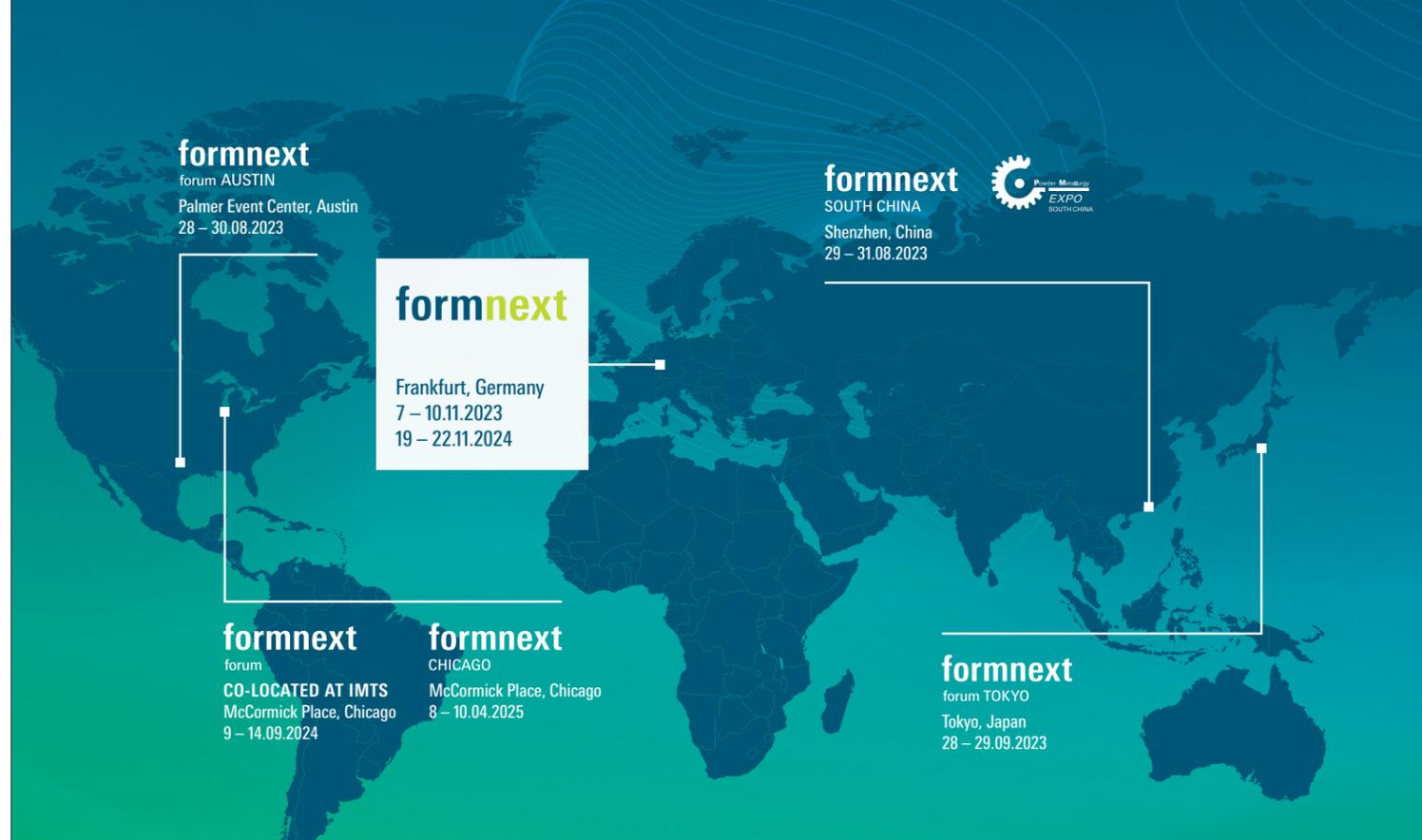
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SUCCESS FROM FRANKFURT TO TOKYO

After its very successful conclusion in November 2022, Formnext is taking off again in the new year and demonstrating very successful development. »The AM world simply knows no boundaries,« raves Sascha F. Wenzler, Vice President for Formnext at event organizer Mesago Messe Frankfurt GmbH. »With our diverse range of products and services, we are creating the ideal platform for more and more companies from the global AM world to successfully do business, expand their networks, and find new investors, customers, or partners. In this context, emerging topics such as 3D Printing in the construction or electronics industries also have a home at Formnext.«

Since it's almost impossible for visitors to explore the entire range of offerings even over four days at Formnext, numerous highlights from the AM4U stage will still be available on Formnext TV on demand after the trade fair. Here, renowned experts such as Arno Held (AM Ventures), Frank Herzog (HZG), Prof. Johannes Schleifenbaum (RWTH Aachen, ACAM), Melissa E. Orme (Vice-President at Boeing), Dr. Markus Heering (VDMA), and numerous renowned scientists and leading representatives of companies around the world will provide valuable insights into numerous topics. These will include start-ups and investments,

construction and architecture, decentralized manufacturing, last year's partner country (France), and AM in education and careers. Feel free to drop by and enjoy your Formnext Recap digitally on Formnext.TV.

Formnext's partner country from 2022 has also been very successful: Sascha Wenzler and Formnext sales professional Thomas Rosen visited the South of France in January 2023 and met numerous AM companies from the Nouvelle-Aquitaine region. Due to the success of the French exhibitors at last year's trade fair, numerous French companies have confirmed for Formnext 2023 and expanded their booth space.

FORMNEXT WORLDWIDE

Meanwhile, Formnext continues to expand its activities all around the world. At Formnext + PM South China, plans are in place to open up excellent business opportunities for Chinese and international companies when the economic and social development in China quickly returns to the successful level of the past. Formnext + PM South China will be held at the Shenzhen International Convention and Exhibition Center (Bao'an New Hall) on 29–31 August 2023. More than 300 companies and over 15,000 visitors are expected to attend. For further success on the Asian continent, the seminar

series and exhibition area at the Formnext Tokyo Forum will provide not only industry knowledge, but a wealth of business and networking opportunities for the Additive Manufacturing industry.

And of course, Formnext also has a presence in the U.S., one of the most important AM markets. There, it has formed a strategic partnership with the Association for Manufacturing Technology (AMT) and Gardner Business Media. Formnext Chicago will be held for the first time in 2025 at the McCormick Place Convention Center. Following the debut of the AM4U Area at the International Manufacturing Technology Show (IMTS) in Chicago last year, Formnext 2023 will partner with the Additive Manufacturing Conference in Austin before hosting the first Formnext Forum Austin as a conference and companion exhibition in 2024.

Formnext will also participate in District 4.0 – the Additive Manufacturing Area at SPS Italia, which will be held in Parma on 23–25 May 2023.

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FORMNEXT REVIEW

RETURNING HOME WITHOUT MACHINES



On the last day of the show, Aextra3D had a white note hanging from its new LumiaX1 machine with the discreet message that it had been sold to California-based service provider Dinsmore. »We also sold the other machine at the booth at the show,« Paul Spoliansky, chief revenue officer, and Praveen Tummala, chief operations and business officer, reported with pride. The latter machine in Germany, at the Naddcon Lab. For the young American-Italian startup, however, it wasn't just the sales aspect that counted towards its successful trade show results: »The market has truly validated our HPS (Hybrid PhotoSyn-

thesis) and TruLayer technologies. Formnext is really the world stage for additive and it has helped us to launch our technologies and products, such as the Lumia X1,« Spoliansky says. »We had several AM service providers, and other market participants visiting our booth,« adds Tummala, who also reports strong interest from the industrial, aerospace, and consumer goods sectors. »The quality of visitors was really high, and we generated loads of serious interest and real projects.«

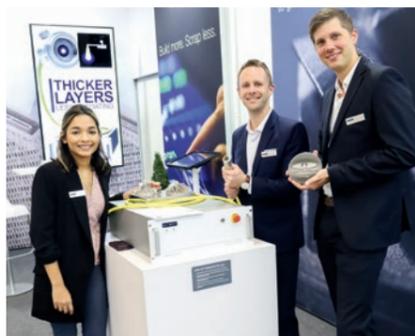
NINE COMPANIES UNITED



For the first time, Desktop Metal assembled a portfolio of nine companies at a European exhibition booth. Very happy with the results were Guersel Demircali (Vice President, EMEA Sales Channel at Desktop Metal) and Anica Melia (Marketing Director, EMEA & APAC the Desktop Metal subsidiary ExOne). »We reached a very international audience with a lot of new contacts. Our booth visitors, which

included representatives from the oil and gas industry, automotive OEMs and foundries, were already well-informed and came to us with specific projects and budgets,« Demircali reports. »Business deals were closed for our sand, polymer, and metal systems.«

»REACHING OEMS AND END USERS«



Innovative marketing approaches are often required to sell complex technology products. At Formnext, the US company nLight, which specializes in laser technology, organized a program of lectures with numerous experts directly at its booth. Andreas Rudolf (MDM Additive Manufacturing at nLight) was more than satisfied with the results and his company's overall trade show appearance: »All of our target groups, including those from the automotive, aerospace, medical, and contract manufactur-

ing sectors, were there with the best personnel – in addition to OEMs, especially end users who are otherwise difficult for us to reach. If there is one trade show to visit on the subject of Additive Manufacturing, this is it. There is no way around Formnext.«

Photos: Thomas Masuch

FORMNEXT REVIEW

POOL OF IDEAS AND MANY LEADS



From Tuesday to Thursday, Johannes Matheis (Managing Director, Murtfeldt Additive Solutions GmbH) »didn't leave my booth,« as he happily reported on the last day of Formnext. Based in Tübingen, Germany, his company presented itself at the Leichtbau BW joint booth and showcased MurSintPA12, a new material for food-grade 3D Printing. »We had very qualified visitors and over 100 leads, and we went home with concrete orders. In fact, to handle these projects, we will have to buy a new machine,« Matheis continues. In addition to the opportunities for business success, he also appreciates the creative potential of

Formnext: »It's always a pool of ideas where people inspire each other.«

MARKET GROWTH WITH TISSUE, BONE, AND IMPLANTS



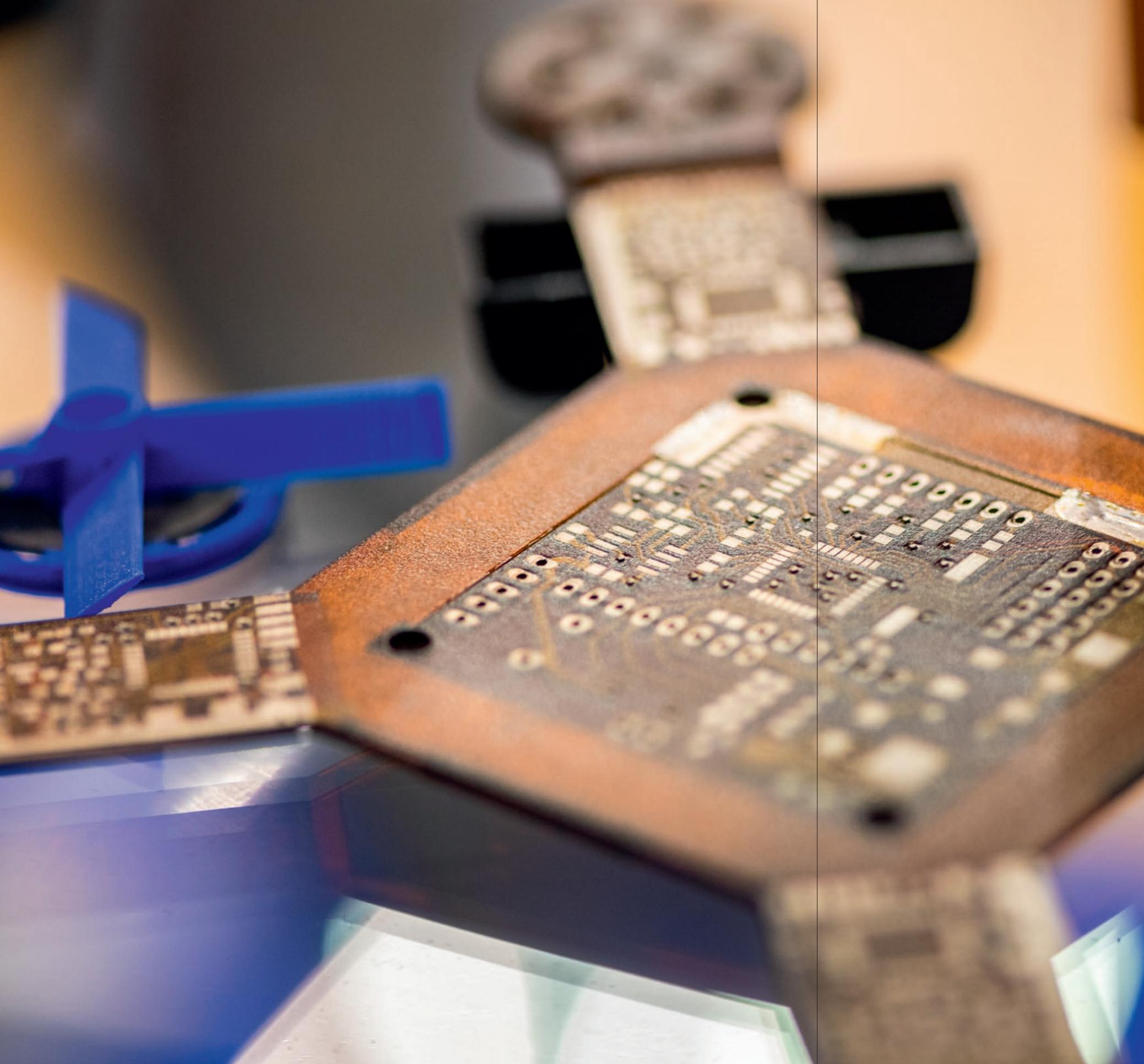
Photos: Mesago/Mathias Kutt, Thomas Masuch

Healthcare is one of the most important user industries of Additive Manufacturing, and it also offers very good prospects for growth. The market research institute Research and Markets expects the market for 3D Printing in healthcare to rise from \$2.08 billion in 2021 to \$5.59 billion in 2027, representing annual growth of around 18 percent. 3D Printing is already being used in numerous applications in medicine – for example, to develop new surgical incisions, drill guides, and prostheses and create patient-specific replicas of bones, organs, and blood vessels. It also helps customize and personalize medical products, drugs, and devices. According to Research and Markets, the continued growth of 3D Printing in healthcare will be based in part on several societal and technological trends. These include the aging global population and the rising incidence of chronic diseases such as cancer and respiratory and cardiovascular illnesses. Among other areas, 3D Printing could be used more extensively in the future in liver modeling and the development of tissue, bone, and medical implants.

NEWS



Cover image
Large-scale components were one of the leading trends at Formnext 2022, including in both plastic and metal 3D Printing. The Portuguese company ADIRA Addcreative provided one striking example with a demonstrator for an industrial gas turbine. Measuring 840 x 425 mm in size and weighing in at 58 kg, this stainless steel part was printed in just 385 seconds using an LPBF process.



A glimpse of the future of additively manufactured electronics: J.A.M.E.S's electronic drone framework, including all the circuit paths and motor coils

»WE'RE TAKING 3D PRINTING TO THE NEXT LEVEL«

Whether it was in smart tools or a full-on revolution in circuit boards, the amount of promise ascribed to the 3D Printing of electronics was almost fanciful just a few years ago. After all, this still-nascent field does present tremendous potential in various areas of application – think of the automotive, microchip, aerospace, or tool-building industries, for instance. While the initial hype has certainly cooled, such methods of AM are now making gradual progress toward industrial use.



The way the 3D Printing of electronics has evolved has parallels with the early days of Additive Manufacturing itself. On the one hand, there are promising ideas, ambitious visions, and some actual completed components; on the other, plenty of challenges still need to be overcome. Meanwhile, more and more people and companies are exploring the subject, both as users and providers of technology.

The increased importance of 3D-printed electronics was perhaps nowhere more apparent than at Formnext 2022, where various exhibitors – including Nano Dimension, Optomec, J.A.M.E.S, and a number of Fraunhofer institutes – demonstrated printers and forward-thinking applications in the field. »In terms of perception, the momentum has really been building over the past six to 12 months,« affirms Alexandre Schäfer, business development manager at J.A.M.E.S, a young platform that operates in additively manufactured electronics (AME). »Every single person who joins our online community is priceless when it comes to getting new ideas off the ground.«

The examples of ways in which 3D-printed electronics can be used are already getting hard to count, ranging from more efficient electric

motors (for which the company Additive Drives prints three-dimensional coil forms) to 3D-printed antennas that see use in spaceflight (an amplifier module has already been in orbit on the ISS). Just one of the paths the evolution of AME could take has been charted by J.A.M.E.S, whose innovations include a 3D-printed drone assembly platform that supports circuit paths, motor coils, and other electronic components. These are printed on a DragonFly IV from Nano Dimension using silver nanoparticle ink, while the platform itself is manufactured from a photopolymer. Acknowledging that it still takes quite a while to print a drone at the moment, Schäfer points out that the team at J.A.M.E.S mainly wants to show what's possible. »We had lots of people visiting our Formnext booth who didn't realize this could be done and were pretty excited to see it,« he says. Some of these new converts were from the mechanical engineering sector, where manufacturers of CNC machines in particular are having to integrate more and more electronics into their products. For design reasons, the amount of space available inside such machines is limited, which sometimes makes it impossible to squeeze in more circuit boards. »With 3D Printing, you can combine the components of all your circuit boards in a 3D-

J.A.M.E.S GmbH

To accelerate the ongoing advancement of AME, Nano Dimension and Hensoldt announced a joint venture dubbed Jetted Additively Manufactured Electronics Sources (J.A.M.E.S) in 2021. One year later, they introduced the world to its first online community for 3D-printed electronics – a collaborative space that brings together designers who use AME and enables them to share their technical expertise. In the future, J.A.M.E.S plans to focus more on the subjects of design, consulting, and project support while offering specialized services, such as printing for existing projects. Its community features not only research institutes, but also manufacturers and technology providers like Nano Dimension, Essentec, Dassault Systèmes, and XTPL.

printed part that also has ventilation built in, for example, which solves the issue of heat dissipation at the same time,« Schäfer explains.

J.A.M.E.S, a network founded by Hensoldt and the aforementioned Nano Dimension, already has in-house expertise in applications like these. At Formnext, it demonstrated another method of printing electronics onto a component in very tight spaces with the J.A.M.E.S. Coin – a near-field communication tag that incorporates an antenna coil and free-formed plate capacitors into a tiny disc.

Text: Thomas Masuch



Top photo: The J.A.M.E.S Coin is a near-field communication tag that demonstrates a way to print antenna coils and free-formed plate capacitors under the strictest space limitations
At right: Fraunhofer IWU created this set of headphones using a 4D printing technique that prints ultra-light components on a flat plane and allows them to transform into a three-dimensional form on their own



With this PLL cube, J.A.M.E.S has shown one path future AME applications might follow: At higher levels of stability, any available space can be filled with electronics or dielectric materials



Photos: J.A.M.E.S, Fraunhofer IWU, Fraunhofer IGCV

Fraunhofer IWU

The 670 employees of the Fraunhofer Institute for Machine Tools and Forming Technology drive research and development in production engineering at its sites in Chemnitz, Dresden, Leipzig, Wolfsburg, and Zittau. Taking a holistic view of the factory, their scientific efforts and commissioned research focus on components, methods, and processes, along with corresponding mechanical systems and the way in which humans interact with them.

The applications J.A.M.E.S is currently overseeing are based mainly in the areas of research, aerospace, and defense, which can be attributed to Hensoldt's involvement. The Bavarian company specializes in radar, optonics, and avionics and has been working on 3D-printing electronic components since 2016.

PATIENCE AND PERSEVERANCE

Although AME is still in its early stages, this area of Additive Manufacturing has already passed through its initial hype phase. Much of its development is reflected in that of Nano Dimension, a leading manufacturer of 3D printers for electronics. Following its foundation in 2012, the Israeli firm went public on the NASDAQ to much fanfare in 2016 and achieved a market cap of well over U.S.\$20 billion. In the meantime, however, its share price has plum-

meted from over U.S.\$90 to around U.S.\$2.50. Nano Dimension has nonetheless stayed the course and continued to develop its technology, which has resulted in constant growth in machine sales of late.

As was the case in the early days of »traditional« Additive Manufacturing, it appears that a good bit of patience and perseverance will be required before AME fulfills the lofty expectations that have been placed on it. »In terms of our technical readiness level, we're between four and six, meaning just after the prototyping phase,« Schäfer reports. »Unfortunately, we're still a long way from serial production.«

It's no wonder the AME market is still rather modest in size. According to Schäfer, many potential users are shying away from buying their own printers due to the unpolished state of the current technology and opting to

work with research partners instead. »We expect that to change as the technology gets more and more mature,« he says. One of the reasons why progress isn't being made more quickly has to do with the complex manufacturing technology involved, as Schäfer's colleague, J.A.M.E.S CTO Andreas Salomon, explains. »In AME, we're taking 3D Printing to the next level, which is the electrification of volumes,« Salomon says. »We're dealing with the printing of not only multiple materials, but conductive and non-conductive structures, as well. That makes it more complex on the whole than conventional Additive Manufacturing.«

PRINTED ELECTRONICS, OR BUILT-IN?

»Our goal is to manufacture electronic components that are entirely 3D-printed, all the way down to the circuit paths,« Schäfer

declares. This involves the use of silver and copper paste, conductive functional fluid, and special synthetics, or even ceramic. Meanwhile, other companies and research institutes are taking a somewhat more technologically feasible route. Instead of 3D-printing electronics, they incorporate such components into the 3D Printing process. Such parts are inserted into semi-finished components (»pick-and-place«), typically in a manual fashion.

For proof that this could also open the door to new areas of application, look no further than the Fraunhofer Institute for Machine Tools and Forming Technology (IWU) in Dresden, Germany. Here, the insertion and mounting of circuit boards, wires, and magnets is combined with multi-material printing and fully automated in a corresponding production system. This presents a broad range of research applications, including in connection with individual cable wiring harnesses, electric drive systems, or speakers that are completely 3D-printed. The IWU showcased the latter at Formnext 2022 in Frankfurt am Main, and the subject resonated

with a great many attendees. »People were already asking how they could get one of these systems,« reveals Lukas Boxberger, head of the biomechanics division at the IWU. »The wire encapsulation Additive Manufacturing (WEAM) technology we've developed and the integration of electronic components represent a huge expansion of the range of possible AM applications. Ultimately, they make it possible to manufacture not only structural parts, but entire products like battery-powered screwdrivers or other handheld devices.«

Boxberger also believes that the ability to integrate wiring into plastic components will open up even more areas of use. Doing so makes it possible to heat parts like these from the inside and make them malleable, which would take much of the effort out of customizing things like orthotic leg braces. Better yet, the process could be repeated again and again to make geometric adjustments, such as when a wearer's muscles increase or decrease in size as part of the healing process or a limb absorbs water throughout the day. »That's a significant

improvement on the current state of the art,« Boxberger points out. He adds that the automotive industry would be another space in which it would be possible to modify prototypes in just a few steps or integrate functions related to sensors, data, power routing, or heating directly into components. »Overall, this technology makes it much easier to develop complex products.«

SCIENTIFIC FOUNDATION NOW IN PLACE

Electronics can also be incorporated into 3D-printed metal parts, as the Fraunhofer Institute for Casting, Composite, and Processing Technology (IGCV) showed in a recent study. In it, Fraunhofer integrated a sensor into 3D-printed steel gearwheels. »Usually, the printing process has to be interrupted to insert sensors like these,« explains Prof. Christian Seidel, head of Additive Manufacturing at the IGCV, which took another step toward industrialization in the project. »We showed that it can also be done automatically using a PBF machine and without disrupting the inert atmosphere, which normal-



ly results in lower-quality components.« According to Seidel, printing electronics into metal parts is more challenging, but it offers the advantage of being able to place sensors right where you want them.

A machine can also be automated in this way on a relatively low budget, Seidel says. »In practically the same amount of production time, you can make a smart component.« The other applications the AM chief has researched at Fraunhofer IGCV include integrating an additional vibration sensor into a 3D-printed measurement device and 3D-printing a multi-material injection mold in which some sections were made of copper to optimize the mold's heat transferring properties. A sensor was also incorporated into the mold to monitor its temperature during the process and fine-tune the production speed.

Although there aren't many applications being used in industrial settings at the moment, Seidel sees a great deal of potential in additively manufactured electronics. »We've laid the scientific foundation and published our work,« he says. »The more word gets around about this subject, the more innovations will follow.« As for the level of interest in this type

of integration in the wider world of AM, Seidel points to his experience at Formnext 2022: »Our booth had a huge influx of people wanting to find out more.«

That said, the professor stresses that assembling a corresponding production setup is hardly trivial. Machine upgrades, choosing the right sensors, the printing process itself, and much more require a high degree of expertise. »As of now, there's also no plug-and-play solution on the market,« Seidel adds. »For that to change, manufacturers have to be willing to take on projects with industrial partners in order to show the market potential of this technology.«

BIG BUSINESS BECKONS IN CIRCUIT BOARDS AND CHIPS

To continue driving these innovations, Andreas Salomon from J.A.M.E.S believes the networking approach is the right way forward. »The technology is so complex and requires so much development effort that it's not really manageable for a single company,« he explains.

The practically endless scope of possible applications – and the sheer size of the potential market – indicate that that effort will be

Fraunhofer IGCV

The Fraunhofer Institute for Casting, Composite, and Processing Technology engages in application-oriented research with a focus on engineering, production, and multi-material solutions. At its locations in Augsburg and Garching (near Munich), Germany, around 160 employees facilitate innovation at the level of production processes, material science, machines and process chains, factories, and business networks.

worth it, however. Right now, developments are under way in fields like medical technology, and in defense under the theme of »the soldier system« (which involves things like wearables and telemetry sensors that monitor performance data during missions). According to Salomon, though, the potential market in circuit boards and chips is the largest by far. He points out that since establishing itself some 50 years ago, the conventional circuit board has been tried, tested, and highly optimized – and will likely never be 3D-printed in the exact same way. »Still, it's important to find synergies in this regard. In doing so, we're thinking of applications that would enable us to say goodbye to the common circuit board. That would be truly disruptive.« Salomon adds that the timeline also needs to be kept in perspective. »We might be able to work our way up to a certified product in 10 years,« he says. After that, he thinks the next phase will be similar to the one those of us in conventional Additive Manufacturing are already familiar with, where it's about achieving greater efficiency and larger production runs. Here, too, some industries will be faster than others, and those with the strictest requirements – aerospace, for example – will need more time in development.

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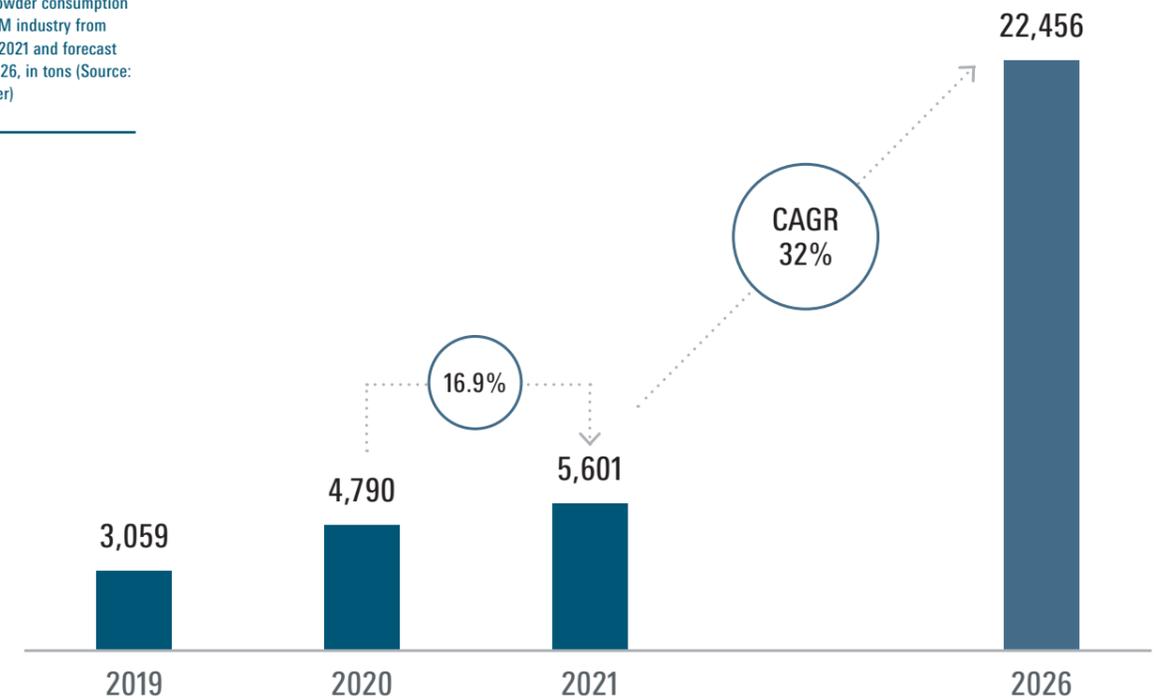
Various electronic applications from Fraunhofer IWU: finger orthotics manufactured using WEAM (left); 200-µm copper wire on 100-µm film with printed-on structural components (p. 13, top); and a WEAM printer head with integrated process monitoring (p. 13, middle)

FIERCELY CONTESTED AND FULL OF OPPORTUNITIES

The market for additive metal powders is experiencing a real boom phase: Demand is increasing rapidly, users have an even greater choice of suppliers, and the range of powders is also growing. For established manufacturers, this is both an opportunity and a challenge; young companies, on the other hand, want to establish themselves with new offerings. These developments are likely to give an additional boost to the entire AM market.



Development in annual metal powder consumption in the AM industry from 2019 to 2021 and forecast up to 2026, in tons (Source: Ampower)



Metal powders may not be particularly spectacular visually, but they are the basis for numerous developments and innovations in Additive Manufacturing. In this regard, the powder sector has picked up an enormous pace of late. The Hamburg-based Additive Manufacturing consultancy Ampower expects annual sales to increase by more than 30 percent over the next four years, with the annual demand for metal 3D-printing powder rising from 5,601 tons in 2021 to 22,456 tons in 2026.

This development shows that the number of applications is also continuing to rise, and that Additive Manufacturing is making significant progress on its way to industrialization. At the same time, the expanding powder market offers promising business opportunities for more and more suppliers both new and more established. »The number of powder manufacturers is steadily increasing, leading to higher competition,« explains Maximilian Munsch, co-

founder and CEO of Ampower. »In all groups of metal materials, such as steels or nickel-based alloys, there are more than three or four dozen internationally competing manufacturing companies for a product that often allows for few unique selling points.«

»VERY GOOD QUALITY FROM MANY MANUFACTURERS«

For powder expert Yannik Wilkens, standard powders »have developed into a commodity product that can be obtained from many manufacturers in a very good quality. It is becoming rarer and rarer for customers to buy from a powder supplier or from the manufacturer of their machine solely for reasons of trust.« Wilkens, co-founder of the Qualloy materials platform, thus concludes that price is playing an increasingly important role in purchasing. »The reason for this is certainly also that AM machines are becoming more and more efficient, which is bringing down the cost of a machine hour, while »

the proportion of powder costs in the end product is rising. Lack of transparency and extensive requirements for metal powders used in Additive Manufacturing also make comparing powders on the market an arduous task.«

Wohlers Report 2022 also notes that in the metal powder industry, sales prices are generally not published and »remain confidential between manufacturers, distributors, and customers.« For Yannik Wilkens, it was then obvious that the AM market needed a way to easily compare prices and different specifications from audited powder manufacturers. Together with Tobias Brune and Daniel Hariri, he founded Qualloy, which launched a digital marketplace for metal powders under the same name in late 2022. »We want to make purchasing metal powders cheaper and more transparent,« Wilkens explains. In addition to potentially lower prices, he wants to achieve a

streamlined procurement process: »Until now, it wasn't that easy to compare quality and prices on the powder market.« Many inquiries would cause a lot of effort for buyers and sellers. In addition, the process would often be complicated by different quality specifications due to other measurement methods or parameters. »The sales effort required to get into business is currently quite high for both buyers and sellers, which is especially annoying for smaller order quantities,« Wilkens adds.

POWDER PRICE PARTIALLY DECLINING

According to Maximilian Munsch from Ampower, the fact that the number of suppliers of metal powders continues to rise has already led to a situation where »in some areas, the powder price has fallen sharply in recent years, such as in titanium materials



Yannik Wilkens, co-founder of the Qualloy materials platform.

On the platform Qualloy, two manufacturers are offering various metal powders, and others are currently undergoing certification

<p>316l 15µm-45µm Certified</p> <p>Atomization process: Viga Atomization gas: Nitrogen</p> <p>LASER POWDER BED FUSION</p> <p>Delivered in 5-7 days via Land</p>	<p>from 32⁹⁰ € / kg</p>
<p>17-4PH 15µm-45µm</p> <p>Atomization process: Gas Atomization gas: Nitrogen</p> <p>LASER POWDER BED FUSION</p> <p>Delivered in 14-26 days via Air <i>1 cheaper shipping method available: Sea</i></p>	<p>from 20⁶⁰ € / kg</p>
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Photos: Fehrmann Materials, Qualloy, m4p material solutions

Text: Thomas Masuch

for PBF processes. Here, powder prices have declined by nearly half. For other materials – stainless steels, for example – prices have remained at a relatively constant level.«

Established powder supplier Fehrmann Materials has also recognized the trend in customers reacting much more sensitively to price than before. »Price sensitivity is so high that even sums of less than one euro per kilo can lead to serious discussions with partners,« says sales VP Jan-Peter Derrer.

Derrer, who has worked in the AM industry for almost 20 years, is also convinced that an expansion of industrial 3D Printing will require a significant reduction in price. The scope for this is certainly there, he says, because the »volumes of powder produced worldwide are now so large that suppliers can pass on economies of scale.«

Qualloy

According to co-founder Yannik Wilkens, this digital platform, which brings together manufacturers, buyers, and users of metal powders, is intended to ensure greater transparency and thus also reduce the overall price level. »Via Qualloy, users can find the right powder for their machines and specifications in the shortest possible time and choose between different tested manufacturers in terms of quality, price, and delivery time.«



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- > CUSTOM ALLOYS

PRICING CAMPAIGN FOR STANDARD MATERIALS

In response, Fehrmann has modified its pricing strategy for standard materials. »We went on the offensive at Formnext 2022 and offered our powders at extremely attractive prices,« says Derrer. »This resulted in us selling almost all of our inventory during the event. It also showed us how sensitive this area is and how grateful people are when things go in the right direction.«

Fehrmann's goal here is to bundle customers' powder needs in order to purchase large quantities at more favorable prices, which can then be passed on. The company hopes that increasing both its sales volume and customer numbers will ultimately pay off in sales of its own special alloy, AlMgty. »New ideas are often born in personal dialog and then give rise to new projects,« Derrer explains, and immediately provides an example: »One of our customers wanted to anodize 3D-printed aluminum parts in deep black, but this does not work well with conventional AlSi₁₀Mg. AlMgty is much better suited for it.«

CONSISTENT QUALITY AS A PURCHASING CRITERION

On the other hand, Andreas Pelz – founder and managing director of m4p, a firm based in Magdeburg, Germany – is somewhat more conservative in his assessment of the importance of powder price. »Our customers' buying criterion is essentially that we have been supplying consistent quality for years and have had no complaints – especially due to our extensive quality assurance measures. Price also plays a role, of course, but it's not the number-one issue.« As an example, he cites how the market has also been dominated by the issue of supply security in the recent past, »where we were under constant pressure to be able to keep our delivery promises.«

m4p makes a large part of its sales with standard materials such as AlSi₁₀Mg, copper or nickel alloys, titanium, and various steels. In total, the company has 54 standard materials like these in its portfolio. »These are available from stock, and we have standard parameters and a defined process chain for them,« says Pelz.



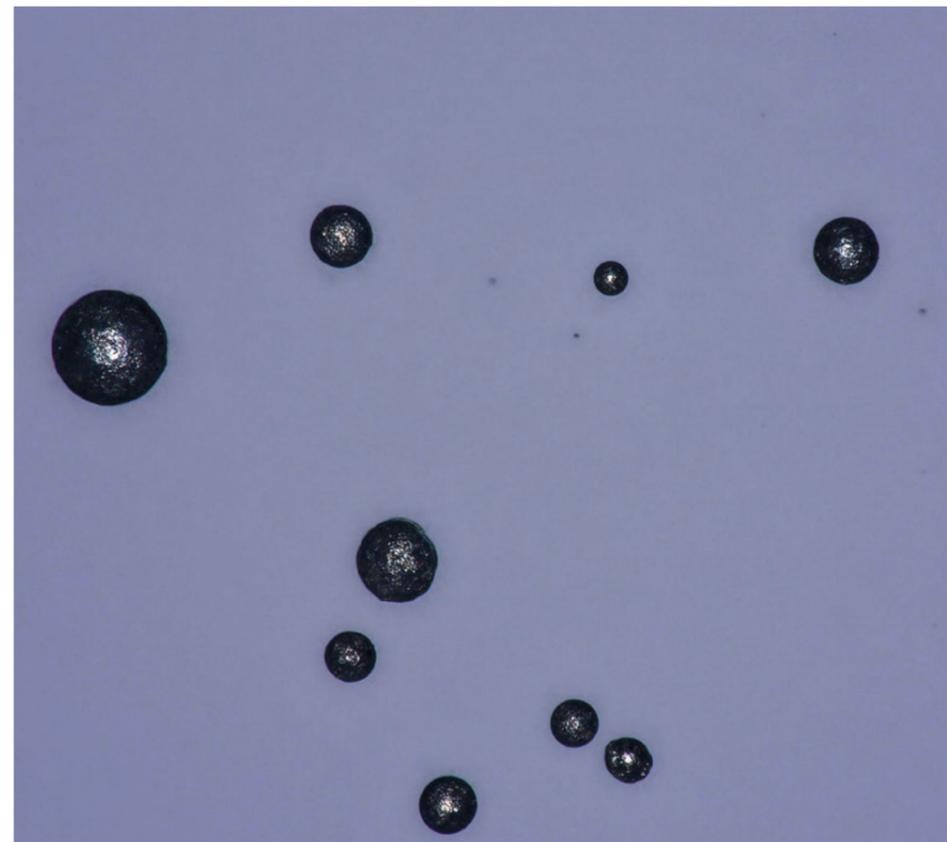
P. 19, photo top left: Jan-Peter Derrer, head of sales at Fehrmann Materials, believes lower powder prices are possible because the amounts of powder being produced around the world are now so large that providers can pass on economies of scale
P. 19, photo below: Andreas Pelz, founder and CEO of m4p material solutions GmbH
P. 19, at right: Quality assurance in progress at Fehrmann Materials

Fehrmann Materials

Fehrmann Materials is a subsidiary of the Fehrmann Tech Group, a traditional company based in Hamburg, Germany. A few years ago, the company decided to make some of its high-performance aluminum alloys available for Additive Manufacturing, as well. Of the 50 employees at Fehrmann Materials, around 20 are now involved in additive manufacturing. Then, in 2018, Fehrmann Materials launched »AlMgty«: an aluminum alloy with magnesium content that the company offers in different variants. According to Jan-Peter Derrer, VP of Sales, this alloy is corrosion-resistant and has high elongation values. Fehrmann's portfolio for Additive Manufacturing also includes the special alloy AlZn₅, as well as various standard materials that range from tool steel and AlSi₁₀Mg to titanium and copper alloys. While the company has its internally produced alloys atomized via a qualified partner network, the standard materials are sourced internationally.

m4p material solutions

This company was founded in 2015 by Andreas Pelz, who comes from a metallurgical background. »At that time, there were few materials for 3D Printing, so I saw opportunities in this niche,« he explains. m4p now has four locations around the world and plans to expand further.



In addition, m4p offers customized powder materials, which has grown the company's total product portfolio to 188 items. For Pelz, this also reveals the diversity of material and process variants in Additive Manufacturing, which range from LPbF and E-PbF to DED and binder jetting.

SPECIAL MATERIALS TO HAVE MORE WEIGHT IN THE FUTURE

Special materials are the topic that Pelz's R&D team is passionate about. »Here, we are working on completely new types of materials that can also only be processed using additive technology,« he says, adding that he expects further leaps in innovation from new types of metal matrix composites (MMCs) and in the area of metal powder processing.

The development of further special alloys also plays an important role at Fehrmann, even though standard materials still account for the vast majority its sales, as well. »In the future, we expect a significant increase here,« says Derrer.

When developing alloys, Fehrmann Materials not only has the additive process in mind, but all manufacturing processes used over the life cycle of a component. »This ranges from 3D Printing in prototyping to small and large series production – for example, in die casting, sand casting, extrusion, or spare parts, also in 3D Printing,« says Derrer. In material development, Fehrmann is increasingly relying on artificial intelligence to develop new materials faster and more cost-effectively.

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- » ampower.eu
- » fehrmann-materials.com
- » metals4printing.com
- » qualloy.com
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TRENDS

PRAYERS BETWEEN 3D-PRINTED WALLS

The world's first 3D-printed mosque is to be built in Dubai. Located in Bur Dubai, the approximately 2,000-square-meter mosque will have space for 600 worshippers. Construction is scheduled to begin in October 2023, with completion in early 2025. According to the plans of the Islamic Affairs and Charitable Activities Department of Dubai (IACAD), the printing will be controlled by just three workers. The entire 3D-printed structure is expected to be in place after only four months, and made functional another 12 months later. According to IACAD engineering department director Al Shaibani, the cost of 3D-printing the mosque exceeds conventional construction methods by 30 percent. He says this is also due to the experimental nature of the project. However, with more 3D Printing experience, Al Shaibani expects the costs to level off in the future. Overall, 3D Printing is a more sustainable construction technology because it generates significantly less waste.



In addition to raw materials, a fast-hardening concrete mixed with minerals will be used. The emirate has been pursuing its »Dubai 3D Printing

Strategy« since 2016 and aims to develop into an important technology location by 2030. Its goal is to 3D-print a quarter of all its new buildings.

INSPIRED BY THE MUREX SHELL



Recently, 3D Printing has also reached the runways of Paris, with both French luxury brand Dior and Reebok (in collaboration with Botter) recently showcasing extravagant additively manufactured shoe models. Dior unveiled its designs, which appear to have been made using SLS plastic printing, at the Dior Winter 23 by Kim Jones show during Paris Fashion Week. No less outlandish is the Venus Comb Murex Shell, a shoe that resulted from a collaboration between Reebok and Paris fashion house Botter. The grooved collection is said to be inspired by Murex shells, which the Greek goddess Venus used to comb her hair. The shoe was made in cooperation with HP, and Botter reports that more projects are to follow: »Our new partnership with HP 3D Printing aims to create products at the intersection of innovation, sustainability and luxury, and this is just the first step.«



Photos: JT+partners/YouTube, Patrick Kenawy

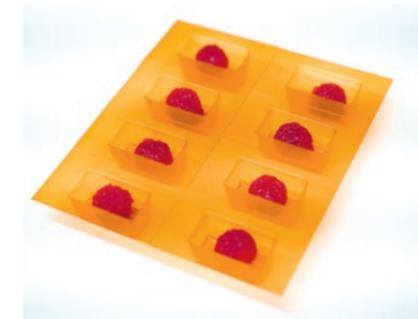
Photos: Vall d'Hebron University Hospital, Mythos

TRENDS

3D-PRINTED CANDY INSTEAD OF SYRUP

The efficacy, tolerability, and acceptance level of a 3D-printed medicine is to be tested for the first time in a clinical trial involving children between the ages of six and 18. In its corresponding study, the Pharmacy Service of Vall d'Hebron University Hospital (Spain) is aiming to develop a way for medications to be dosed individually. It also wants to make it easier for children to take them. The drugs, which consist of an active ingredient and suitable excipients, are being 3D-printed in a semi-solid and chewable form (similar to candy). Unlike the usual treatment with syrups, this allows the dosage to be tailored to each child according to their weight and clinical characteristics. »Until now, families have had to measure out the syrup themselves. This new method is much more convenient and avoids possible errors in the dose administered,« explains Dr. Maria Josep Cabañas, head of the Pharmacy Section of the Children's Hospital and Women's Hospital of Vall d'Hebron and a researcher in the Basic, Translational and Clinical Pharmacy group of the Vall d'Hebron Research Institute (VHIR). The clinical trial will first test the efficacy and tolerability of the new formula. It will also investigate whether children accept

and take the medication better – especially when they suffer from chronic diseases and need daily treatment. »Since syrups can sometimes have an unpleasant taste, we have worked to give the printed medications a taste that masks the active ingredient,« Cabañas says. The taste, smell and color can even be modified to suit each child's preferences. In addition, the 3D Printing of medicines is expected to improve logistics, as such medicines do not need to be stored in a refrigerator. According to Vall d'Hebron University Hospital, most drug formulas can be 3D-printed, provided they are not affected by the heat produced during the printing process.



SPACE-AGE QUALITY FOR BICYCLES

Additive Manufacturing is also becoming increasingly common in the bicycle industry, where it is apparently making the transition from prototype production to industrial use. Mythos, a manufacturer of bicycle components from Great Britain, has launched a 3D-printed stem for mountain bikes. Made of titanium, the Mythos IXO stem is not exactly cheap at a price of around €330, but the company says the material is of »aero-space quality (Ti6Al4V)« and printed using an EBM process. In addition, Mythos promises a higher resistance to torsion and bending. The stem was developed and manufactured by Metron Advanced Equipment.



A SUSTAINABLE COMBINATION OF TRADITION AND MODERNITY

For the first time, the Institute for Advanced Architecture of Catalonia (IAAC) has 3D-printed an earthen building in Spain. The shelter, named Tova, is located in Valldaura Labs on the outskirts of Barcelona and constitutes a prototype that combines traditional manufacturing (vernacular earthen architecture) with modern technology. The construction, which was completed with a WASP printer, took seven weeks. Materials were sourced within a 50-meter radius around the hut. The available earthen materials were mixed with additives and enzy-

mes to achieve the required structural integrity and material elasticity. The foundation is made of geopolymers, and the roof is based on a wooden structure. To ensure the longevity of the material in terms of its weather resistance, a waterproof coating made of raw materials such as aloe and egg white is being added. The project was developed as part of the 3DPA post graduate research program at IAAC. The aim of this course is to train young architects and academics for the future of construction and to explore the possibilities of 3D Printing in this

field. Here, Tova is said to be just the beginning: The researchers hope the project will serve as a model for other construction projects around the world.

OUTSIDE THE BOX



Learning from...Cows?

In the world of AM and every other sector of industry, managers, engineers, and CEOs wrack their brains to figure out how they can make their companies more efficient. Ideally, they're looking to generate higher output with their existing equipment, and with the same or even better quality. While efficiency gains like these are still relatively easy to achieve in the young AM industry, it typically gets more difficult to make advancements the longer a production method has been in use.

Even in cases like these, though, the last word need not have been spoken on the subject of productivity. The optimization-obsessed among us can find inspiration in unlikely places – at the nearest farm, for instance. The increases in productivity that have been attained in agriculture over the past several decades are virtually incomparable to anything else, especially in milk production. Simply put, cows are giving more and more milk.

That doesn't really do the recent developments justice, though. Let's take a look at the numbers, which are rather astounding: Back in

1900, the average German cow produced 2,165 kilograms of milk per year. By 2021, that figure had soared to 8,488 – that's about four times as much! Meanwhile, cows have been raised as cattle for around 10,000 years. In some modern stalls (many of which are getting larger all the time), an app monitors the cows' health and fills their troughs with customized granulate feed. Other stalls are now so industrialized that one might start wondering whether the cows are still animals, or more like machines.

All this notwithstanding, a number of nutrition experts believe that the days of the traditional dairy cow are numbered. A major shift is likely in the offing in the global milk market, which has a current volume of over €800 billion. The U.S. think tank RethinkX, is already predicting that the number of cows in its home country will decline by half by 2030. These days, the new mantra in milk production is precision fermentation. This involves using a bioreactor to turn plant-based materials into milk with the help of microbes and genetic technology, which generates much less CO₂ and requires signifi-

cantly less water. Here, it's important to note that dairy farming accounts for around three percent of the world's carbon emissions. Perhaps even more crucial to the success of precision fermentation, however, is the fact that milk from bioreactors is projected to be significantly less expensive than the type from cows kept in stalls.

Ice cream and cream cheese produced using this method are already being sold in supermarkets in the United States. So far, we haven't heard anything about the taste, and it remains to be seen whether the predictions associated with some of these »disruptive« food innovations will come true. Come to think of it, Additive Manufacturing can offer some solid insight in this regard: The hype that comes with overly optimistic expectations can eventually give way to bitter disappointment, but over the long term, there's just no stopping new technologies.

Text: Thomas Masuch

Illustration: iStock/Veronika Karpenko

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