Vol. 7 No. 3 AUTUMN 2021

THE MAGAZINE FOR THE METAL ADDITIVE MANUFACTURING INDUSTRY

METAL AM

in this issue

AIDRO: AM IN HYDRAULICS

SUPPORTS: TIME TO BREAK FREE?

SINTERING SIMULATION FOR BJT

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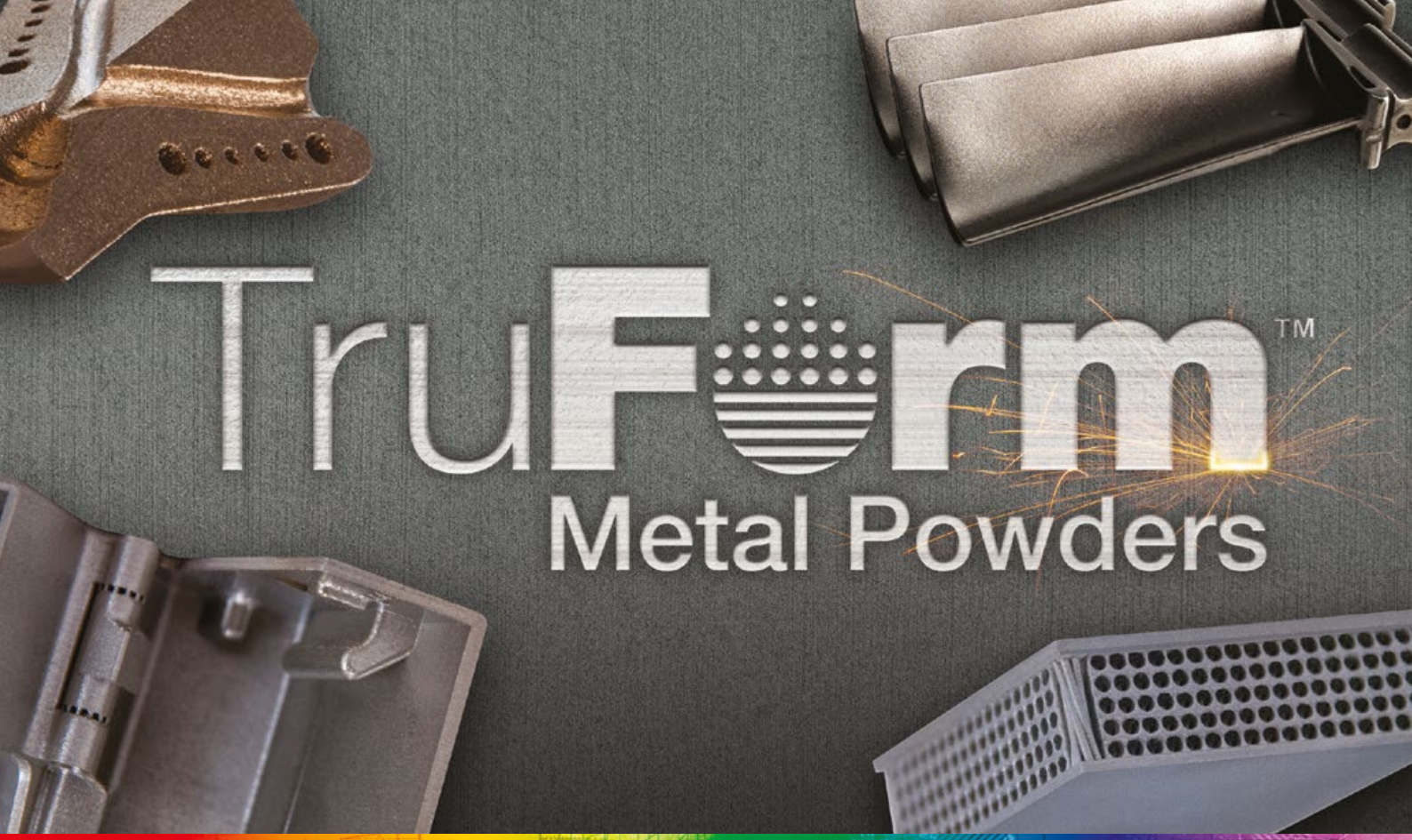

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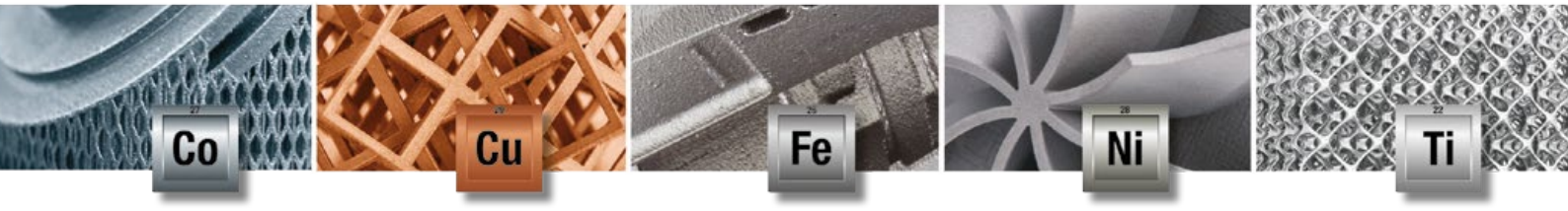

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INOVAR COMMUNICATIONS

METAL ADDITIVE MANUFACTURING

As we await Formnext, just how much has the AM industry changed since 2019?

As we head towards an in-person Formnext for the first time in two years, the excitement of that distant November in Frankfurt in 2019 feels as though it was a very long time ago. So much has changed in the industry in the meantime, as a result of intense M&A activity and several public listings.

But what about progress on that much-used phrase, the 'industrialisation of AM'? Answers to this rather open question inevitably veer towards opinion rather than fact, but what I think is reasonably clear is that, while the tone of the debate around AM continues to change, discussions are shifting in the right direction.

More than ever, they focus not on whether AM works, but on how to make the AM business case, how to find the right application for your organisation, how to make the transition to high-volume production, and how to reduce costs.

Of course, AM production technology itself still has to develop in order to deliver larger, faster, and ever more stable machines, and innovation must remain a permanent focus. Tied in with this, we are also seeing the evolution of materials for AM, of standards, and, crucially, progress on streamlining the AM workflow, from design to post-processing.

So, it is with great anticipation that the *Metal AM* team looks forward to Formnext 2021. It has been a long time coming, and the wait holds the promise of the most enlightening of conversations. We hope to see you there!

Nick Williams
Managing Director

Cover image
Testing of an AM hydraulic block for a marine application. AM enabled a weight reduction from 3.8 kg to 0.63 kg (Courtesy Aidro)

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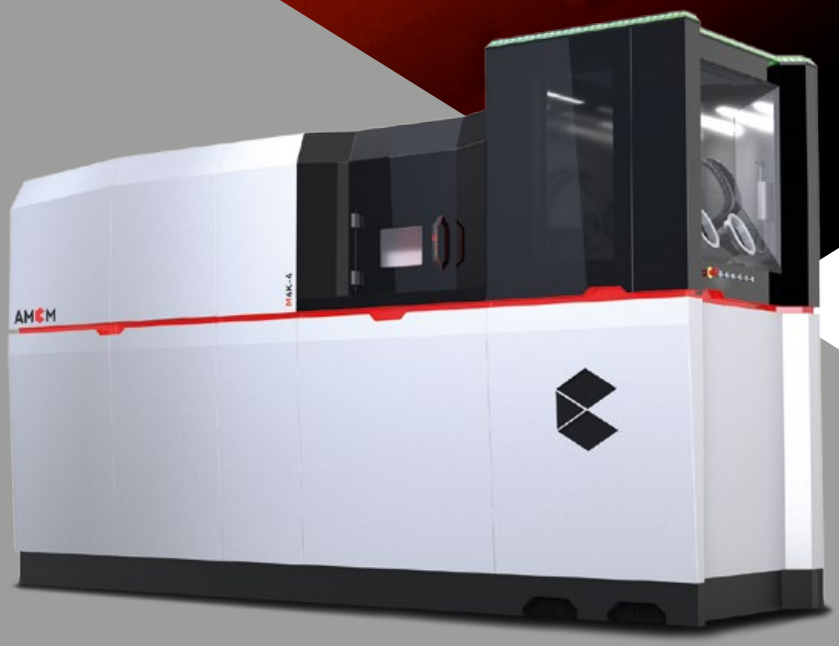

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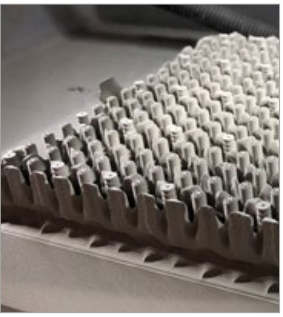

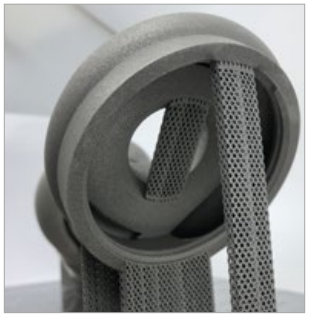

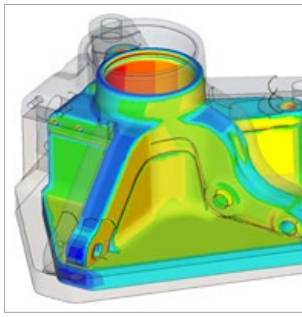

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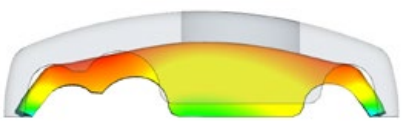

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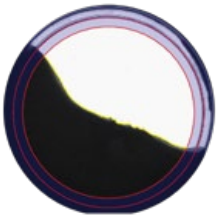
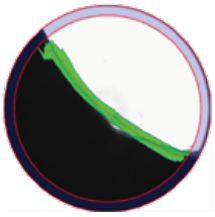
175 Metal powder characterisation for Additive Manufacturing: Beyond state-of-the-art standards





The control of powder feedstock characteristics is essential in metal Additive Manufacturing in order to guarantee the quality of built parts and reduce production costs. However, powder behaviour is influenced by a large number of particle properties, along with environmental conditions which can modify these properties.

In this article, Granutools' Dr Aurélien Neveu reviews some of the current standards applicable to powder feedstock characterisation, and highlights how to make such procedures more robust, repeatable and meaningful for end-users with regards to real AM powders and process conditions. >>>

183 A look at the future: What does the next decade hold for metal Additive Manufacturing?

Machine price and size, maintenance costs, production speed, safety, materials, metallurgy and quality – these are just some of the factors that will play a role in driving the development of metal AM over the next ten years.

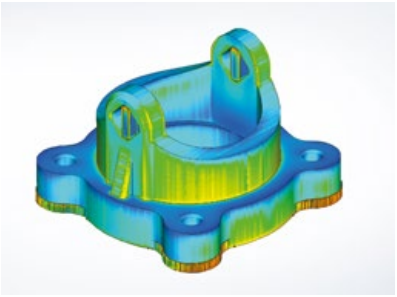
Concerns, such as repeatability, post-processing and ease of use, will determine whether the technology can fulfil the potential it promises. One thing is clear: many factors must improve before metal AM can become a true mainstream production technology.

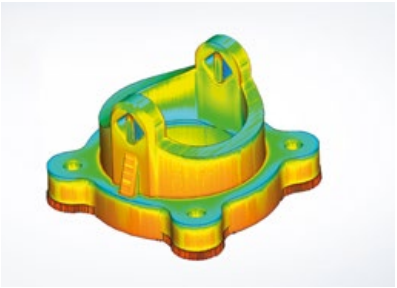
Olaf Diegel and Terry Wohlers, Wohlers Associates, draw on their expertise and experience to predict what the next decade may look like for metal Additive Manufacturing. >>>

189 Reducing residual stress with 500°C build chamber preheating for 'first time right' PBF-LB

According to Germany's Trumpf GmbH + Co. KG, preheating the substrate plate in Laser Beam Powder Bed Fusion (PBF-LB) to 500°C brings significant advantages in serial production: complex parts are more likely to be built successfully on the first try, design freedom increases, there is little residual stress and no cracks – and, for the first time, high-carbon alloy parts can be built reliably, without cracks, to a density comparable with their conventionally produced counterparts.

Here, the company shares the results of tests demonstrating the advantages of 500°C preheating, and introduces the technology making it possible for manufacturers to integrate this step into their PBF workflow, and reap the benefits. >>>





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Industry news

Desktop Metal expansion continues with purchase of ExOne and Aidro

Desktop Metal, Inc., Boston, Massachusetts, USA, is continuing to grow its business through a further round of company acquisitions. Announced in August, Desktop Metal entered into a definitive agreement to acquire The ExOne Company, North Huntingdon, Pennsylvania, USA, and in September it reported that it had acquired Aidro, a producer of additively manufactured hydraulic systems based in Taino, Italy.

The ExOne Company

The deal to acquire ExOne will see Desktop Metal acquire all of the issued and outstanding shares of ExOne common stock. Under the terms of the agreement, ExOne shareholders will receive $8.50 in cash and $17.00 in shares of Desktop Metal common stock for each share of ExOne common stock, for a total consideration of $25.50 per share, representing a transaction value of $575 million.

"We are thrilled to bring ExOne into the DM family to create the leading Additive Manufacturing portfolio for mass production," stated Ric Fulop, founder and CEO of Desktop Metal. "We believe this acquisition will provide customers with more choice as we leverage our complementary technologies and go-to-market efforts to drive continued growth. This transaction is a big step in delivering on our vision of accelerating the adoption of Additive Manufacturing 2.0."

"We are excited to join forces with Desktop Metal to deliver a more sustainable future through our shared vision of Additive Manufacturing at high production volumes," commented John Hartner, CEO of ExOne. "We believe our complementary platforms will better serve customers, accelerate adoption of green technologies, and drive increased shareholder value. Most importantly, our technologies will help drive important innovations at meaningful production volumes that can improve the world."

Aidro

Aidro is a pioneer in the volume production of next-generation hydraulic and fluid power systems through metal AM across a wide range of industries, including oil and gas, agricultural equipment, aerospace, and mobile and industrial machinery and more.

"This acquisition advances Desktop Metal's strategy to support our major OEM customers with proprietary design and application know-how as well as through a combination of best-in-class AM products and high-value parts production across killer applications for AM 2.0," added Fulop. "Aidro brings a talented team with decades of experience in hydraulics and fluid power systems and a passion for leveraging AM to deliver performance advantages to their customers."

Aidro has invested in AM facilities and processes alongside its conventional manufacturing capabilities. The company's dedicated AM department features metal AM machines, 3D scanning technologies, and ISO9001 and AS/EN9100 certifications, all leveraged to deliver high-performance products while reducing production lead times.

Valeria Tirelli, co-CEO and president of Aidro, commented, "This partnership is the next step in our AM evolution, and now, with access to Desktop Metal's scale and industry-leading AM 2.0 technology portfolio, including its volume production-focused metal Binder Jetting solutions, we're thrilled at the growth potential for Aidro."

www.exone.com
www.aidro.it
www.desktopmetal.com

Aidro currently uses Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing to create innovative hydraulic solutions (Courtesy Aidro)

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3D Systems announces strong Q2 2021 results

3D Systems, Rock Hill, South Carolina, USA, has reported its financial results for the second quarter ended June 30, 2021. Revenue reached $162.6 million, an increase of 44.1% for the second quarter of 2021 compared to the same period last year of $112.8 million. The results triggered a surge in the company's share price, closing 21% higher on the day of the announcement.

Revenue from the company's Healthcare business segment increased 68.6% to $82.8 million, compared to the same period last year, and increased 14.2% compared to last quarter. This increase from last quarter included double digit growth in medical applications, as well as strong demand for dental materials. Compared to the same period last year, Industrial sales increased 25.3% to $79.7 million, and increased 49.6% when excluding businesses divested in 2020 and 2021. Compared to the last quarter, Industrial sales increased 8.3% with solid demand in both products and materials.

Gross profit margin in the second quarter of 2021 was 42.4% compared to 31.2% in the same period last year. Operating expenses increased 14.5% to $79.1 million in the second quarter of 2021, compared to the same period a year ago, primarily as a result of expenses related to stock compensation including bonuses.

"In our second quarter last year we were in the rapidly-tightening grip of the COVID pandemic, with virtually no visibility into the magnitude or duration of the impact on our company," commented Dr Jeffrey Graves, president and CEO, 3D Systems. "It was into this tumultuous environment that we launched our four-phase transformation plan: reorganise into Healthcare and Industrial business units, restructure to gain operating efficiencies, divest non-core assets and then invest for the future. Today, after perhaps the most challenging twelve months that any of us has experienced, our world has changed for the better in several ways. Not only is the global economy rebounding, but Additive Manufacturing is being implemented at an increasing rate in production as companies seek a more capable and flexible supply chain for critical components."

"From a divestment standpoint, we have announced the sale of both our On-Demand Parts business, which focused on the rapid production of components using a multitude of digital manufacturing methods, and Simbionix, a medical simulation business," Dr Graves continued. "We are excited about the tremendous progress we have made this past year, reinforcing our foundation in Additive Manufacturing and positioning ourselves for a very exciting future."

Consistent with prior guidance, on a non-GAAP basis, 3D Systems states that it expects 2021 gross profit margins to be between 40% and 44%.

www.3dsystems.com

Acerinox Group, parent company of VDM Metals, achieves best half-yearly results since 2007

Stainless steel manufacturing group the Acerinox Group, Madrid, Spain, the parent company of VDM Metals International GmbH, reports that it has achieved the best half-yearly results in fourteen years, with EBITDA of €378 million (130% higher than the same period of 2020) and profit after tax and non-controlling interests of €203 million (€78 million in the first quarter and €125 million in the second), compared with just €2 million in the January–June 2020 period. Revenue totalled €3,066 million in the half-year, representing a 32% increase on the first half of 2020, thanks to a good performance in terms of both volume and price.

The group's total production, which improved in both the stainless steel division (+28%) and the high performance alloys division (+6%), increased by 29% compared with the same period in 2020 to 1,343,946 tonnes.

Net financial debt, amounting to €838 million, increased by €66 million with respect to December 31, 2020, following the increase in working capital (€253 million) and the payment of a dividend (€135 million).

In line with Acerinox's commitment to sustainability, it has also announced the launch of a sustainable stainless steel product line. These products are characterised by the large proportion of recycled material used in the manufacturing process and by the use of renewable energies.

Integration of VDM Metals

VDM Metals International GmbH, Werdohl, Germany, was acquired in March 2020. Despite the difficulties arising as a result of the uncertainty surrounding COVID-19 and global travel restrictions, online meetings enabled major milestones to be satisfactorily reached resulting in a positive integration.

Synergies valued at €5.2 million were achieved in the first half of the year, 42% higher than the estimated target for this period. Best practices in the stainless steel and high performance alloys divisions – which were incorporated into long- and flat-product technical exchange projects, both in Europe and the United States – boosted efficiency in the manufacture of standard products. Shared resources enabled new products to be created in eight different types of alloy, such as wide coil, plates and precision strips.

www.acerinox.com
www.vdm-metals.com

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Essentium acquires Collider and its DLP AM technology

Essentium, Inc, Austin, Texas, USA, has signed a Letter of Intent to acquire Collider, Chattanooga, Tennessee, a developer of programmable tooling which combines Digital Light Processing (DLP) Additive Manufacturing and the material strength of injection moulding. Essentium believes that the addition of Collider to its portfolio will enable manufacturers to reduce lead times and increase innovation.

"Collider has a lot to bring to the table," stated Jeffrey Lumetta, CTO, Essentium. "Their innovative method of bringing together proven technologies to create high-value use cases has already proven their industry value. We see significant opportunities in tooling for low volumes of parts and the ability to manufacture geometrically complex, custom parts on-demand and quickly."

Instead of the permanent, hard tooling mould, Collider's DLP AM technology creates a thin photopolymer shell which is then injected with a variety of materials and cured through a chemical process. After post-processing, a production-quality part or mould is left.

Collider's AM technology is said to unlock a vast array of high-performance thermosetting polymers and composites including polyurethanes, silicones, epoxies, polyesters, foamed resins, carbon fibre composites, as well as sintered metals and ceramics, with one machine.

The technique is reported to have structural integrity on a par with injection moulding processes and creates highly detailed aesthetic surfaces, enabling manufacturers to speed up the design process and obtain parts at shorter lead times.

www.essentium.com

Sandvik Group releases interim results for the second quarter of 2021

Sandvik AB, headquartered in Stockholm, Sweden, has released its interim report on the second quarter of 2021. Revenues increased organically by 22%, while adjusted operating profit increased by 19.1% to SEK 4,469 million (Q2 2020: 2,837). Order intake saw organic growth of 43% to SEK 25,857 million. Demand strengthened both year on year and sequentially across most regions, with the largest increase noted in Europe (+63%) and North America (+49%). Asia, mainly driven by China, grew strongly year on year, albeit at a slower rate due to more challenging comparables than in the other regions. Changed exchange rates had a negative impact of -6% on both order intake and revenues.

Sandvik Materials Technology

Sandvik Materials Technology saw increased order intake (74%) and a decrease in revenue (-4%). Organic revenue was reported to be negatively impacted by weak backlog for umbilicals, which was somewhat offset by strong development in consumer-related segments, industrial heating and application tubing. Strong increases in order intake were reported from all regions compared with the corresponding period in the preceding year.

During the second quarter, the Kanthal division within Sandvik Materials Technology signed a strategic partnership with HYBRIT (Hydrogen Breakthrough Ironmaking Technology) in order to produce fossil-free heating.

Sandvik Manufacturing and Machining Solutions

Sandvik Manufacturing and Machining Solutions saw order intake (+44%) and revenues (+33%) increase year on year, driven by automotive and engineering. The strongest year-on-year growth in order intake was noted in North America and Europe of 48% and 50%, respectively. Growth of 23% was recorded in Asia.

Three acquisitions were announced during and after the quarter: agreements were signed by Sandvik Manufacturing to acquire Cambrio, a company with an end-to-end portfolio in CAD/ CAM software for manufacturing industries and DWFritz, a global provider of precision metrology, inspection and assembly solutions for advanced manufacturing. Sandvik Machining Solutions, meanwhile, signed a deal to acquire Fanar, a manufacturer of round tools based in Poland.

Sandvik Mining and Rock Technology

Sandvik Mining and Rock Technology reported order intake and revenues increases of 31% and 21%, respectively. The organic order intake is well above the levels seen prior to the COVID-19 pandemic, with high demand in load & haul, underground drilling and surface drilling. All major regions reported strong growth rates, with South America reporting an increase of 93%; Europe, 50%; North America, 39% and Africa/the Middle East, 15%.

During the quarter, Sandvik signed an agreement to acquire Tricon Drilling Solutions Pty. Ltd. On July 7, Sandvik completed the previously announced acquisition of DSI Underground, a global actor in ground support and reinforcement products, systems and solutions for the underground mining and tunnelling industries.

"We are, indeed, operating in a different business environment compared with a year ago, with stronger momentum for both our short and long-cycle businesses," stated Stefan Widing, president and CEO of Sandvik. "We are seeing strong demand for our products and services, and are combining this with solid operational execution and profitability levels. We are also stepping up the pace of acquisitions, firmly executing on our shift to growth ambition."

www.home.sandvik.com

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6K raises $51M to accelerate battery materials development and AM powder business

6K, North Andover, Massachusetts, USA, announced that it has closed a $51M Series C financing round. With this investment, the company intends to complete its Battery Development Center of Excellence, adding 3,066 m^2 of product development space and doubling its 6K Energy team. Funding will also enable a tripling of production capacity for Additive Manufacturing metal powders at its 6K Additive division, increase the portfolio of powder product offerings, and expand its commercial sales activities globally. The financing round was led by Volta Energy Technologies, joined by new investors Catalus Capital and S Cap/Prithvi Ventures, and existing investors Anzu Partners, Launch Capital, Material Impact, and RKS Ventures.

"This round of capital is a validation of 6K's model to replace wasteful legacy production technologies with the UniMelt® platform, enter scaled production, meet customer needs, move toward profitability, and transform industries," stated Aaron Bent, CEO. "We are joined by world-class investors who are aligned with our vision to transform the way performance materials are produced. And in doing so, we are teaming to solve critical needs of the US and the planet, addressing climate change, supply chain security, and reducing the demand on our fragile and limited resources."

6K intends to use the proceeds of the financing to expand product development and commercial activities across its multiple divisions. At 6K Additive, plans are laid for production to set up sales & distribution in Europe and Asia and expand the production by an additional 600 tons/year.

6K has announced its intent to invest $25M over twenty months in 6K Energy's Battery Development Center of Excellence, enabling partnerships for rapid product development and deployment. The Center will be fully capable of pilot production with UniMelt capacity equivalent of 400 MWh. 6K is currently sampling customers, and developing products across NMC cathode, LFP, silicon-dominant anode, lithium, solid-state electrolyte, and recycled cathode materials.

In response to demand from companies across the performance materials spectrum, 6K intends to invest in the identification and development of performance and electronic materials that can be produced cost effectively and sustainably with its UniMelt plasma production system. 6K has established an advanced R&D team for the development of performance materials including those for a variety of applications, ranging from semiconductors to electronic packaging to bio-ceramics.

Zander Arkin, Volta's Chief Investment Officer, has also joined 6K's board as director, alongside members such as Congressman Joe Kennedy III and Mark Little, previously CTO at GE.

Arkin commented, "Our investment strategy focuses on technologies that bring a positive impact to the environment and contribute to the rapid adoption of electric vehicles and renewable energy on the grid. Not only does 6K and its UniMelt platform align perfectly to our investment strategy, but the company is well poised to impact advanced material manufacturing for electric vehicle batteries with a solution that changes the dynamic of sustainability in the supply chain for battery materials."

www.6kinc.com

Höganäs finalises agreement to supply KBM's AM and MIM powder sales platform

Sweden's Höganäs AB has finalised its agreement with US-based KBM Advanced Materials for the supply of metal powders for both Additive Manufacturing and Metal Injection Moulding (MIM) applications. KBM announced its unique sales platform earlier this year, established to bridge the inventory gap between smaller lot customers and larger metal powder producers.

"Höganäs and KBM are a great culture fit for each other, as both companies emphasise offering superior service and creating value for our customers," stated Jerome Stanley, Director of Global Sales for Customisation Technologies, Höganäs. "Höganäs' high-quality products, broad capabilities, large scale, and global footprint coupled with a tech savvy, nimble and service focused distribution partner in KBM creates a very attractive offering for all customers regardless of the scale of their operations."

KBM will offer products and services to consumers of AM and MIM powders in the USA and Canada as a first step. The business model results in KBM having large amounts of stock available for order at any given time, allowing customers to get their metal powder quickly and efficiently.

Höganäs states it will benefit from regular, predictable order patterns while reaching new customers through KBM's platform. Support for KBM includes equity investment from Koch Metallics, LLC, a subsidiary of Koch Minerals & Trading, LLC, headquartered in Wichita, Kansas, USA, and Sumitomo Corporation of Americas, New York City, is acting as a supply chain partner.

www.kbmadvanced.com
www.hoganas.com

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Global Centres of Competences

Mantle sees $25 million investment in Series B amid reported customer success

Mantle, an Additive Manufacturing startup based in San Francisco, California, USA, has announced that its Series B financing totalled $25 million, bringing the total amount raised by the company to $41.5 million. The financing round was led by Fine Structure Ventures and existing investors Foundation Capital, Hypertherm Ventures, Future Shape, 11.2 Capital, and Corazon Capital also joined this second funding round.

"Fine Structure Ventures sees that a digital transformation is happening in the manufacturing industry," stated Shyam Kamadolli, Managing Director at Fine Structure Ventures. "Mantle is helping manufacturers redefine how they bring products to market by reducing lead times and costs while implementing more digital, flexible, and local supply chains. We are impressed by the value that Mantle's early customers have realised, and look forward to supporting Mantle's expected growth."

Mantle stated that its customers have produced over one million end-use parts with tool components made from Mantle's technology. Unlike other AM technologies that can struggle to produce high-volume end-use parts directly, Mantle has chosen to focus on additively manufacturing the tools used to make these end-use parts.

Medical device made using Mantle's additively manufactured tooling inserts (Courtesy Mantle)

Traditionally, these tools have been time consuming and expensive to make, representing a bottleneck in manufacturers' product launch schedules. Mantle's combination of accuracy, surface finish, and multiple tool steel materials has allowed manufacturers to meet tooling needs while reducing lead times and costs, thereby shaving months off lengthy, costly hardware development cycles.

"Mantle has demonstrated tremendous progress in addressing the $45 billion tooling market," added Steve Vassallo, General Partner at Foundation Capital. "They are consistently proving that they can help manufacturers reduce time and cost from their tooling programmes. We believe that our further investment in the company will help bring Mantle's precision metal 3D printing technology to a market that has desperately needed this innovation."

Mantle intends to use the new financing to increase its hardware, software, materials science, and manufacturing teams to accelerate the development and installation of its first commercial systems in early 2022.

www.mantle3d.com

Additive Manufacturer Green Trade Association welcomes new members

The Additive Manufacturer Green Trade Association (AMGTA) has announced that it has been joined by a further eight AM organisations, and now totals twenty-eight members. The non-commercial, unaffiliated association was launched in 2019 to promote the environmental benefits of Additive Manufacturing over traditional manufacturing.

Stratasys, with headquarters in Eden Prairie, Minnesota, USA, and Rehovot, Israel, has joined the AMGTA as a new Founding Member and will serve alongside existing Founding Members ExOne, QC Laboratories, Sintavia and Taiyo Nippon Sanso Corporation. These five founding members will determine the strategic direction of the AMGTA, provide governance oversight, and consider future research projects that members may vote to commission.

Joining the AMGTA as new participating members are 3D Metalforge, 3D Systems, 3YOURMIND, AMT, Hyperion Metals, NatureWorks and The Barnes Global Advisors. They will serve alongside existing Participating Members AMEXCI, BASF 3D Printing Solutions, Danish AM Hub, DyeMansion, EOS, Fraunhofer Institute for Laser Technology (ILT), GE Additive, HP, Materialise, National Manufacturing Institute Scotland, Rusal America, Siemens Digital Industries Software, SLM Solutions, Stryker, Trumpf, and 6K.

"I'm elated to welcome aboard our new Founding Member Stratasys, as well as each of our new Participating Member companies," stated Sherry Handel, Executive Director of the AMGTA. "Their collective pledge to support the AMGTA's mission well positions our trade group for accelerated growth and investment in new sustainability research projects in Additive Manufacturing. I look forward to working with each of our members as we expand the AMGTA as the key industry resource committed to advancing sustainability in the AM industry."

www.amgta.org

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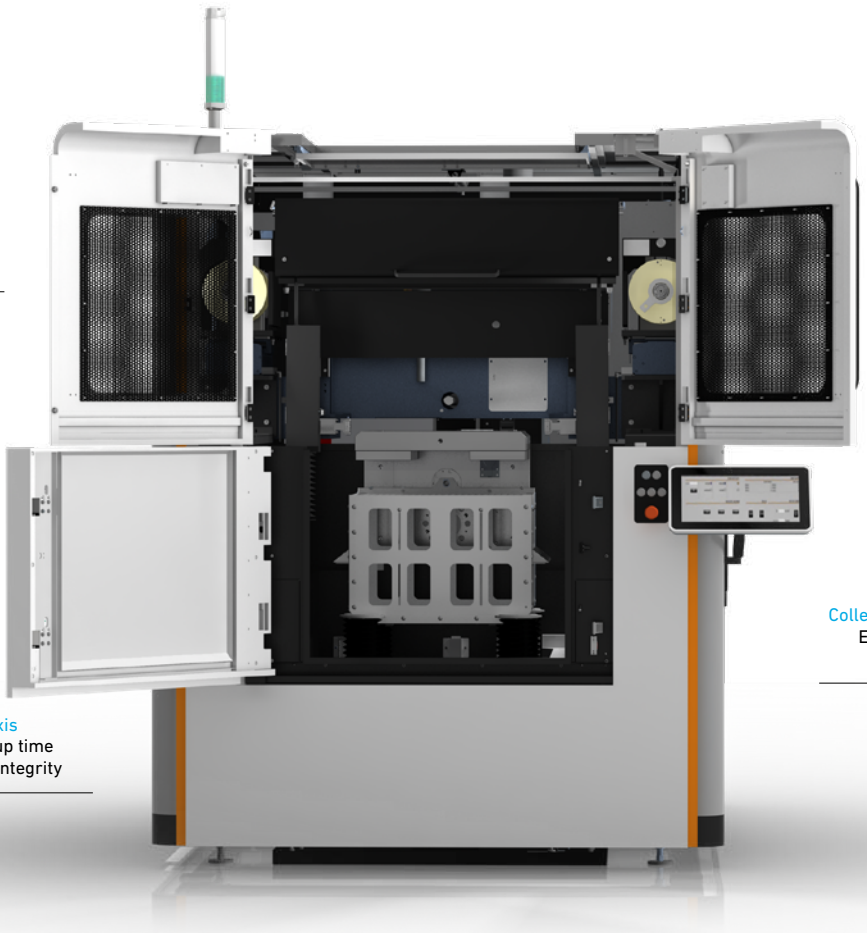

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Cutting rate	Total leadtime*	Total Cost of Ownership	Total Cost of Ownership*
3-4x faster	3-4x faster	3x cheaper	4-6x cheaper
than standard EDM	than a bandsaw	than standard EDM	than a bandsaw

These figures are based on real case studies with various geometries printed in maraging steel, nickel alloy and titanium.
* including building process

Learn more at
www.gfmsadditive.com

Farsoon launches FS273M as AM machine sales surpass five hundred

Farsoon Technologies, headquartered in Changsha, Hunan, China, has introduced the FS273M metal Additive Manufacturing machine – the next generation of its FS271M – to the global market for commercial orders.

The FS273M, a Laser Beam Powder Bed Fusion (PBF-LB) AM machine, is designed to address productivity, cost efficiency, and industrial workflow in metal AM and features a build envelope of 275 x 275 x 355 mm. The machine features many updates that are designed to enable a streamlined metal production workflow with a wide range of industrial metal materials.

Farsoon has added the FS273M metal AM machine to its range (Courtesy Farsoon Technologies)

The advanced dual-laser scanning strategy and calibration algorithm offer a build volume rate said to be improved by up to two times, compared to the single-laser configuration. The enhanced communication signal control and the new recoater design reputedly enables robust operational speeds and stable powder delivery throughout the whole manufacturing process.

Additionally, the FS273M features an integrated, long-lasting filtration system which allows for extended operation time for longer builds and reduces the cost of filter changes. Features such as a preheated baseplate, robust recoating operations, removable overflow containers, and a powder supply sufficient for a full build are expected to enable ease of operation and good serviceability.

"Farsoon's latest FS273M is the next generation of our medium-sized metal system FS271M, which was first introduced to market in 2015," stated Don Xu, Director of Farsoon Global Business Group and Managing Director of Farsoon Americas Corp. "We've spent the past six years optimising the productivity, performance of the machine through continuous collaboration with our industrial partners; meanwhile, we keep pushing the true industrialisation of metal AM by reducing customers' cost of operation, especially for tight margin industries like moulds & tooling."

The company also reported that, as of the end of June 2021, the total number of installed Farsoon Additive Manufacturing machines at customer sites has surpassed 500. Farsoon's line of AM machines, first introduced in 2015, has benefited from the rising civil aerospace industry and reports an even split between its installed base of metal and polymer machines.

"We are seeing an increasing demand of large-volume functional parts fabrication, especially in aerospace and automotive industries, using specialised materials in order to achieve designated performance tolerances, mechanical properties and reliability under a variety of operational conditions," added Xu.

"In order to address customers' pain points around size, productivity and quality, Farsoon has been introducing the multi-lasers, large-format metal systems FS421M, FS621M, as well as the latest FS721M to the market," he continued. "As of today, Farsoon has installed more than eighty large-format metal systems (build platform > 400 mm) in the aerospace and automotive industries."

In the first half of 2021, Farsoon's global team expanded from 300 to 400, with significant growth in technology and development, technical support and manufacturing.

www.en.farsoon.com

AM startup Fortius Metals raises $1.4 million in pre-seed funding

Metal Additive Manufacturing startup Fortius Metals, Inc, headquartered in Boulder, Colorado, USA, has raised $1.4 million in pre-seed funding, according to a Form D filed with the US Securities and Exchange Commission, reports *Daily Camera/BizWest*.

Fortius, which was incorporated on June 21, is a spinout of Elementum 3D, Erie, Pennsylvania, USA. The company states that it will be focusing on aluminium and offer 'reactive Additive Manufacturing' to help deliver products for the aerospace, automotive and defence industries, said not to have been possible previously with robotic AM.

Jeff Lints, CEO of Fortius Metal, stated that its technology "introduces new components into the metallurgy that dramatically improve its grain structure. It's stronger, so it allows for the fabrication of lighter products. We can advance traditional fabrication."

Fortius currently lists two employees and is in the process of hiring engineers and seeking commercial facilities to lease. The company will now transition into a seed round, which Lints hopes will be complete by the end of 2021. Around half of the funding raised will be used for capital equipment.

www.fortiusmetals.com

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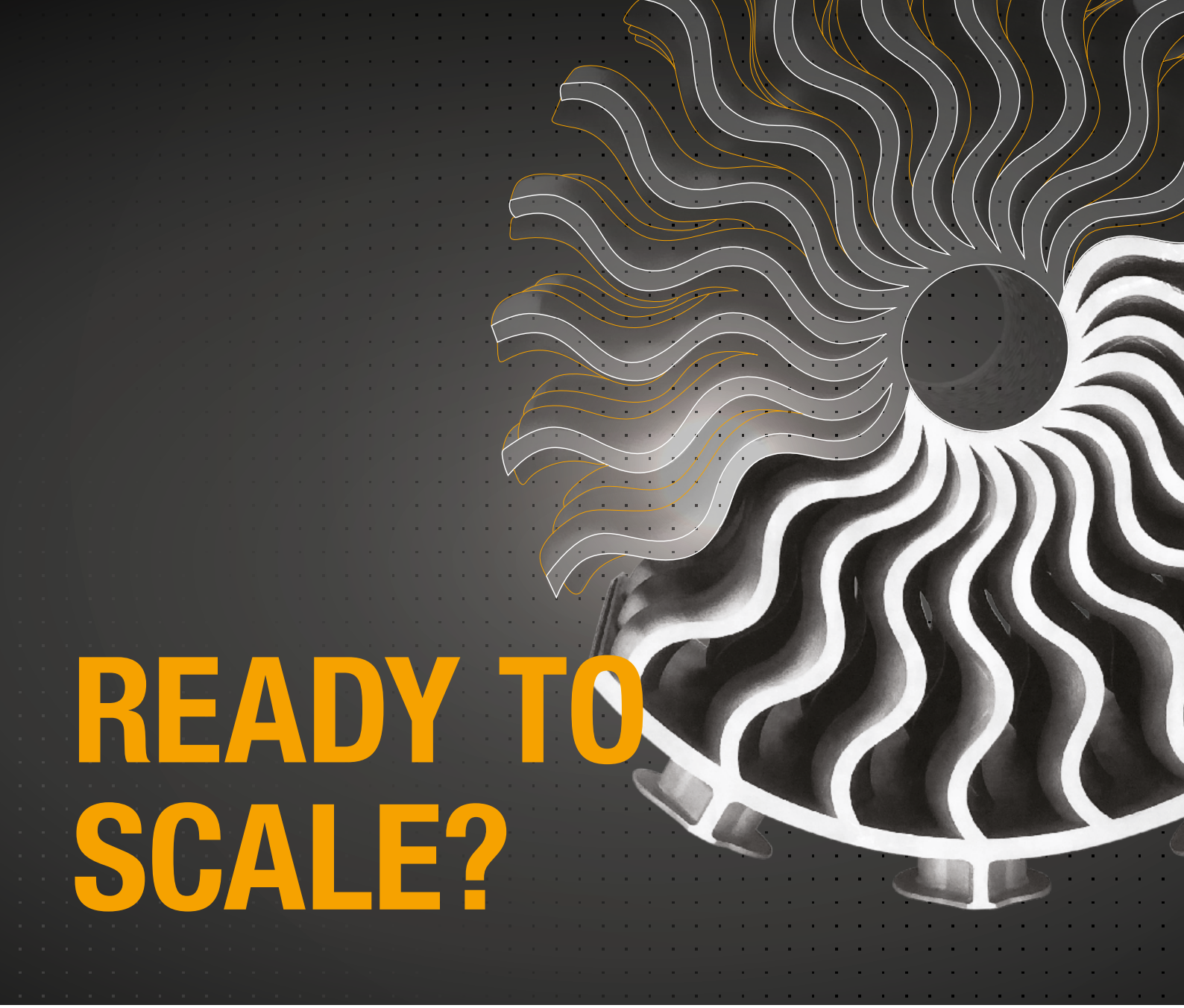

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Sigma Labs appoints former GE AM executive Jacob Brunsberg as senior vice president

Sigma Labs, Inc, Santa Fe, New Mexico, USA, has announced the appointment of Jacob Brunsberg as senior vice president. Brunsberg, who will be responsible for leading the company's strategic relationships, product management and marketing programmes, joins after holding senior positions at General Electric Additive, the Additive Manufacturing division of General Electric (GE), over the past four years.

Most recently, Brunsberg had management responsibility for strategy, development, commercialisation and overall business performance in General Electric's Binder Jet Technology unit. From 2017 to 2019, he served as Senior Managing Director of the Central Region, tasked with helping establish the US sales infrastructure for post-acquisition integration of several Additive Manufacturing technology companies – including Concept Laser, Arcam and GEonX – into the newly formed GE Additive business.

Prior to GE, Brunsberg worked for the American Roller Company in sales leadership and product marketing positions, where he was responsible for the development and oversight of growth strategies, focused on advanced welding, cladding, thermal spray, and Powder Metallurgy technologies across a number of industrial markets. Brunsberg holds a Bachelor of Science degree in Material Science and Engineering from the University of Wisconsin-Madison.

Mark Ruport, president and CEO of Sigma Labs, stated, "Jacob brings a strong base of additive industry management and sales experience to Sigma Labs. He is well known as an innovator and business builder, and is exactly the type of individual we need to round out our superb management team."

"Jacob's history of driving revenue and profitability, plus his expertise in commercialising and bringing complex technology portfolios to market will be beneficial to Sigma Labs as we further grow market awareness and revenue," he added.

"I could not be more pleased to be a part of Sigma Labs," said Brunsberg. "Our mission of setting the Additive Manufacturing in-process quality standard is important to manufacturers and OEMs, as well as the entire industry. I've been following Sigma Labs for some time and believe its unique technology and commitment to quality present a tremendous growth opportunity. I look forward to contributing to the company's ongoing success."

www.sigmalabsinc.com

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SPEE3D adopts corrosion-resistant stainless steel for use in oil and gas sector

SPEE3D, Melbourne, Australia, has added 316L stainless steel to the list of materials that can now be used with its cold spray metal Additive Manufacturing machines, opening up applications in the oil and gas sector that rely on the corrosion-resistant material. The latest development follows financial support from National Energy Resources Australia (NERA), a federally-funded industry growth centre which aims to drive growth and productivity in the energy resources sector.

"Stainless steel is used very extensively in the oil and gas industry and when parts break or need replacing, waiting for something to be delivered to a remote location or repaired on site can cause extremely costly delays," stated Byron Kennedy, CEO. "SPEE3D's on-site printing of 316L stainless steel means these delays can be overcome, and a new part can be printed and installed in a far shorter timeframe."

SPEE3D machines use a cold fusion process where compressed air is used to fuse powders, meaning no volatile gases or heat sources are required to bond layers together. Component production is reported to be up to 1000 times faster than conventional metal AM technology.

NERA first partnered with SPEE3D in 2018 to help develop the Warp-SPEE3D machine, designed to additively manufacture large-scale parts commonly found in the oil and gas sector. Since then, NERA has supported the redesign and re-engineering of SPEE3D's machines to enable the use of 316L stainless steel.

"NERA's support in the development of our ability to print 316L stainless steel has been crucial," commented Steve Camilleri, SPEE3D's co-founder. "We're confident being able to print stainless steel on demand will attract many industries to SPEE3D's technology, particularly within the oil and gas sector, and undoubtedly bring new collaboration, sales, and export opportunities."

"Manufacturing stainless steel parts using SPEE3D technology will completely redefine Additive Manufacturing's place within the sector. For the first time, the supply chain will be able to source parts on demand, and substantially reduce cost," Camilleri continued.

Miranda Taylor, CEO, NERA, added, "SPEE3D's movement into producing stainless steel as a 3D printed part is really critical because – as is the case with oil and gas – there are a number of sectors in which steel is the medium of choice. The ability to produce those products at point of need using stainless steel will open up a whole new world for SPEE3D."

www.spee3d.com

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Melrose reports trading ahead of expectations in half-year results

Melrose Industries PLC, UK, reports that it is trading ahead of expectations, with better profit margins, higher earnings per share and significantly lower net debt. All Melrose GKN businesses were said to have improved their adjusted operating margin in the period compared to full year 2020, with GKN Aerospace up by +2.9 ppts; GKN Automotive by +4.0 ppts and GKN Powder Metallurgy by +6.9 ppts. GKN Automotive and Powder Metallurgy are said to be ahead of plans on their restructuring projects.

GKN Powder Metallurgy was reported to be making clear market share gains, growing revenue at 43% in the first half, and with close to 70% of the business achieving more than 14% adjusted operating margins.

Aerospace was said to be well positioned on many significant platforms; the civil aerospace business is now weighted more towards the faster narrowbody recovery. Additionally, defence demand remains strong.

Automotive is said to be well placed to benefit from the transition to electric vehicles. In the first half of this year, over one-third of new business bookings awarded were for pure electric platforms – over 50% if full hybrid platforms are included. Additionally, during the last eighteen months, automotive has been awarded six major eDrive programmes for global and Chinese vehicle manufacturers. Automotive is anticipated to grow at more than double the rate of light vehicle production over the long term.

"We are continuing to see recovery in all our businesses, with trading ahead of expectations," stated Justin Dowley, chairman of Melrose Industries PLC. "Encouragingly, our aerospace business is now weighted towards the expected narrowbody recovery. Our Automotive and Powder Metallurgy businesses are poised for strong growth as soon as the well-publicised chip shortage abates and the progression in margins is ahead of plan with more to come. As with all its promises, Melrose has delivered its acquisition funding commitment to GKN pensioners early. We have scope on our balance sheet to return more money to shareholders next year and we are excited by the upcoming possibilities."

The company stated that its commitment, made on the acquisition of GKN by Melrose, to improve the funding of the GKN UK defined benefit pension schemes has been delivered ahead of schedule. The funding deficit of around £1 billion has reduced to approximately £150 million. Consequently, the annual contribution halves to £30 million with no ongoing requirement to contribute from future disposal proceeds.

Net debt as of 30 June 2021 was significantly lower at £300 million; proforma net debt at the same date is £1,029 million after adjusting for the announced Return of Capital settled on 14 September 2021 (1.5x proforma leverage). The group recorded an adjusted earnings per share of 2.2 pence. Adjusting for the accretion post the announced return of capital and share consolidation, the proforma EPS increases to 2.5 pence. The statutory loss per share was 3.1 pence.

On September 14, Melrose was scheduled to return £729 million, 15 pence per share, to shareholders. In addition, Melrose reports that its balance sheet has spare capacity for a significant further capital return next year.

www.melroseplc.net
www.gknpm.com

Aluminium Materials Technologies now transferred to Eckart

Following the announcement in September 2020 that Germany's Eckart Group, a company of Altana AG, was to acquire Aluminium Materials Technologies Ltd. (AMT), Worcester, UK, the company has reported it has now completed integration and business operations were transferred to Eckart on October 1, 2021. The company will continue to supply the full range of AMT products, notably the established A20X powder for Additive Manufacturing and A205 alloy for foundries.

AMT developed the A20X special alloy for Additive Manufacturing, which is said to enable the manufacturing of significantly lighter components with outstanding mechanical properties. In July 2021, the company secured aerospace recognition with the publication of AMS7033 standard for its high-strength and high-temperature properties.

Eckart is one of the world's leading manufacturers of effect pigments, with almost 150 years of experience in the production of powders. Specialised in the atomisation of metal and in particular in the production of aluminium powders, Eckart provides an annual capacity of more than 10,000 metric tons.

The integration of AMT and Eckart is now complete. Eckart will continue to supply the full range of AMT products, including the A20X powder for AM (Courtesy Eckart/AMT)

www.a20x.com
www.eckart.net

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Digital Metal and Etteplan agree partnership to advance transition to AM

Digital Metal, part of Sweden's Höganäs Group, and global engineering company Etteplan, Espoo, Finland, have announced that they will enter a strategic partnership to offer guidance to existing and new customers looking to make the transition to Additive Manufacturing. The companies aim to provide design optimisation solutions for Digital Metal's Binder Jetting (BJT) processes, and to offer manufacturing companies the full benefit of the technology – from idea to complete component with volume production in mind.

"Together with Etteplan, we will be able to offer a stronger value proposition, covering a complete design and manufacturing process, to our customers," stated Christian Lönne, CEO at Digital Metal. "The partnership gives us access to a world-class design team that complements our business very well."

Etteplan provides solutions for software and embedded solutions, industrial equipment and plant engineering and technical documentation solutions to leading companies in the manufacturing industry. In 2020, it had a turnover of approximately €260 million and currently has over 3,500 employees. By combining Digital Metal's expertise in BJT with Etteplan's knowledge in the design of components for AM, their goal is to accelerate the transition from traditional manufacturing to AM.

Riku Riikonen, SVP, Engineering Solutions, Etteplan, added, "Etteplan has invested heavily in Additive Manufacturing and has been involved in groundbreaking engineering already for a long time. We look forward to exploring and creating synergies together with Digital Metal. The partnership will strengthen both Etteplan's as well as Digital Metal's offerings towards existing and future customers."

www.digitalmetal.tech
www.etteplan.com

6K Additive launches refractory metal powders for AM

6K Additive, a division of 6K, headquartered in North Andover, Massachusetts, USA, has announced the commercial availability of refractory metal powders for Additive Manufacturing. Materials such as tungsten, rhenium, tungsten/rhenium and niobium-based powders used for defence, aerospace and medical industries are sought after materials for high-temperature, high-strength applications.

Frank Roberts, 6K Additive president, stated, "The leading defence organisations are not only looking for refractory materials like tungsten and rhenium, they are looking for it at production scale. The uniqueness of 6K's UniMelt® microwave plasma process, combined with the expertise of our operations team, has allowed us to manufacture production scale volumes for many of the refractory powders like tungsten and tungsten/rhenium. We have spheroidised the full spectrum of refractory powders including tantalum, niobium and molybdenum and we are ready to help organisations advance their applications with these materials."

The UniMelt system is reported to be the world's only microwave production-scale plasma system, with a highly uniform and precise plasma zone with zero contamination and high throughput production capabilities. 6K Additive currently produces, as commercially available powders, Ti6Al4V (Grade 5 and Grade 23), SS316L and nickel superalloys Ni718 and Ni625, along with the announced refractory materials.

In 2020, 6K Additive completed the construction of a 4180 m^2 powder production facility in Burgettstown, Pennsylvania, USA. The facility currently has two UniMelt microwave plasma systems commissioned with two additional systems scheduled for installation in Q4 of 2021. The company will also begin construction to expand the powder manufacturing building in Q4, 2021 to add space for six additional systems. Installation of the additional systems will begin in Q1 of 2022.

"We have a focus on propulsion applications that require high-temperature, high-strength materials used in modern rocket nozzle applications," commented Joe Sims, Director of the Quadrus Advanced Manufacturing Division. "Our tungsten/rhenium powder spheroidised by 6K processed exceptionally well in our selective laser melting machines. Having a reliable, trusted supply chain partner like 6K Additive for refractory materials is critical to our business and to our defence customers. Our powder quality requirements are extremely high, and 6K Additive easily cleared that hurdle for us."

Quadrus Corporation used 6K's services to make spherical tungsten-rhenium used to produce a non-eroding throat insert for a solid rocket motor nozzle (Courtesy 6K Additive/Quadrus Corporation)

www.6kinc.com/6k-additive

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3DGBIRE and CMG Technologies to provide AM debinding & sintering services in UK

The sole distributor of BASF Forward AM products in the UK and Ireland, 3DGBIRE, Chorley, Lancashire, UK, and legacy user of BASF Catamold feedstock for Metal Injection Moulding, CMG Technologies, Woodbridge, Suffolk, have announced a partnership to provide UK-based debinding & sintering options for parts manufactured from BASF Forward AM's Ultrafuse metal filaments.

Additional aims of the partnership will include finishing services for debound & sintered AM parts, as well as encouraging the adoption of AM by facilitating the training, upskilling and professional development of staff within customer organisations.

Because the service debinds and sinters additively manufactured and MIM parts in the same furnaces at the same time, it is stated that costs are reduced, along with lead times for customers using these services.

"3DGBIRE and CMG Technologies have merged two industries in their service offering: conventional Metal Injection Moulding based on Catamold technology and 3D printing with metal Fused Filament Fabrication [FFF] using Ultrafuse 316L or 17-4PH," stated Tobias Rödlmeier, Business Development Manager for Metal Filaments at BASF Forward AM. "We are very pleased that this efficient solution is now open to our UK Ultrafuse metal filament customers."

Previously, parts had to be shipped to Germany, which has become an increasingly costly and prolonged process according to Paul Croft, 3DGBIRE Director. "Before Brexit, you could quickly and cost effectively ship parts and goods to Germany, that is no longer the case so we were very keen to establish a debinding and sintering offering in the UK that enables customers to realise the huge cost saving opportunities of Additive Manufacturing," Croft stated.

Rachel Garret, Managing Director, CMG, added, "CMG is thrilled to be expanding our relationship with BASF into the AM market. We have over twenty years of experience within the MIM industry and our extensive knowledge developed over the last two decades means that this is a very natural progression for us. We can apply our skills within debinding & sintering of MIM parts directly to the debinding & sintering of 3D metal printed parts to ensure we are processing parts to the highest quality and accuracy."

www.cmgtechnologies.co.uk
www.3dgbire.com

3DGBIRE and CMG Technologies have partnered to process parts manufactured from BASF Forward AM metal filaments (Courtesy CMG/3DGBIRE)

Aubert & Duval creates superalloy heat treatment line

With the support of the France Relance recovery plan and The French Agency for Ecological Transition (ADEME), Aubert & Duval, Paris, has announced a new heat treatment line at its facility in Pamiers, France.

The special processes employed in heat treatment are a key area of knowledge for Aubert & Duval, enabling the modification of materials' and parts' microstructures to achieve the highest specifications required by its customers, including those in demanding industries such as aeronautics, energy and defence.

Almost all the parts produced by Aubert & Duval's new Pamiers line undergo heat treatment procedures. As these are post-processing operations, the performance must be right first time in order to not negatively impact lead times or costs.

The new line has been designed to the highest standards in order to reduce safety risks, ensure process & quality control the digitisation, increase productivity & flexibility and make processing greener (an 8% reduction in CO_2 emissions was resultant across the entire site).

www.aubertduval.com

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More information at www.trumpf.com/s/500-degree

Freemelt establishes German subsidiary and AM centre

Freemelt, Mölndal, Sweden, has announced the opening of a showroom in Esslingen, Germany to demonstrate the company's Electron Beam Powder Bed Fusion (PBF-EB) technology. The company has also established Freemelt Deutschland GmbH, a wholly owned subsidiary, to coordinate the activities of the Esslingen centre, as well as to manage the commercialisation of Freemelt systems in Germany and in Europe at large. Peter Jain, part of the Freemelt management team since September 1, 2021, has been appointed the Managing Director global sales of Freemelt, and will be based at the Esslingen centre, scheduled to open its doors on November 1, 2021.

"The opening of a subsidiary in Germany is an important milestone for Freemelt, as we take our first steps outside of Sweden," stated Ulric Ljungblad, CEO, Freemelt. "We are extremely excited to offer our customers the possibility to meet with us also in Germany and to experience the possibilities of new material development for PBF-EB."

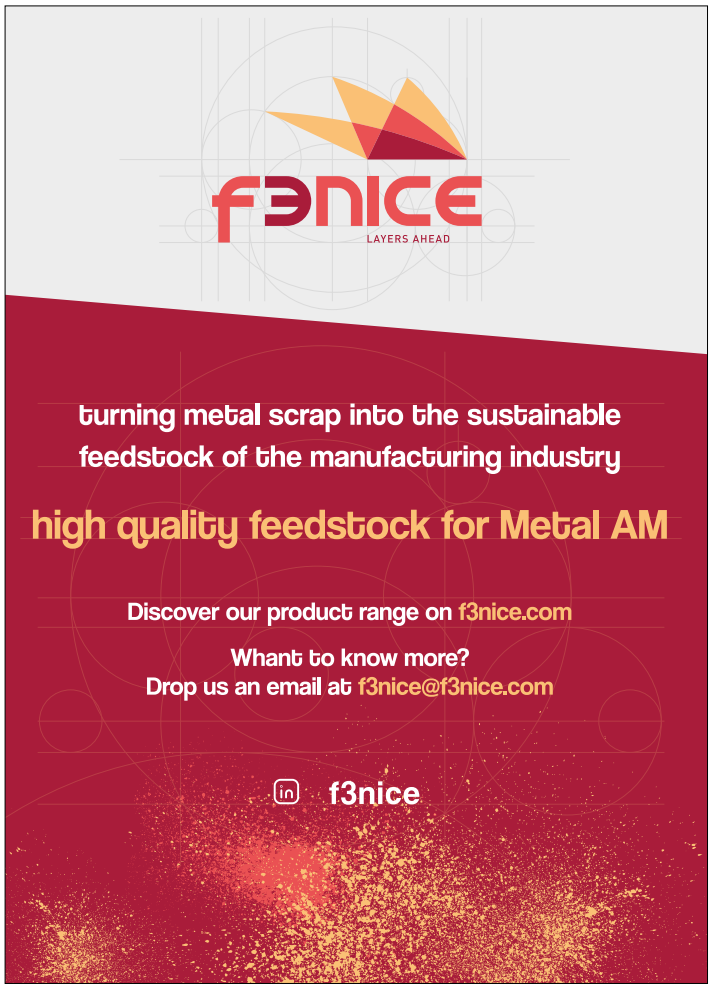
Freemelt is focused on bringing the advantages of PBF-EB to a wider range of industrial applications in a variety of industries, such as the medical, electromobility and special metals segments. In 2019, the company launched Freemelt One, a patent-pending development platform, and machines have been installed in several locations in Europe. The Freemelt One is an open platform that allows users to customise and optimise build parameters and, by so doing, possibly facilitate the development of new metal alloys that had not previously been possible to use on PBF-EB systems.

The Freemelt process features a 6 kW electron gun with high resolution over the entire power range for exceptionally fast processing at temperatures of higher than 1200°C. This enables production with crack-sensitive materials, such as refractory metals. Qualification of materials on the Freemelt One can be conducted with very small powder quantities in a small vacuum chamber, making new material development both fast and cost effective.

"Developing new processes for the Additive Manufacturing of new alloys is a key factor for expanding the use of PBF-EB to new and exciting applications. Materials and process parameters developed for the Freemelt One can be seamlessly applied to the Freemelt production system, which is currently under development," Ljungblad explained.

Freemelt will be exhibiting at Formnext in Frankfurt, Germany on November 16 to 19, 2021.

www.freemelt.com



Eplus3D and Shining 3D become independent companies

Eplus3D, Hangzhou, China, reports it has become an independent company and is no longer a subsidiary of Shining 3D Tech. Co., Ltd., Hangzhou, China. In a joint statement, the companies announced that Eplus3D will continue to offer its range of industrial AM machines and aftersales service directly to customers globally, as well as maintaining aftersales services to customers of its machines sold through Shining 3D.

Eplus3D was established in 2014 and has been engaged in research and development of industrial-grade Additive Manufacturing systems and application technologies. The company is the original developer and manufacturer of Shining 3D's metal and polymer AM machines, as well as offering a range of systems for the aerospace, automotive, tooling, healthcare, dental and consumer goods markets.

Shining 3D, established in 2004, owns and operates subsidiaries in Stuttgart, Germany, and San Francisco, USA, and lists customers in more than seventy countries. In addition to AM machines, the company develops, manufactures and commercialises a wide range of 3D technologies, including 3D scanners for multiple industries and applications, professional software from CAD design to 3D inspection and dental solutions.

www.eplus3d.com | www.shining3d.com

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SLM Solutions to deliver three metal AM machines to Morf3D's new headquarters

SLM Solutions, Lübeck, Germany, has announced a partnership with Morf3D, El Segundo, California, USA, which will see three metal Additive Manufacturing machines – two SLM® 500s and an NXG XII 600 – delivered to Morf3D's new headquarters, the Applied Digital Manufacturing Center (ADMC) located in Long Beach, California, in 2022.

Morf3D explains that its new 8400 m^2 ADMC facility aims to leverage partner networks to transform supply chain norms and develop the industry's first certified production system to accelerate the industrialisation of digital manufacturing. The addition of the two SLM 500s and the NXG XII 600 is expected to support Morf3D's goal of advancing a global production setup while improving production lead time, order flexibility, cost efficiency, and quality.

"Our partnership with SLM Solutions dramatically shifts the landscape of serial production, enabling our customers to achieve unmatched levels of quality and performance," commented Ivan Madera, CEO of Morf3D. "The NXG XII 600 platform is an engineering marvel that addresses many aspects of a production-ready system, and the ADMC will enable new industry partnerships, significantly scaling AM to new heights. Our goal is to accelerate the qualification process by collaborating on new application development and part certification within the aerospace, space, and defence market."

In addition to the supply of machines, SLM Solutions will also offer on-site support in the form of education, training, and consulting. All of ADMC's research and development partners will work together to drive new innovations and deploy novel methods of aerospace engineering in order to increase productivity and automation. All partners will also have access to collective training, meeting, and gathering spaces for customer events and business development efforts.

The NXG XII 600 is equipped with twelve 1 kW lasers and offers a square build envelope of 600 x 600 x 600 mm. It is designed to be used in serial production for high-volume applications, as well as for building large parts.

Sam O'Leary, CEO of SLM Solutions, stated, "Adding the NXG XII 600 to Morf3D's SLM Solutions' machines at the Applied Digital Manufacturing Center bolsters the collective digital manufacturing ecosystem, helping to improve production speed, quality, and automation. We are united in our customer-first approach, which reflects the training and education we provide to all of our partners."

www.slm-solutions.com
www.morf3d.com

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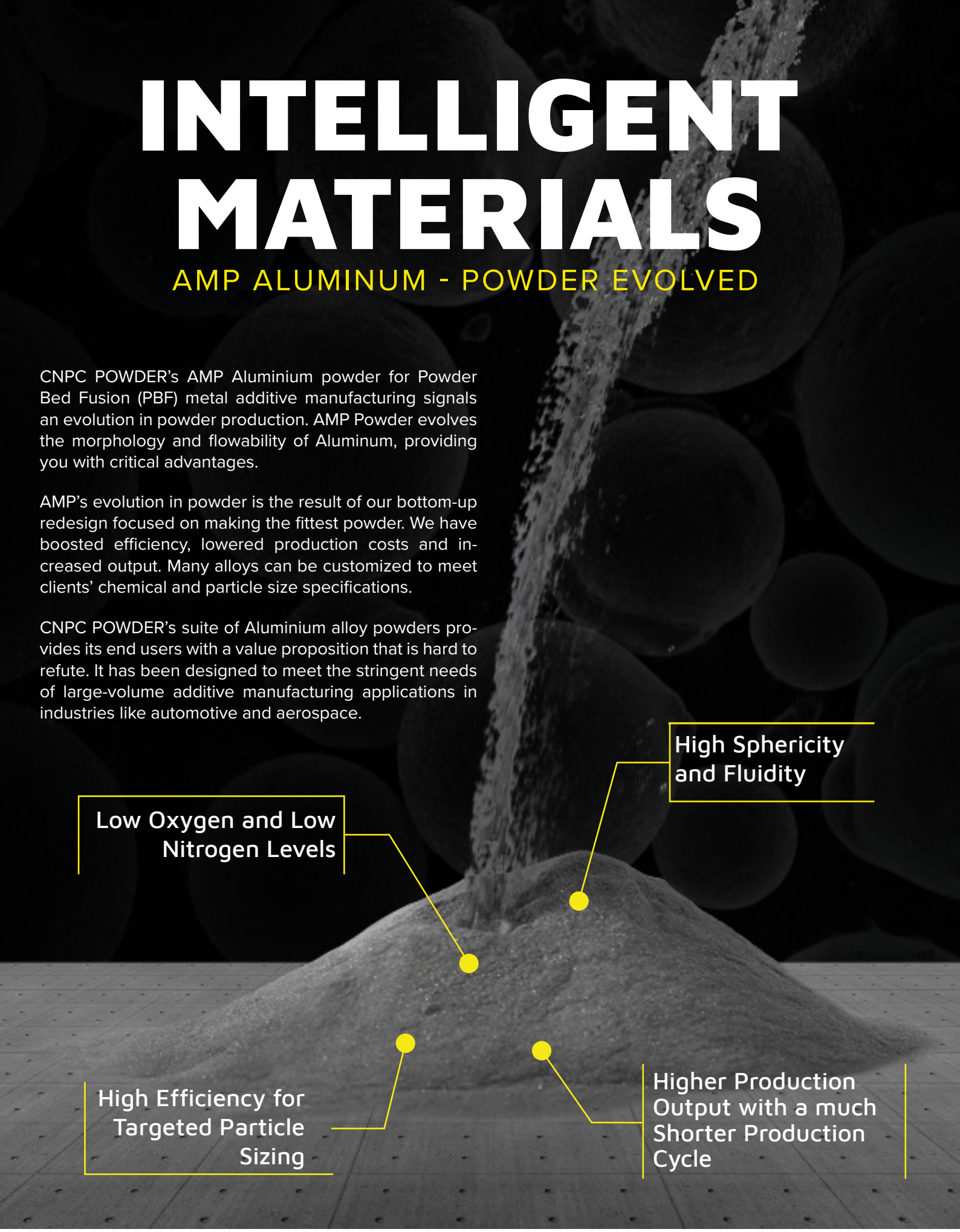
CNPC POWDER's suite of Aluminium alloy powders provides its end users with a value proposition that is hard to refute. It has been designed to meet the stringent needs of large-volume additive manufacturing applications in industries like automotive and aerospace.



CNPC POWDER

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Burloak adds second metal Additive Manufacturing facility in California

Burloak Technologies Inc, headquartered in Oakville, Ontario, Canada, a division of Samuel, Son & Co., Limited, has established its second Additive Manufacturing centre in Camarillo, California, USA. The new facility will boost the manufacturing capacity available at the company's AM Center of Excellence in Oakville.

Between the two facilities, Burloak offers Laser Beam Powder Bed Fusion (PBF-LB), Electron Beam Powder Bed Fusion (PBF-EB), Binder Jetting (BJT) and both wire and powder Directed Energy Deposition (DED) technologies. These AM capabilities are offered alongside post-production services, including design, engineering, CNC machining, heat treatment and finishing capabilities.

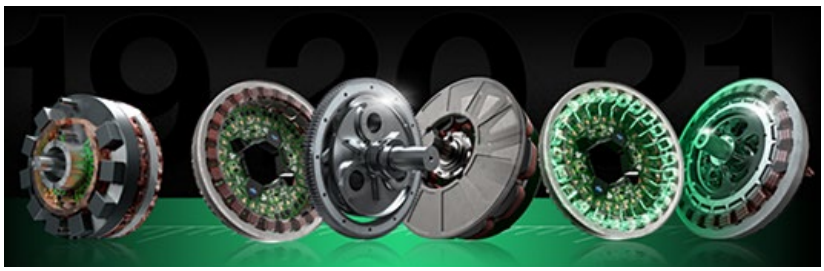
Formerly operating as CalRAM, the facility, assets and equipment have been acquired from Carpenter Technology Corporation, based in Philadelphia, Pennsylvania, USA. Burloak and Carpenter Technology have formed a further agreement to collaborate on future product design and development opportunities, with Carpenter Technology becoming the preferred metal powder supplier for certain Design for AM (DfAM) projects led by Burloak.

"DfAM expertise, combined with scalable manufacturing capacity, is often the missing link for customers seeking to embrace additive," stated Colin Osborne, president and CEO of Samuel, Son & Co. "The establishment of our multi-site capacity, along with our expanded relationship with Carpenter Technology, further demonstrates our commitment to closing this gap. By leveraging the expertise Samuel has in large-scale manufacturing, along with Burloak's deep additive experience, we offer customers the easiest, most direct path to develop and scale even their most complex Additive Manufacturing projects."

In addition to the expanded collaboration agreement with Carpenter Technology, Burloak has recently announced relationships with The Boeing Company, MDA Ltd., Smiths HP and the National Research Council of Canada, and is actively working with additional leaders in the space, aerospace, automotive and industrial markets.

www.carpentertechnology.com
www.burloaktech.com

Höganäs joins Connactive to develop new eDrive concepts based on metal powders



Höganäs has joined the Connactive project to develop new electric drive concepts based on the use of metal powders (Courtesy Connactive)

Sweden's Höganäs AB reports it has joined the Connactive project to help develop new electric drive concepts based on the use of metal powders. The Connactive project was established in 2019 as a way to bring companies together with the goal of fostering innovation. Currently, the work is focused on the production of an enhanced-efficiency motor.

Deniz Yigit, Director of Global Business Development – Customisation Technologies, Höganäs, stated, "It's essential for electrical engines to become more powerful and efficient to allow electric vehicles to fulfil their vast potential, and this can be done by using AM-enabled technology and dedicated material solutions that take technology to the next level."

"Höganäs AB and Alvier Mechatronics have joined the Connactive project, which is dedicated to achieving high speed, high frequency and power density eDrive solutions. This cross-company collaboration will leverage the different areas of expertise of each member, and the results will drive the evolution of the modern electric engines," he added.

Höganäs's metal powders were used in the Connactive's first project: the Dual Drive System, a powersplit planetery gearset and matching RX II unit in combination with the high torque AX motor and highly integrated electronics. Leveraging the abilities of partner companies Dontyne Gears, Moteg and Vishay, the Dual Drive System was brought from blueprint to series production standard prototype within six months.

"Höganäs' vision is to inspire industry to make more with less. By utilising the endless opportunities of our metal powders, we know that we can improve resource efficiency and lead a wave of change for the better," stated Lars Sjoberg, currently Head of System Design at Alvier Mechatronics and former Manager of Application Development at Höganäs. "Co-creation brings a new dimension to our way of working and we expect that this will take us to the next level as well as speeding up market introductions at lowest total cost."

www.connactive.tech
www.hoganas.com

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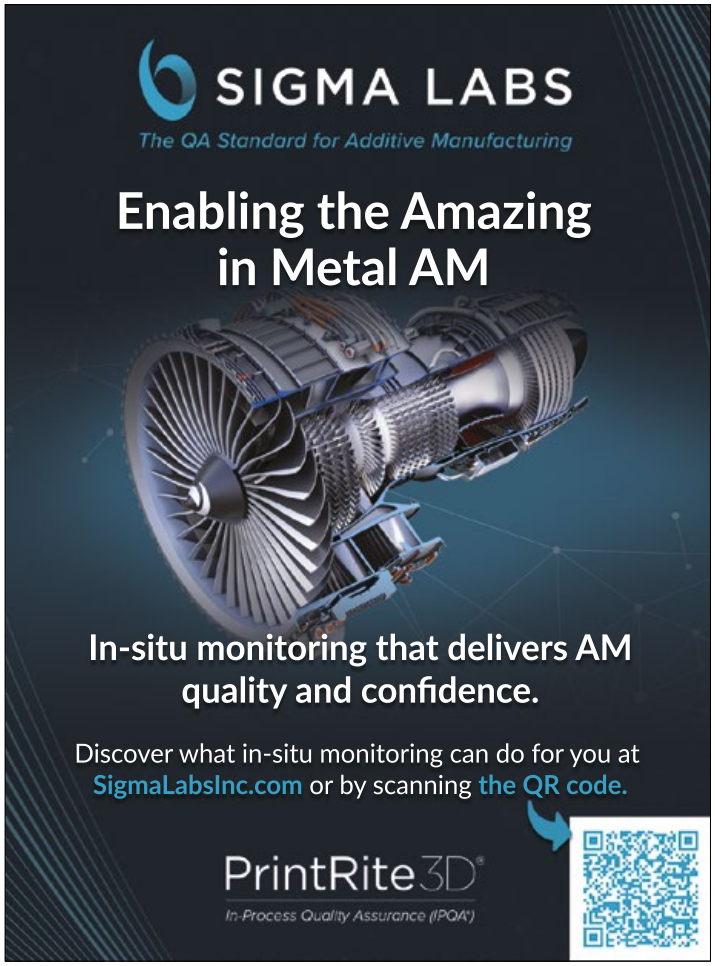
Pometon establishes new AM metal powders division

Pometon S.p.A., headquartered in Maerne, Venice, Italy, has established PometonPlus, a new business division specialising in the production of metal powders for Additive Manufacturing. Founded in 1940, Pometon is a manufacturer of metal powders for the automotive, chemical, aerospace and electronics industries, offering a wide range of ferrous and non-ferrous powders as well as stainless steel abrasives.

The company believes that Additive Manufacturing is one of the most promising sectors and, in order to satisfy this trend and meet the needs of its clients, Pometon decided to invest in and start producing metal powders specifically for AM. PometonPlus was expected to start production in the second half of October 2021. Products will initially belong to six major product families: copper and copper alloys, steel and stainless steel and alloys, cobalt-chromium and alloys, nickel-chromium and alloys, titanium and titanium alloys, aluminium and aluminium alloys.

Pometon will showcase its metal powder production services at Formnext 2021, Frankfurt, Germany, on November 16–19, 2021, in Hall 12, stand E48.

www.pometon.com



thyssenkrupp Materials UK launches metal AM services

thyssenkrupp Materials UK, headquartered in Cradley Heath, West Midlands, part of Germany's thyssenkrupp AG, reports that it has launched a new metal Additive Manufacturing product and service offering to supply metal powders and provide post-build services. thyssenkrupp has appointed Nigel Evans as Business Development Director, a role which will see him lead the new metal AM programme. Evans is reported to have vast experience in providing thorough support to customers within the aerospace, defence and machining industries.

"With the rapid growth of metal Additive Manufacturing, we have recognised as a business that we are in an advantageous position to support our customers with their newly set-up additive supply chains," stated Evans. "Our high-quality metal powders are covering a wide range of applications, making them the ideal material for developing prototypes, short run manufacturing and complex one-off designs."

thyssenkrupp Materials UK offers a selection of metal powders that include stainless steel, aluminium, titanium and nickel-base alloys. Additionally, the company has a wide range of modification capabilities with regard to alloy structure, atomisation and subsequent powder processing that allow it to manufacture and supply custom powders in batches from 50 kg. The company is further supporting the metal AM supply chain with a post-build service offering, using the company's in-house technology and enabling a simpler and more efficient production process. This allows thyssenkrupp Materials UK to oversee the entire AM thread – from the initial part model and material selection to the verified finished part, working closely with the customer.

"At thyssenkrupp Materials UK, we offer a full post-build CNC machining and turning service on all additive manufactured metal parts to ensure product performance as per the design. We own the longest CNC machining centre in the UK as well as CNC vertical bed mills. This allows us to process even large-scale pieces, with a maximum weight of 30 tonnes and up to 1,150 mm thick and 2,200 mm wide. With our efficient machinery and an expert technical team, we can guarantee consistency in every one of our workpieces. For our clients, this means a better and more consistent performance of their end product and increased efficiency in delivery."

Having a network of sites across the UK, operated by thyssenkrupp Materials UK, there is capacity and the capability to produce both complex prototypes and low-volume production runs of metal AM parts, with various surface finishes. Furthermore, with an optimised logistics system, centrally manufactured metal powders and some 480 sites worldwide, the business can support global customers in industries such as aerospace, automotive and medical, whose supply chains are geographically complex.

www.thyssenkrupp-materials.co.uk

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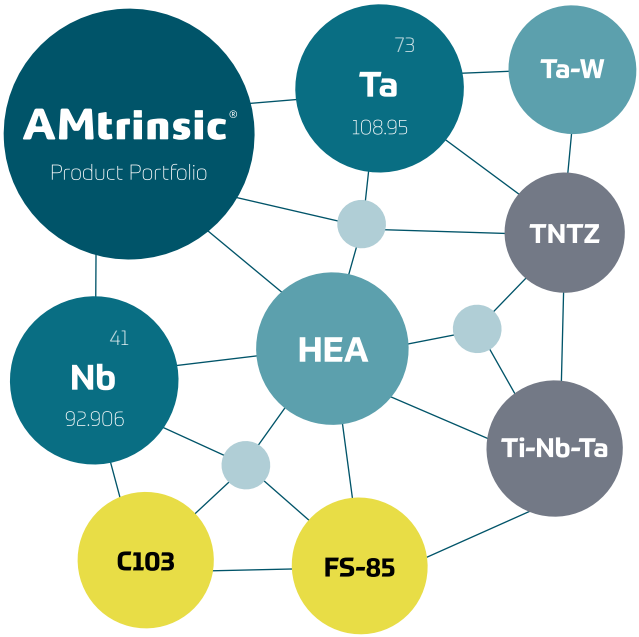
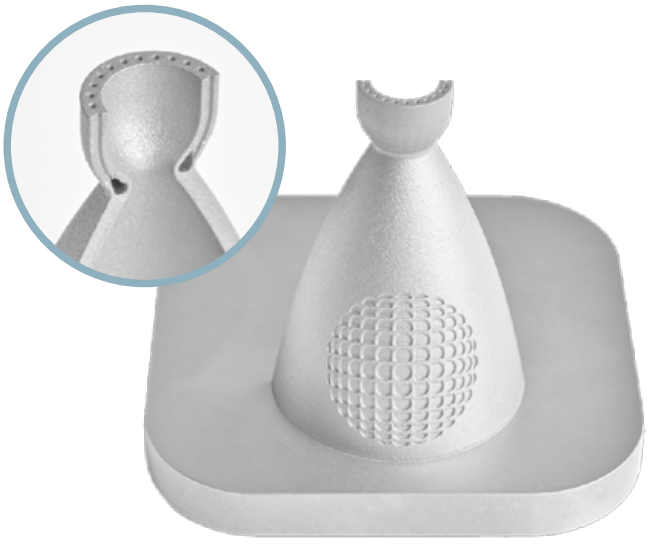


AMtrinsic® spherical Tantalum and Niobium powders provide outstanding combinations of material properties customized for specific applications. Aligned with 3D-printing technology, **AMtrinsic®** powders can help overcome hurdles in various high-tech industries. The high temperature stability, excellent corrosion resistance and biocompatibility of **AMtrinsic®** Ta, Nb powders and their alloys deliver a perfect fit for biomedical (Ta, TNT and TNTZ), chemical (Ta, Nb, Ta-W) and aerospace (Ta-W, C103 and FS-85) applications. In addition, **AMtrinsic®** Nb with its prominent superconducting properties is applied in related industries.

TANIOBIS GmbH announces the expansion of its metal additive manufacturing powders by addition of C103 (Nb-10Hf-1Ti) and FS-85 (Nb-28Ta-10W- 1Zr) pre-alloyed powders to its product portfolio. High-temperature strength, superior creep properties and their excellent processability with AM make these alloys great candidates as structural material for various aerospace applications. Additive manufacturing offers design freedom enabling manufacturing of lightweight components with complex features e.g. rocket thruster with integrated cooling channels which is the main application of our **AMtrinsic®** C103 and FS-85 alloys.



info@taniobis.com | www.taniobis.com

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ExOne and Fraunhofer expand partnership for the development of new binders and materials

The ExOne Company, North Huntingdon, Pennsylvania, USA, and the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Bremen, Germany, report that they are deepening their partnership on binder and materials development projects, following the success of the CleanFuse™ metal binder.

Fraunhofer IFAM and ExOne's collaboration on metal Binder Jetting (BJT) spans more than two decades, having begun working together in 1998 when ExOne, then part of Extrude Hone, launched the world's first commercial metal BJT system, the RTS-300. In recent years, they have jointly refined and optimised CleanFuse, an ExOne binder based on a development by Fraunhofer IFAM. The result is a clean-burning binder for optimal Additive Manufacturing of stainless steels and premium metals.

"When we started developing the first binder version on the Innovent, we soon realised we had a major breakthrough," explained Prof Frank Petzoldt, Deputy Director of Fraunhofer IFAM since 1999. "ExOne was immediately very enthusiastic about our development, because of its exceptional green part strength and clean burnout at low curing temperature. Together with ExOne, we refined the binder, which is now CleanFuse."

With the new X1 25Pro from ExOne, Prof Frank Petzoldt and his team aim to investigate pilot and pre-series production of components using metal Binder Jetting (Courtesy Fraunhofer IFAM)

Following this success, Fraunhofer IFAM and ExOne have decided to intensify their cooperation and are currently working on a CleanFuse version for processing reactive materials such as aluminium and titanium.

Rick Lucas, ExOne's Chief Technology Officer and VP, New Markets, commented, "At ExOne, we truly believe in the power of collaboration – of bringing together a diversity of experts and knowledge – to solve complex problems in the best possible way. Fraunhofer IFAM has been a leading collaboration partner for us – helping to improve our understanding of binders, different types of powders, and how they work together through the entire process chain from printing to final sintering to deliver a quality part."

Fraunhofer IFAM has a strong foundation in the development and processing of metallic and polymer materials as well as comprehensive knowledge of AM technologies – especially for sinter-based processes. The institute's facility in Bremen is fully equipped for sinter-based Additive Manufacturing and offers all technologies for the printing, depowdering, debinding and sintering of metal parts.

For research and development in the field of metal BJT, Fraunhofer IFAM researchers work with a range of ExOne AM machines including the Innovent+ for material and process development. Three of its AM machines feature ExOne's patented Triple Advanced Compaction Technology (ACT) delivering industry-leading green part density, and the institute recently put the X1 25Pro production-speed metal BJT system into operation to investigate pilot and pre-series production.

www.exone.com
www.ifam.fraunhofer.de

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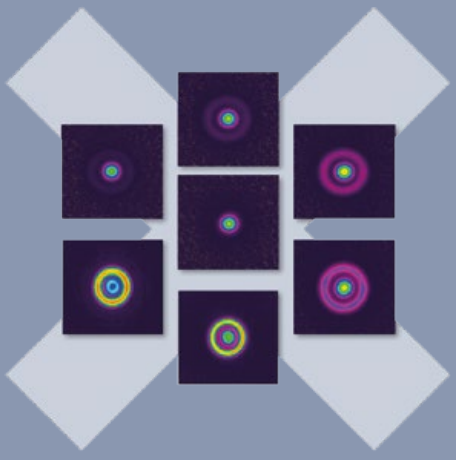

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This new degree of freedom overmelt pool behavior is being leveragedto control microstructures forimproved yield strength, ductility, andcreep resistance.

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Schunk focuses on high-tech materials at new Innovation Centre

The Schunk Group, headquartered in Heuchelheim, Germany has opened a new Innovation Centre in Heuchelheim. The facility, in which the company has already invested €20 million, hosts state-of-the-art technology, including plasma torches and Additive Manufacturing machines, and will be used to develop high-tech materials and products. Schunk also intends to open a further Innovation Centre at the Reiskirchen site of Weiss Technik.

"Today is a very special day for Schunk," stated Dr Arno Roth, CEO of the Schunk Group. "As a technology company, innovations are quite crucial for us. And our new Innovation Centre, which we are opening today in Heuchelheim, creates the best conditions for developing innovations for the future."

The company believes these investments underscore the importance of its facilities in the region, having invested around €220 million in the state of Hesse alone over the last five years, creating 340 new jobs. The Schunk Group currently employs 3,700 people at its sites in Heuchelheim, Wettenberg and Reiskirchen, making it one of the largest industrial employers in the region.

"Our new innovation center at the Heuchelheim site will be our think tank, where we intend to develop new high-tech materials and technologies and transfer them to industrial production," stated Dr Ulrich von Hülsen, a member of the executive board of the Schunk Group. "The world is facing enormous challenges in the areas of climate protection, mobility and energy supply. All these megatrends require new materials to solve the existing problems. We are excellently positioned here by developing components for efficient electric motors or industrialising the production of bipolar plates for fuel cells that are suitable for mass production. Reducing the carbon footprint is an important driver for our materials innovations."

In the Innovation Centre, Schunk's engineers have all development and manufacturing processes at their disposal in one hall. The entire hall is air-conditioned and the temperature and humidity can be precisely controlled. It is therefore possible to create different climates, creating good conditions for the development and production of high-performance materials.

In the AM technical centre, a variety of different machines are available, with which almost all AM processes can be represented.

www.schunk-group.com

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Blue Power to showcase ultrasonic atomiser at Formnext

Blue Power Casting Systems GmbH, Walzbachtal, Germany, will showcase the final version of its new AUS 500 ultrasonic atomiser at Formnext 2021. The prototype was announced in November 2020, and has been developed in cooperation with Amazemet, a spin-off company of the University of Warsaw.

Ten years after the introduction of Blue Power's first gas atomisation system, the AUS 500 is set to expand its portfolio of systems for powder production and classification. Dr Fischer-Bühner, head of R&D at Blue Power, stated that the system will enable users to produce small batches of high-quality, spherical powder at an affordable price, without complex infrastructure.

The induction heating system and pre-installed programmes for numerous alloys enable precise control of the melting temperature. Melting can be done either under vacuum or in a controllable atmosphere. The medium frequency induction generator is reported to create a stirring/mixing effect that improves the alloy quality.

"A crucible-based induction heating system has many economic advantages over plasma-assisted ultrasonic atomisation," stated Mateusz Ostrysz, co-founder of Amazemet. "For example, the loss of volatile alloy components through evaporation is prevented without the need for complex and expensive filter systems. The system is not limited to pre-alloyed wires and rods only; in fact, the starting material can be more or less any shape. In this way you avoid the time and effort required to manufacture complex and expensive wires and you do not need any peripheral devices such as continuous casting machines and drawing benches. "

The AUS 500 will be revealed at Formnext (Courtesy Blue Power)

Very small batch sizes of around 100 g or even less are technically and economically feasible, while larger batches of up to several kg (bronze) per hour are also possible. The yield is also said to be high, for example, bronze can be manufactured in particle sizes in the range of d50 = 40 to 60 µm.

www.bluepower-casting.com
www.amazemet.com

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Titomic awarded AUS $2.3 million grant for space-based applications

Titomic Ltd, Melbourne, Australia, has been awarded a AUS $2.325 million Federal Government Modern Manufacturing Initiative grant to manufacture and commercialise low-carbon-emission ('green') titanium space vehicle demonstrator parts for the Australian space sector and export markets.

This grant will be part of a planned total eligible project expenditure of AUS $4.65 million, which will allow Titomic to use its Kinetic Fusion (TKF) cold spray Additive Manufacturing technology to build and commercialise space vehicle parts using green titanium, heterogeneous material blends, and high-performance coatings for radiation shielding and hypersonic protection.

Titomic, Swinburne University of Technology and the Australian Nuclear Science and Technology Organisation (ANSTO), will conduct extensive testing and validation of demonstrator parts produced within an Industry 4.0 AM platform embedded within its TKF technology.

Titomic is teaming with commercial partners, such as Inovor Technologies, reportedly Australia's only sovereign commercial satellite manufacturer, to provide specific application use cases and establish performance, testing and acceptance requirements for the technologies. The AM capability is intended to drive high-value technological and material developments, accelerate space and manufacturing sector growth, create high-value jobs, and attract investment.

The grant project includes the supply of a Titomic TKF 1000 Additive Manufacturing machine to Swinburne University of Technology (Courtesy Titomic Ltd)

Professor Pascale Quester, vice-chancellor and president, Swinburne University of Technology, added, "We welcome this MMI space-based applications grant and hail both its educational potential and the economic value to Australia. Having the TKF 1000 Additive Manufacturing system in the heart of Swinburne's Hawthorn campus offers our students direct access to a world-leading technology facility in the growing advanced manufacturing and space sector – it's a learning experience you cannot find anywhere else in Australia. We're proud to be partnering with Titomic on this exciting new facility, and grateful to the Commonwealth Government for their foresight in funding a collaboration that will help shape our future economy."

The grant project is scheduled to run until December 2022, and includes the supply of a Titomic TKF 1000 Additive Manufacturing machine to Swinburne University of Technology with the company's Industry 4.0 AM platform embedded within its TKF technology.

Herbert Koeck, Titomic CEO, commented, "This $2.325 million Federal Government MMI grant awarded to Titomic showcases our ability to seamlessly integrate our custom cold spray Additive Manufacturing (CSAM) technology systems into partner supply chains, and Joint Venture partners in aerospace with shared risk and reward. This project allows us to show our unique capability to use industrial scale Additive Manufacturing to create world leading 'low-carbon-footprint' green titanium and high-performance coatings for satellites and space vehicles. Our supply of a TKF 1000 System to Swinburne University of Technology with its Industry 4.0 Additive Manufacturing platform to drive high-value technological and material developments, will also accelerate space and manufacturing sector growth in Australia, creating high-value jobs, and attracting local investment."

www.titomic.com

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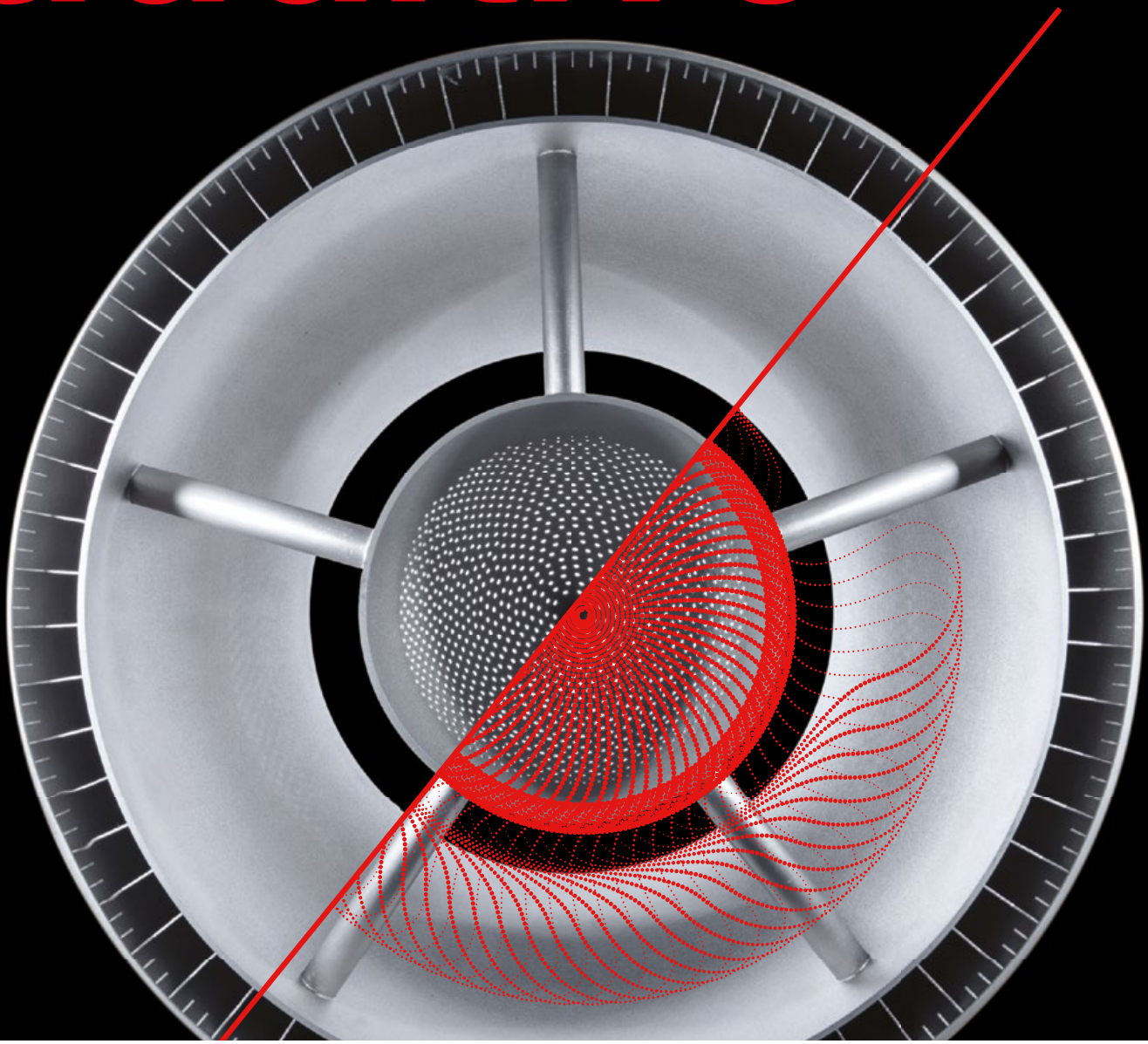
we are additive



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www.oerlikon.com/am

oerlikon am

Metal AM part failure sees Australian cycling team crash out of the Olympics

During the Tokyo 2020 Olympics, the failure of a metal additively manufactured bicycle handlebar caused the structure to snap while being ridden by Alex Porter, a member of the Australian cycling team (AusCycling), during his fourth lap in the men's team pursuit challenge.

The resulting crash left Porter with friction burns and damage to his face, arms and legs. While the Australian team was permitted to ride again under a rule allowing second opportunities in case of mechanical failure, the team did not qualify in the top four, but, rather, placed fifth. This ranking meant AusCycling could no longer compete for the silver or gold medal in the event.

The failure occurred in the bike's one-piece integrated base bar and stem, at the junction where the stem area transitions into the outward-facing base bar. The exact cause of the failure is unknown, but speculation in the metal Additive Manufacturing community on LinkedIn has been that the break was due to the type of brittle fracture which is a known risk in metal AM parts, which can have a lower ductile strength than forged materials.

However, an analysis of the fault in *Cycling News* by Josh Croxton suggests that the failure may have been caused by an over-torqued bolt, with the snap having occurred very close to the location of the base bar and stem's frontal bolt hole.

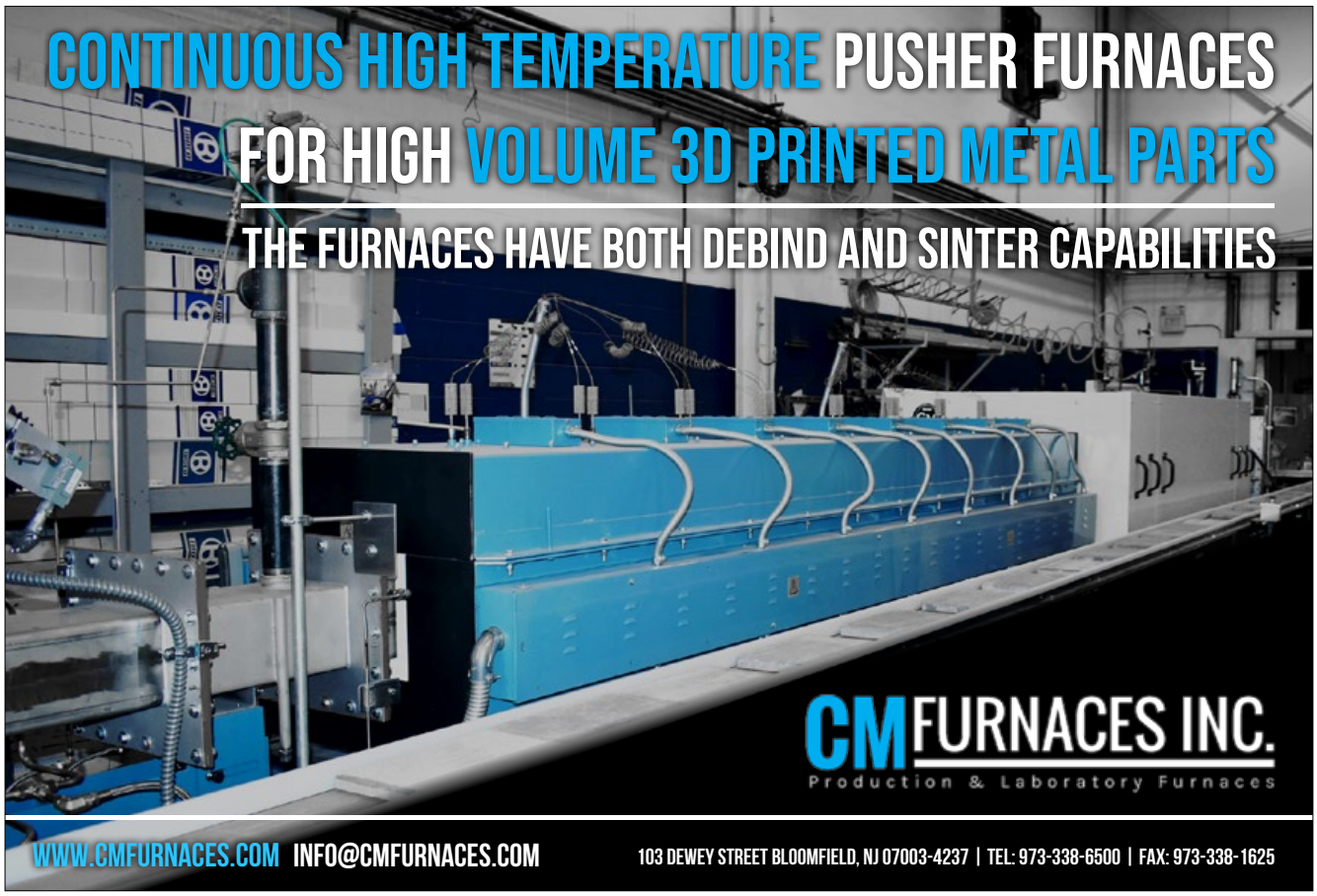
The titanium part was produced by Bastion Cycles, Fairfield, Australia. In a statement issued by the company, a Bastion spokesperson said, "The team at Bastion Cycles is working with the Australian Olympic team to understand the cause behind the failure of one of its handlebar units during the four-person, Australian pursuit challenge at the Tokyo Olympics."

"Our first concern was for Alex Porter and the entire team. We are in constant contact with the Australian Olympic cycling team and coaches, and give our assurances that we are using all means available to investigate why this occurred."

"Bastion has been providing custom-made components for elite athletes since 2016, using leading-edge composite and titanium 3D printed materials, and remains committed to supporting the Australian Olympic and Paralympic Team."

AusCycling has announced a full investigation into the incident.

www.auscycling.org.au



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Protolabs report shows oilfield services going green, adopting on-demand manufacturing

The oilfield services sector is radically restructuring to survive in a world moving towards net-zero carbon emissions, according to 'Decision Time', a report published by Protolabs, exploring the challenges and opportunities for Europe's oilfield services sector. The research saw more than 180 senior leaders from oilfield services companies across Europe, including Welltec and Swire Energy Services, interviewed by digital manufacturer Protolabs, headquartered in Maple Plain, Minnesota, USA.

The majority of business leaders in the sector, who took part in the research, see sustainability as an opportunity, with 77% saying sustainability is a way to differentiate and grow their business, and with 80% saying that experience in sustainability gives European businesses an edge in global markets. Some 82% of respondents stated that they plan to engage in Manufacturing-as-a-Service (MaaS) – Additive Manufacturing and on-demand manufacturing – to streamline component production in order to survive.

"3D printing is valuable for creating spare parts that are not easily accessible," stated the CTO of a Swedish oilfield services company. "It also allows the re-creation of the necessary piece or can recreate the moulds, templates or tools used in the manufacture of spare parts."

Bjoern Klaas, vice president and Managing Director of Protolabs Europe, added "The sector's appetite to secure a long-term future means companies are branching out into other industries and extending their capabilities. With energy transition revolutionising the sector, combined with a much lower profit environment, it is imperative that companies continue to innovate and embrace renewable markets. Companies in the sector appreciate the value of environmental credibility – not only to secure their own reputation and funding, but also in response to the legislative need to cut down on emissions and the competitive need to be sustainable within the global marketplace."

"Our 'In Charge' report earlier this year showed that 58% of respondents believe sustainability principles will give European battery makers an edge in the international market. Also mirroring our battery industry report, 83% of UK respondents to the 'Decision Time' report say they are planning to move their supply chain closer to their manufacturing base within the next twelve months."

"This is an important tactic when considering the need to rely on innovation, create a leaner business and turn to Manufacturing-as-a-Service to deliver an operation that will flourish in the new era," concluded Klaas.

www.protolabs.co.uk

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Launcher adds second Velo3D Sapphire metal AM machine

Velo3D, Inc, Campbell, California, USA, reports that Launcher, headquartered in Hawthorne, California, USA, a developer of high-performance rockets for small satellites, recently purchased a Velo3D Sapphire® Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing machine. The new machine will be used to build titanium parts and is the second Sapphire metal AM machine that Launcher has purchased, having invested in one in April 2021 to produce Inconel parts.

Founded in 2017, Launcher is an emerging-technology company dedicated to developing efficient rockets that can deliver small satellites to orbit. Its Launcher Light rocket aims to carry payloads of up to 150 kg to low-earth orbit using a single E-2 engine, with the first launch scheduled for 2024.

One of the company's strategies is to use AM in as many rocket components as possible. While Launcher's new advanced manufacturing facility in Los Angeles will include a wide variety of in-house capabilities, the company reportedly also plans to take advantage of Velo3D's contract manufacturing partners, like Stratasys Direct Manufacturing, when scaling up production.

Following successful testing at NASA's Stennis Space Center of Launcher's liquid oxygen (LOX) turbopump for its high-performance closed cycle liquid rocket engine, the company is now working with Velo3D to additively manufacture its fuel pump, flight turbine housing parts, and Orbiter pressure vessels — the latter to be manufactured with the second Sapphire AM machine.

"Velo3D really delivered on our turbopump, including its 3D printed rotating impeller, all of which functioned perfectly the very first time at 30,000 rpm, using the first prototype," stated Max Haot, founder & CEO of Launcher.

"Rocket engine turbopump parts typically require casting, forging, and welding," he continued. "Tooling required for these processes increases the cost of development and reduces flexibility between design iterations. The ability to 3D print our turbopump — including rotating Inconel shrouded impellers, thanks to Velo3D's zero-degree technology — makes it possible now at a lower cost and increased innovation through iteration between each prototype."

Benny Buller, founder and CEO of Velo3D, commented, "We're very excited about working with innovative companies like Launcher. Not only have they already proven out the value and experienced the quality of advanced metal AM through current projects, they understand the potential that this technology holds for expanding the success of their out-of-this-world enterprise."

www.velo3d.com
www.launcherspace.com

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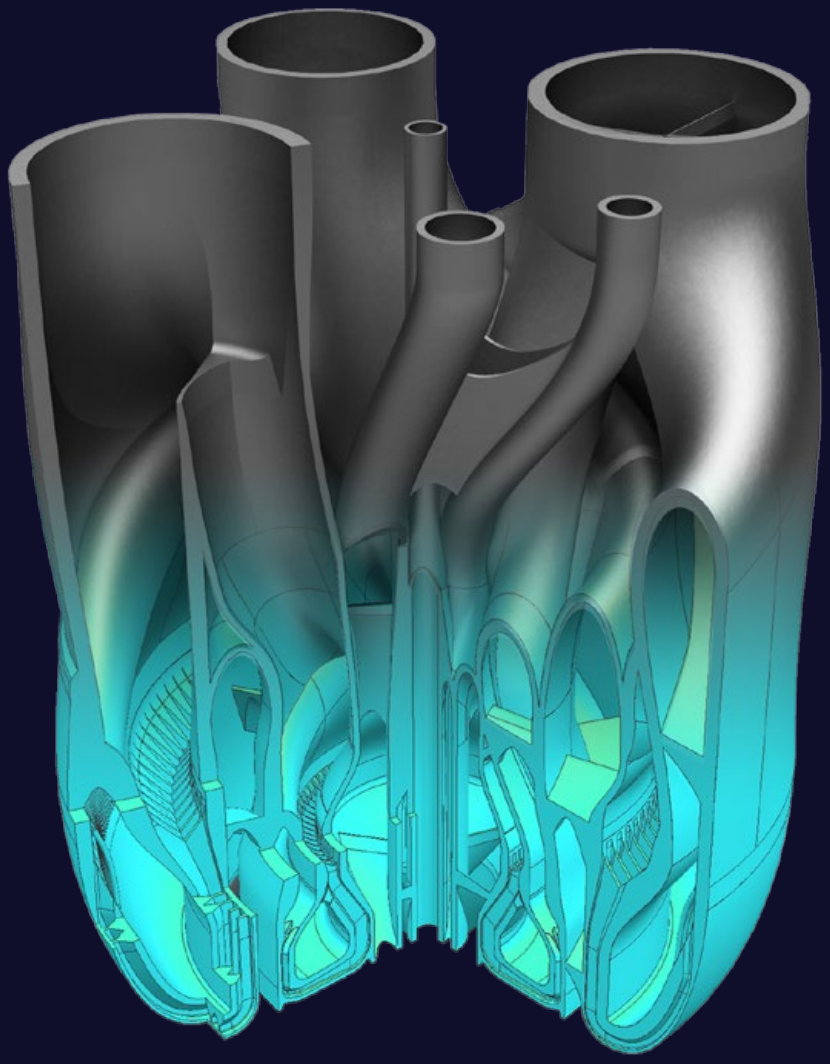

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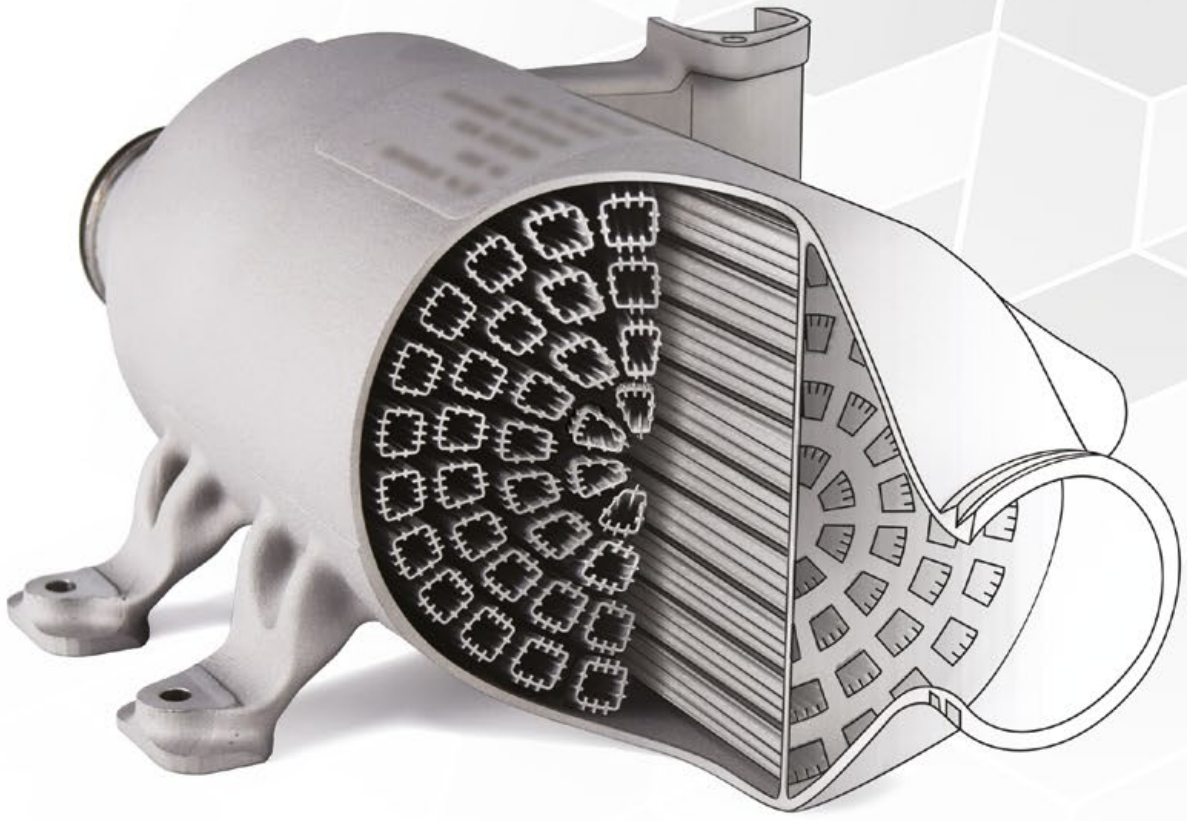

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DMC among first to test new Renishaw Flex Additive Manufacturing machine

The Digital Manufacturing Centre (DMC), Towcester, Northamptonshire, UK, will be one of the first businesses to receive the new RenAM 500 Flex from Renishaw plc, Wotton-under-Edge, Gloucestershire, UK. The new metal AM machine is intended to enhance commercial operations by allowing users to easily switch between material types without compromising part quality. Through long-term collaboration with Renishaw, the DMC has been selected as a key beta site for 'in industry' testing of the updated machine. These final phases of the development programme aim to verify the capabilities and versatility in a busy commercial production environment.

The RenAM 500 Flex is expected to improve pre-production testing and material selection, while also allowing users to establish parameters that can be easily transferred to more automated machines, like the RenAM 500, for faster serial production.

"One of the most limiting factors in metal Additive Manufacturing is the restriction on material changes," stated Jonathan Archer, General Manager at Renishaw. "This hampers the speed of material testing, impeding exploration and experimentation in the development and production of new parts. Our engineering development team have comprehensively addressed this challenge with the exciting new RenAM 500 Flex."

He added, "As part of our final development testing, we are trialling the real-world performance of the RenAM 500 Flex in the busy production environments of key beta sites – one of which being the DMC. Over the past eighteen months, we have worked closely with the DMC leadership and engineering team to develop and implement new systems and products. This is yet another reflection of the ongoing strength and trust of this collaborative relationship."

The RenAM 500 Flex combines the gas flow capabilities and build chamber of the RenAM 500 with a simplified, non-recirculating powder system that enables a complete material change in around eight hours. Available in both single and quad-laser configurations, the Flex includes the same process monitoring capabilities as the regular RenAM 500, allowing for transferable melt pool analysis.

The machine has been designed to minimise material loss between transitions, with easier retrieval and cleaning than conventional machines – particularly within the same material family.

digitalmanufacturingcentre.com
www.renishaw.com

Right to left: Nigel Robinson (COO, DMC), Kieron Salter, (CEO, DMC), Bryan Austin (Director of Sales AMG, Renishaw) and Lily Dixon (Project Manager, Renishaw) (Courtesy DMC/Renishaw)

B2N becomes an official sales partner for Meltio's metal AM solutions

Meltio, Linares, Jaen, Spain, reports that Additive Manufacturing equipment distributor B2N, located in Sofia, Bulgaria, is now an official sales partner for the South-East Europe market. B2N will reportedly play a key role in the distribution and support of the Meltio metal AM solutions in Bulgaria, Romania, Serbia, Bosnia and Herzegovina, Montenegro, Albania, Macedonia, Croatia and Slovenia.

Meltio's machines use an Additive Manufacturing process based on what it refers to as 'wire-powder laser metal deposition', a form of Directed Energy Deposition (DED) technology that enables the production of parts using either metal wire or metal powder independently or simultaneously.

B2N provides solutions for rapid product development, production optimisation and innovative product, part and tool manufacturing. The company's portfolio includes professional and industrial AM machines, 3D scanners, software for simulative design and materials. The company provides delivery, on-site installation, training and maintenance by certified technicians.

B2N explains that it will focus on building a supportive ecosystem for Meltio's technology in the region, partnering and driving business opportunities alongside technology centres, tooling machine companies, robotic integrators, academia and industry.

www.meltio3d.com
www.b2n.bg

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Fehrmann Alloys adds six new aluminium alloys to range

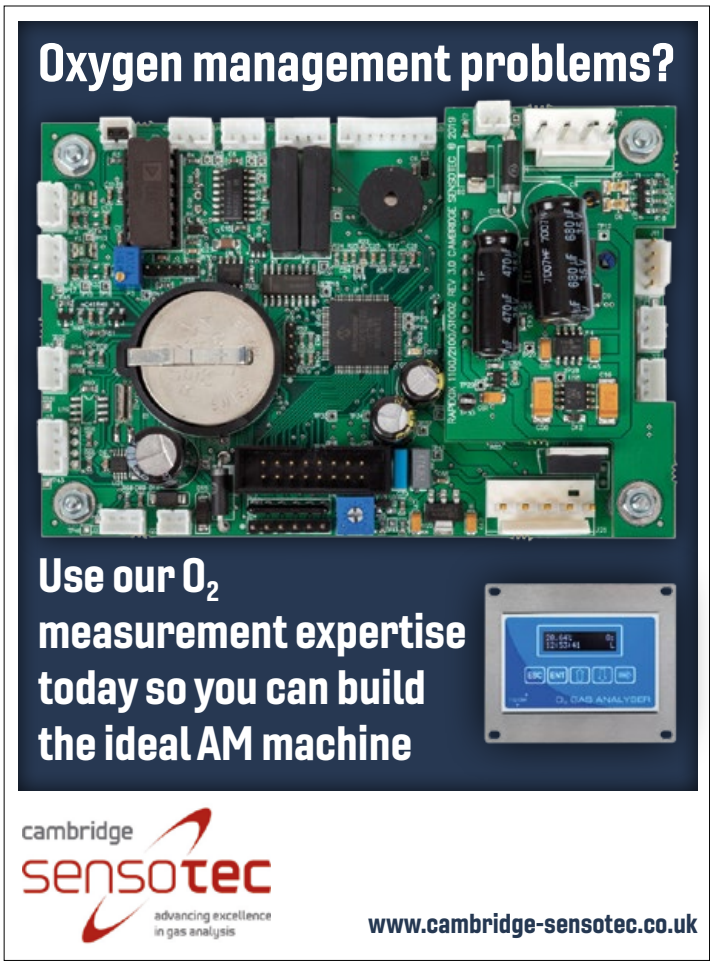
Fehrmann Alloys GmbH & Co KG, Hamburg, Germany, has added six new aluminium alloys to its portfolio, suitable for Additive Manufacturing processes. After the success of its corrosion-resistant, high-performance AlMgty80 and AlMgty90, the company has now added AlMgty70, AlMgty100 as well as standard cast aluminium AlMgty3, AlMgty5, AlMgty50 and the aluminium-zinc alloy AlZnty5.

All of the new alloys can be processed by AM, they can be polished, anodised in colour, are non-corrosive and are said to show excellent mechanical properties that are transferable across AM and casting applications.

In the development of new materials, the company states it leverages in-house expertise and technology partnerships with leading institutes such as Fraunhofer Research Institution for Additive Production Technologies (IAPT). Fehrmann Alloys has developed high-performance aluminium alloys for AM one-off or small series production, as well as for casting on an industrial scale.

Fehrmann Alloys will showcase its range of materials and services at Formnext 2021, Frankfurt, Germany, from November 16–19, on booth 12.0 C121.

www.alloys.tech



3D Systems to acquire software company Oqton

3D Systems, Rock Hill, South Carolina, USA, has announced an agreement to acquire Oqton, Ghent, Belgium, a software company that provides a cloud-based Manufacturing Operating System (MOS) platform that is tailored for flexible production environments to utilise a range of advanced manufacturing and automation technologies, including Additive Manufacturing, in production workflows. The transaction, expected to close in the fourth quarter of 2021 following regulatory approvals, totalled $180 million and comprised of cash and 3D Systems' stock. With the addition of Oqton, 3D Systems expects the run rate revenue from software to exceed $100 million by the end of 2025.

The cloud-based solution aims to leverage the Industrial Internet of Things, artificial intelligence, and machine learning technologies to deliver a new way for customers to automate digital manufacturing workflows, scale operations and enhance competitive positioning. The use of these tools, along with an agile platform, is said to allow for rapid adoption of even the most challenging production workflows such as those for dentistry, healthcare, biotech, aerospace, and automotive.

"Customers across our industrial and healthcare segments are accelerating the adoption of Additive Manufacturing into production environments," stated Dr Jeffrey Graves, president and CEO, 3D Systems. "They have increasingly identified the need for a manufacturing software platform that can easily and intelligently incorporate not only the printers themselves, but all digital production systems and key enterprise software to optimise the entire workflow, from raw material to finished and inspected components."

"The system must be flexible enough to accommodate not only today's manufacturing technologies, but also be easily adaptable to future platform changes. The Oqton MOS fills this market need by seamlessly leveraging enterprise information and data in the customer's current ERP, MES, PLM, and CRM systems, as well as the full range of shop floor manufacturing operations and software. The use of APIs to create ease of linkage between these systems is a distinctive attribute of the Oqton MOS."

"This allows customers to use their choice of manufacturing and automation equipment on the shop floor to meet their unique factory needs. Oqton's cloud-based MOS solution, with its embedded AI and machine learning capabilities, then optimises and automates these manufacturing elements in a manner that is not available today. This solution lowers the barrier to adopt AM in a transformative way – through the integration of the solution and the optimisation of the production workflow," Graves concluded.

www.oqton.com

www.3dsystems.com

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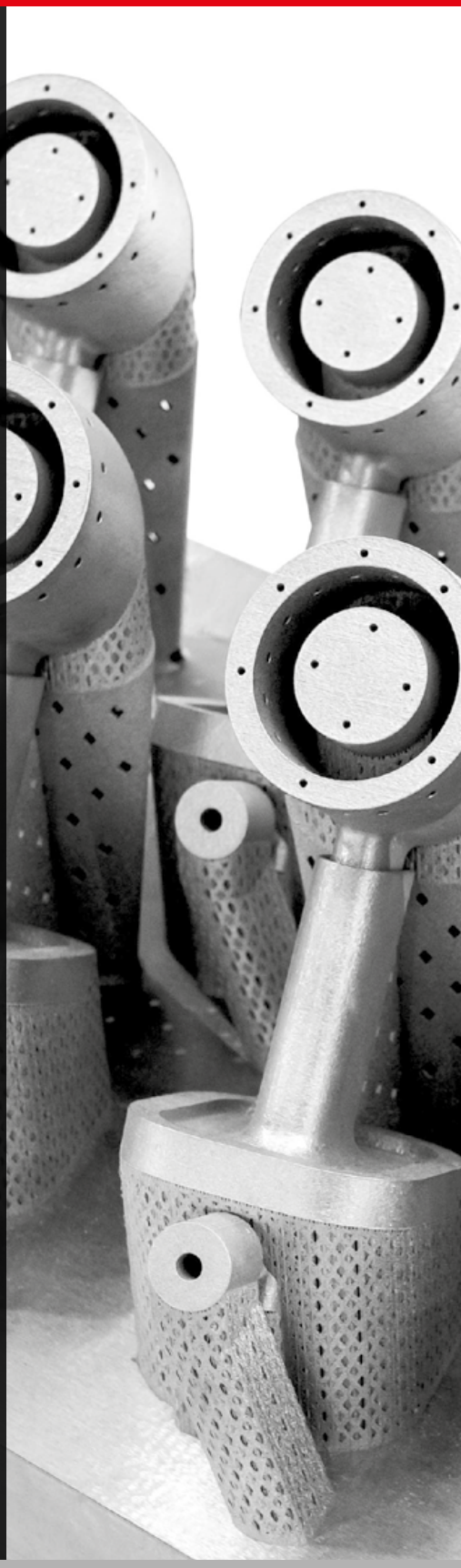

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AddUp and Kif Parechoc partner for high-precision watchmaking

AddUp, Clermont-Ferrand, France, recently signed a partnership agreement with Kif Parechoc, a subsidiary of Acrotec Group based in the Vallée de Joux, Switzerland, to use metal Additive Manufacturing in its high-precision watchmaking. Kif Parechoc supplies a range of watch movement components, such as shock-absorbing systems, ratchets and barrels, to famous names in the Swiss and European watchmaking industry.

The collaboration's first project has involved the design of a watch clasp made of low-carbon 316L stainless steel. By utilising Laser Beam Powder Bed Fusion (PBF-LB), the number of components was reduced by a factor of two compared with clasps manufactured traditionally.

"For this project, we started with a classic product, but integrated new aspects, such as lattice structures, organic shapes and recessed markings," stated Yoann Canon, Industrial Director, Kif Parechoc. "We are now working on the development of new post-treatment processes, adapted to the requirements of our industry and our production volumes. At each stage of this project, AddUp was eager to collaborate. Between their mastery of the printing process and our knowledge of the products, or their industrialisation and our finishing operations, our companies complemented each other well."

AddUp's development of its FormUp 350 AM machine, capable of using fine grain size metal powders, was said to be key to the partnership. These fine powders make it possible to produce complex parts without supports and obtain precise parts with smoother surfaces. When combined with Kif Parechoc's experience in surface treatments, it is hoped that these characteristics will give rise to parts and mechanisms that are new to the watchmaking world.

This is where the work currently being carried out by the partners could be of interest on a wider scale, it was stated. Industrialists in the micromechanics sector have been hesitant to adopt metal AM, but, if the proposed innovations of AddUp and Kif Parachoc regarding both the optimisation of the process and the post-processing are successful, this partnership could pave the way to new applications of metal AM in the watch industry, and more generally in the entire microtechnology and micromechanics industry.

www.addupsolutions.com
www.kif-parechoc.ch

The Kif Parechoc workshop (Courtesy Kif Parechoc)

3D Metalforge partners with Par Pacific to develop AM parts for oil and gas sector

3D Metalforge Pte Ltd, headquartered in Singapore, has announced that it has partnered with Par Pacific Holdings Inc, a leading oil refining company that operates three US-based refineries with a total refining capacity of 154,000 barrels per day. 3D Metalforge is working with Par Pacific in Hawaii to identify a range of parts that will be suitable for production using 3D Metalforge's Additive Manufacturing technology.

After successful field testing of the parts, and the expected adoption of API (American Petroleum Institute) standards, both companies plan to introduce AM parts into Par Pacific's regular supply chain, initially in Par Pacific's Hawaii refinery, before being expanded to the rest of the company's refineries.

Matthew Waterhouse, 3D Metalforge CEO, stated, "We are thrilled to be starting this project with Par Pacific and having an opportunity to show how our additive technology can help refineries make their operations and supply chains more robust and sustainable."

www.3dmetalforge.com
www.parpacific.com

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PyroGenesis reports Q2 2021 results

PyroGenesis Canada, Inc, Montréal, Québec, Canada, has announced its financial and operational results for the second quarter ended June 30, 2021. The company reported record revenue of CAD $8,280,572 in Q2 2021, representing an increase of 289% compared to the same period of 2020. The gross margin for Q2 2021 was CAD $4,933,481 (59.6% of revenue) compared to a gross margin of CAD $1,266,592 (59.5% of revenue) for Q2 2020. The modified EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortisation) gain in Q2 2021 was CAD $1,090,915 compared with a modified EBITDA loss of CAD $265,804 for Q2 2020. Net income from operations (not including share-based expenses) was profitable at CAD $850K, up from a reported loss of CAD $370,879 in Q2 2020.

Revenue for the six months of fiscal 2021 was CAD $14,545,075 an increase of 411% over the first half of 2020.

"We are happy to be announcing financial results for Q2 2021 and, once again, they are historical," stated P Peter Pascali, CEO and chair of PyroGenesis. "This is the fourth quarter in a row that PyroGenesis has posted more revenues in each quarter than for all of 2019, and the company is on track to exceed the record revenues of 2020. Not only is PyroGenesis posting record revenues, with an overall gross margin of 59.6%, but the company's backlog of signed contracts is increasing at the same time, which bodes well for the future. We expect this trend to continue."

Focusing on Additive Manufacturing, the company states that it continues to expect to see significant year on year improvements in its AM metal powders offering, as its NexGen™ facility, which incorporates all the previously disclosed benefits (increased production rates, lower capex, lower opex), is now online. There are said to be major top tier aerospace companies and OEMs, in both Europe and North America, awaiting powders from this new state-of-the-art production line, and PyroGenesis is currently in the process of supplying sample powders to these customers for analysis.

Regarding the financial outlook, PyroGenesis explains that it continues to be well positioned, with a clean balance sheet, to execute on all its organic growth strategies as well as to continue actively pursuing growth through synergistic mergers and acquisitions. Despite this, the company adds that it is not immune to the negative impact COVID-19 has had on businesses, specifically related to the workforce and, more importantly, the supply chain. Management believes that the company is better situated than most and is doing everything to mitigate these challenges. It does not expect any improvements from the impact of Covid before Q2 2022.

www.pyrogenesis.com

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Eplus3D installs AM machine at dental lab in North Macedonia

Eplus3D, Hangzhou, China, has installed an EP-M150 Additive Manufacturing machine at a dental laboratory in North Macedonia, a sale which follows the recent purchase of two EP-M260 by other European manufacturers.

The company explains that, as a result of the increasing accessibility of AM, the dental industry is undergoing a rapid transition from traditional industry to digital manufacturing, leveraging AM's high levels of customisation as well as benefits regarding precision, quality and cost. The EP-M150 machine will be used by the dental lab to manufacture bridges, crowns, partial frameworks, and more.

The EP-M150 is said to offer an improved powder feeding and sieving system which enables a high material utilisation rate – reportedly producing more than 550 crowns from only 1 kg of powder. It takes approximate five and a half hours to additively manufacture approximately 220 crowns, and around six and a half hours to produce a full plate of partials.

www.eplus3d.com

Sakuú Corporation to build pilot facility for solid-state batteries

Sakuú Corporation, San Jose, California, USA, has announced the commencement of a pilot facility which will produce up to 2.5 MWh of solid-state batteries per year. The facility will also serve as a customer learning centre for its Additive Manufacturing platform. Sakuú is developing technology to produce solid-state batteries that will be up to 50% smaller and 30% lighter than today's lithium-ion batteries, and less expensive to produce in high volume.

The corporation has collaborated with Relevant Industrial and Honeywell Process Solutions to aid in the design and development of Sakuú's pilot facility to produce solid-state batteries. This pilot facility will demonstrate the viability of the battery manufacturing process and enable Sakuú to deliver sample products to its early-access strategic partners. Relevant and Honeywell will provide engineering, process design, systems integration, and process manufacturing expertise to efficiently build the factory.

Relevant and Honeywell will aid in the process design by taking Sakuu's proprietary technology and scaling up the lab environment into a fully functioning pilot manufacturing plant. The second phase is expected to follow in 2022, utilising a range of Sakuú AM Platforms to mass produce up to 1 gWh of solid state batteries per year.

www.sakuu.com
www.relevantsolutions.com

One Click Metal expands to Italian market with Synergon

One Click Metal's BOLDseries will be available through Synergon in the Italian region (Courtesy One Click Metal)

Synergon, a machine products distributor, has become a sales and service provider of One Click Metal, Tamm, Germany, covering the Italian market. Through the new partnership, Synergon is expanding its Powder Bed Fusion (PBF) portfolio to meet the reported demand in the region.

One Click Metal's BOLDseries – including the MPRINT+ Laser Beam Powder Bed Fusion (PBF-LB) machine; the MPURE unpacking station, which includes a sieving unit; and the MPREP data preparation software – will be available through the Italian reseller.

Synergon is also a longstanding reseller of Index, the company holding the majority shares in One Click Metal.

One Click Metal will present its BOLDseries on a partner booth with Index at the EMO Milano 2021, a global metalworking trade fair.

www.synergon.it | www.index-werke.de
www.oneclickmetal.com

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Digital Metal launches automated depowdering station for metal Binder Jetting process

Digital Metal has added the DPS 1000 automated depowdering station for metal Binder Jetting to its AM solutions (Courtesy Digital Metal)

Digital Metal, part of Sweden's Höganäs Group, has launched the DPS 1000 depowdering machine, said to be the world's first commercial automated depowdering station for metal Binder Jetting (BJT) Additive Manufacturing. The company also announced that a renowned German research institute is one of the first to invest in the new technology, along with a complete metal Binder Jetting machine from Digital Metal.

"A key benefit of the DPS 1000 for Digital Metal customers is that it will free up time, and also bring consistency by removing the human factor from the equation," stated Alexander Sakratidis, Sales and Marketing Manager at Digital Metal.

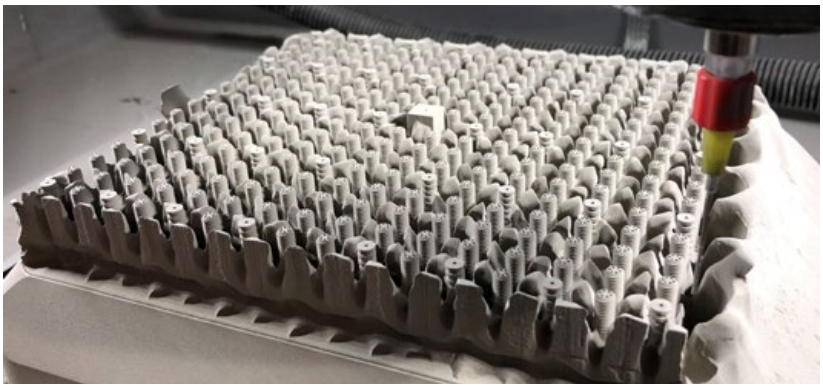
The German research institute's mission is to industrialise Additive Manufacturing technologies to create resource-efficient products for the future.

"Metal Binder Jetting will enhance productivity and precision while at the same time reducing costs of metal Additive Manufacturing, which opens the door for series production," stated the Head of AM Process Department at the institute. "However, one major technical challenge is depowdering of the green parts and we see a huge potential in working on automation solutions in this context."

The customer was said to be impressed with the DPS 1000's ability to precisely remove metal powder from most geometries of any parts, with the added manual cleaning option making it possible to clean complex components after the initial program has removed most of the powder. The institute believes automated depowdering will be key to the industrialisation of AM. "To date manual depowdering and cleaning have taken up most of the work hours in the Binder Jetting process. Automating this step makes the whole AM process cost efficient while ensuring more consistent part quality," added the Head of AM Process Department at the institute.

"With this system, we can easily test multiple different powders to enhance the print quality and make more precise predictions on the shrinking of the sintering process. It convinces with its precision, and even very delicate structures can be printed."

www.digitalmetal.tech



Metal binder jetted parts depowdered (Courtesy Digital Metal)

AMGTA establishes fund for Binder Jetting research

The Additive Manufacturer Green Trade Association (AMGTA) has established the Sustainability of Additive Manufacturing Research Fund, a $100,000 fund which will support research at Yale School of the Environment's Center for Industrial Ecology. More specifically, the fund will support researchers examining the sustainability benefits of AM using life-cycle assessment (LCA) tools and modelling.

"This new fund will be used to conduct LCA research that compares several conventionally manufactured metal industrial parts with those designed and manufactured via the binder jet Additive Manufacturing process," stated Sherry Handel, AMGTA's Executive Director.

"The goal of this research is to understand the environmental and economic impacts of Binder Jetting compared to conventional manufacturing. Using LCA tools and modelling, the research will characterise impacts related to emissions of principal greenhouse gases and other associated impacts."

"Through robust and independent research studies, the AMGTA will continue to publish research reports that evaluate environmental sustainability within the Additive Manufacturing industry," added Handel.

The research report is expected to be published in autumn 2022.

www.amgta.org

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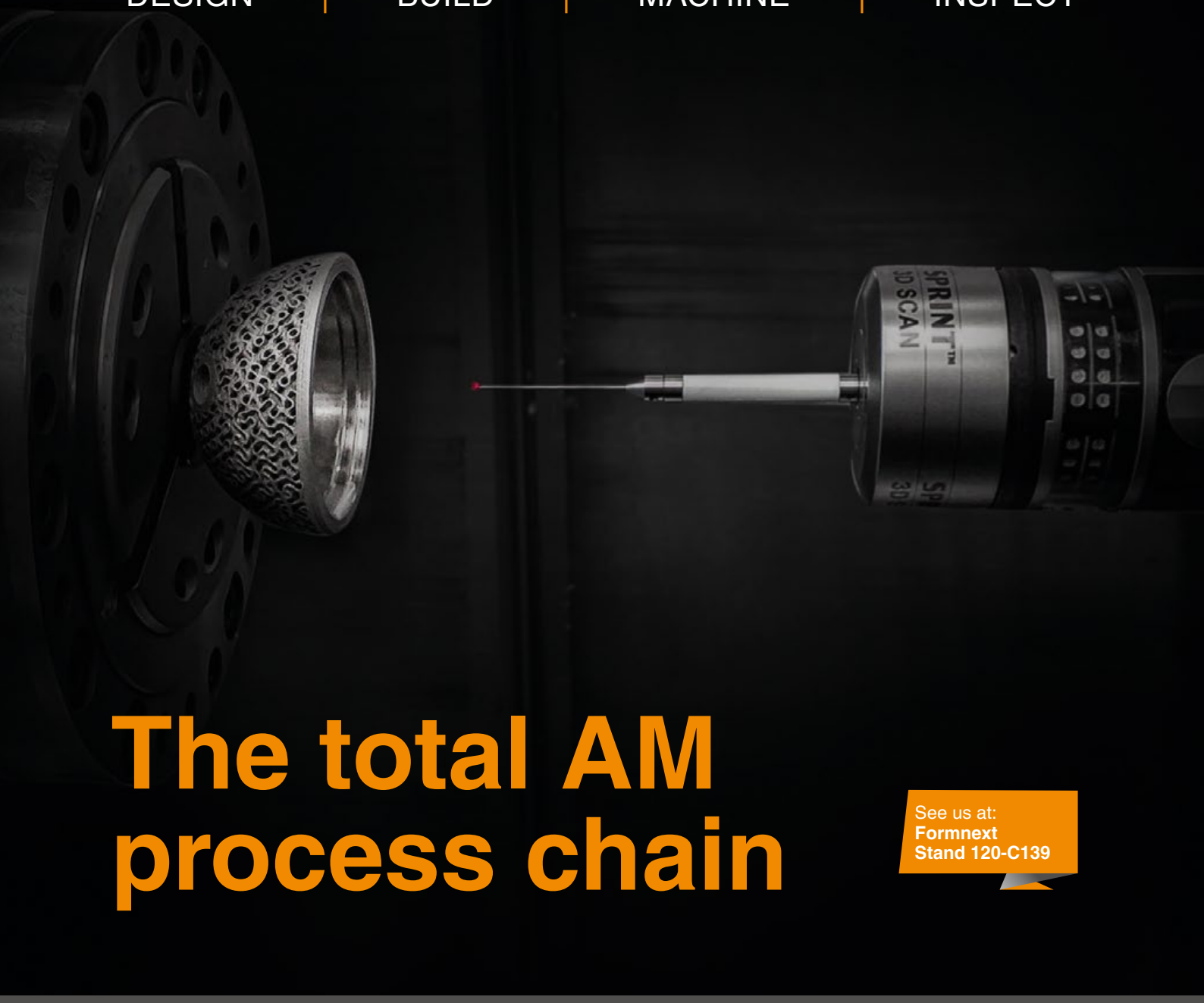

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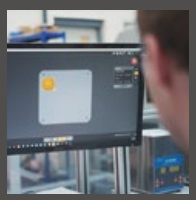

www.renishaw.com/am

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voestalpine's Q1 results show continued positive trajectory

Austria's voestalpine Group reports that it has continued along its positive trajectory in the first quarter of the 2021/22 business year (April 1–June 30, 2021). With the exception of the aerospace segment's relatively subdued performance, all of the group's market and product segments delivered positive performance. Revenue rose year over year by 45.6%, from €2.4 billion in Q1 2020/21 to €3.5 billion in Q1 2021/22. Earning also rose substantially in the current business year's first quarter: EBITDA increased by 242%, €158 million to €540 million.

The group noted that the European automotive industry was still confronted with the semiconductor supply chain problems that had started at the turn of the calendar year; consequently, some automotive manufacturers had to stop production for short periods of time. However, this did not trigger any noticeable decline in demand for voestalpine's steel products. In the US and China, the group faced relatively few semiconductor-related production shutdowns.

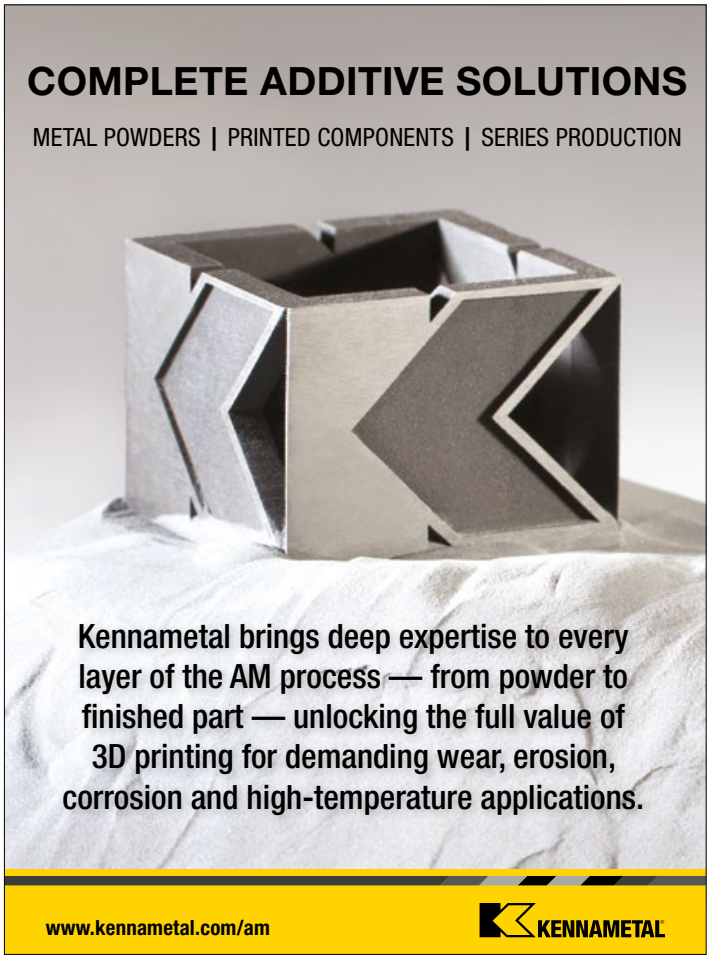
Conditions in certain segments of the oil and natural gas industry improved, but European production facilities are still reported to be affected by the protectionist Section 232 tariffs that still apply in the United States. The rail technology systems business segment continued to deliver stable performance. Orders in the storage technology business segment reached record highs due to the e-commerce boom.

While EBIT was negative (€ –49 million) in Q1 2020/21, it jumped to €340 million in Q1 2021/22. The profit before tax rose in Q1 2021/22 to €319 million (Q1 2020/21: €–74 million), and profit after tax to €259 million (Q1 2020/21: –70 million). At €272 million (Q1 2020/21: €–34 million), cash flows from operating activities also continued to develop well. The gearing ratio (net financial debt as a percentage of equity) improved year over year, from 71.7% to 43.8%. Equity rose by 8.2% to €6 billion.

Herbert Eibensteiner, chairman of the management board of voestalpine AG, commented, "voestalpine succeeded in exploiting the economic upturn that followed the previous year's pandemic-induced recession to the fullest. Almost all of our market and product segments developed very well in the current business year's first quarter, and the individual divisions delivered excellent performance."

Based on the group's results for the first quarter of the business year 2021/22 and the assumption that the current economic momentum will hold, at this time the management board of voestalpine AG expects EBITDA within a range of €1,900 to €2,200 million for the business year 2021/22.

www.voestalpine.com



3D Metalforge recertified to ISO 9001:2015 standard

3D Metalforge Pte Ltd, headquartered in Singapore, has been recertified to the ISO 9001:2015 standard by the internationally accredited certification body, DNV, a leading certification, assurance and risk management provider. The certification is valid for the Additive Manufacturing of metal and non-metallic parts and components including CAD design, production and post-production activities.

3D Metalforge states that this certification to international standards demonstrates its commitment to continuous improvement and sustainable business performance. The company hopes to continue to gain the benefits of the certification, including increases in business efficiency, greater reliable quality of processes and products, and higher levels of customer satisfaction. Additional benefits come from being recognised as a qualified supplier, required for many customer contracts, and widely used as a supply-chain requirement.

"3D Metalforge will continue to work toward providing greater value to our customers through new and innovative manufacturing solutions," stated Matthew Waterhouse, CEO. "This qualification will support us in our discussions with partners and future customers, many of whom are large international firms requiring these qualifications."

www.3dmetalforge.com

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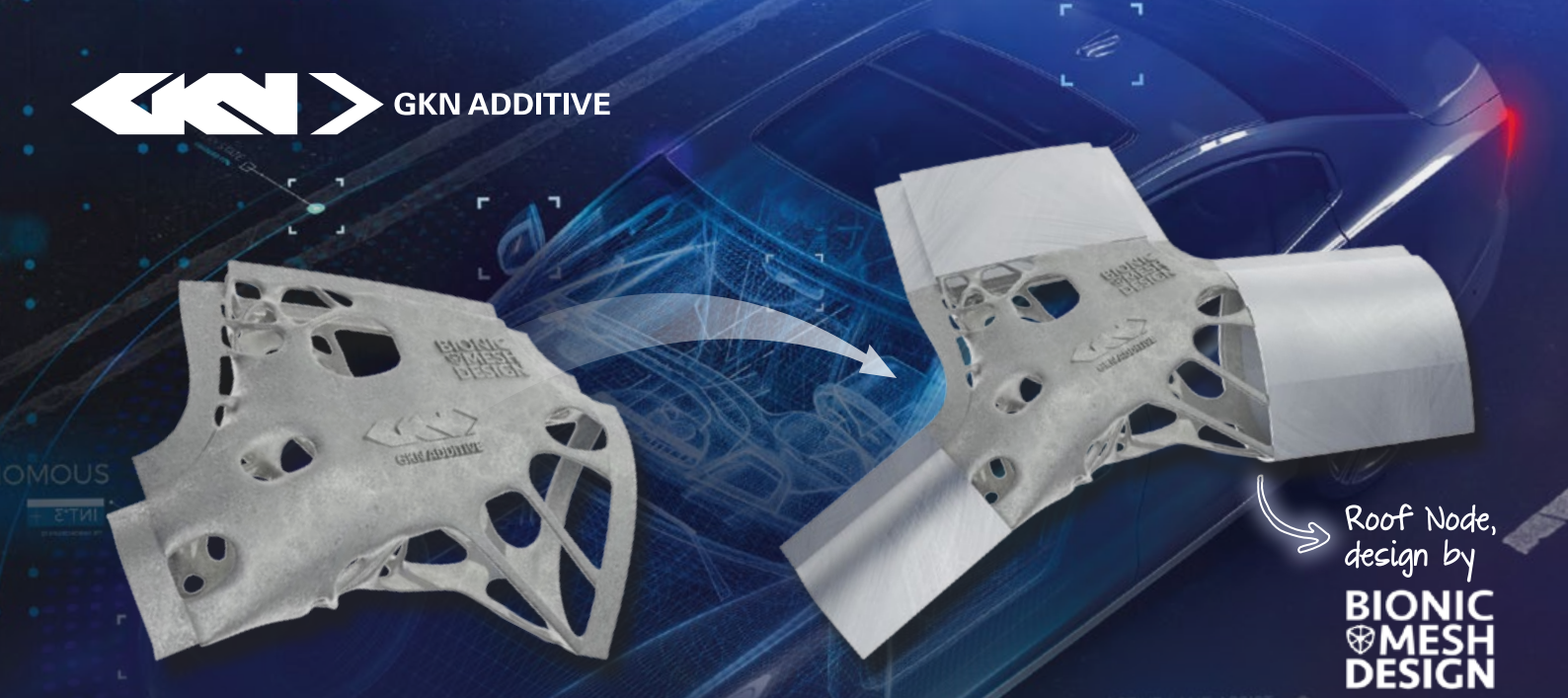

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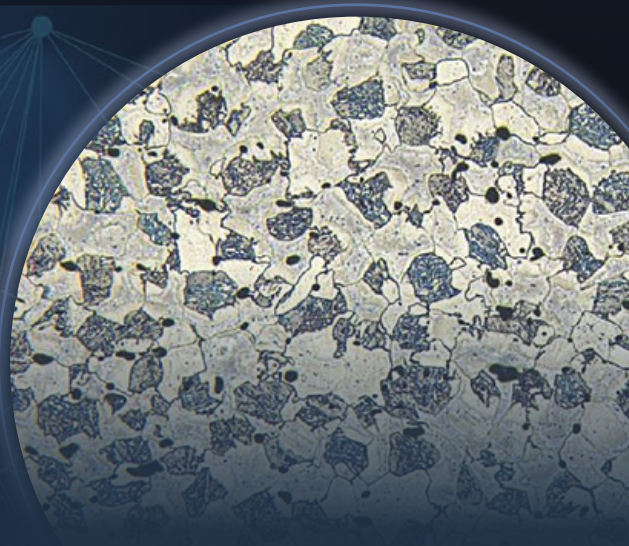

www.gknpm.com/additive

Additive Laser Technology launches two metal AM machines

Additive Laser Technology (ALT), a manufacturer of Powder Bed Fusion (PBF) machines headquartered in Dnipro, Ukraine, has launched two new Laser Beam PBF (PBF-LB) machines. The ALFA-280 is aimed at industrial applications, including both prototyping and small batch production, while the ALFA-150D is a compact machine for R&D and high-precision, short run use.

The ALFA-280 has a build envelope of 280 x 280 x 300 mm, with either single or double 500 W ytterbium fibre laser options and build rate of up to 50 cm^3/hour. The ALFA-150D has a build envelope of 150 x 150 x 180 mm, with a single 200 W laser and build rate of up to 25 cm^3/hour. Both machines can be easily tailored specifically for customer's needs as a bespoke solution for the most sophisticated technological challenges.

Additive Laser Technology has launched the ALFA-150D (left) and ALFA-280 (right) (Courtesy Additive Laser Technology)

ALT's machines can be used to process a range of metal powders, including Inconel 718 nickel alloy for high-temperature applications and Ti6Al4V titanium alloy for high strength and corrosion-resistant applications. Other qualified materials include 316L stainless steel, AlSi10Mg aluminium alloy and CoCr cobalt-chrome alloys.

Complementing its new metal AM machines, the company also offers a range of vacuum powder removal units and automated powder sieving systems.

"We are proud to be the first Ukrainian manufacturer of Laser Beam Powder Bed Fusion Additive Manufacturing machines," stated Evgeny Zhykh, co-founder of ALT. "After successfully testing the ALFA-150 and ALFA-280 at both research and industrial level, we are at a stage to offer the new machines to the international market."

www.alt-print.com

GF Additive obtains Nadcap, EN 9100 and ISO 9001 recertification

GF Additive, also known as the GF AMotion Center, located in Novazzano, Switzerland, reports that it has obtained three recertifications for its outstanding quality management system. The recertifications include Nadcap, EN 9100 and ISO 9001:2015.

Nadcap, formerly known as the National Aerospace and Defense Contractors Accreditation Program, is a company-level accreditation based on specific processes used by aerospace suppliers such as heat treatment, conventional machining and welding among others. It proves that a company meets the highest quality requirements with regard to special processes in the aerospace industry. Nadcap accreditation is conducted based on specific criteria and by highly qualified inspectors, as aerospace is a very sensitive industry where special requirements are placed on the products.

The Georg Fischer company explains that, in addition to the customers, the aviation authorities also set high standards, therefore GF has not only to display its strengths but also has to be aware of any safety risks of its products and always try to reduce them to a minimum. For this reason, GF Additive is said to be one of only six companies worldwide that hold this accreditation according to checklist 7110/14.

GF states that it passed the EN 9100 certification with top marks in terms of improvement potential and without any deviations from the quality guidelines. Similar to Nadcap, EN 9100:2018 is an international standard for design, development, production, assembly and maintenance for the aerospace industry. The EN 9100 certificate represents the modern definition of quality, and aims to ensure the safety, reliability as well as the quality of the products.

The ISO 9001:2015 standard indicates the sustainable and systematic market positioning of the company, whereby the demonstrably fulfilled requirements should lead to the development of trust and image enhancement among customers and stakeholders. It is based on four fundamental principles that are applicable to all organisations, regardless of type, size or product: process orientation, risk management, continuous improvement and orientation to customer satisfaction. The certificate is internationally valid and recognised worldwide through the IQNet partnership.

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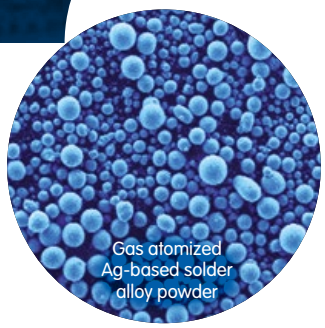

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Sigma selected by DMG Mori as official in-process quality assurance

Sigma Labs, Inc, Santa Fe, New Mexico, USA, has been selected by DMG Mori, headquartered in Bielefeld, Germany, as the official supplier of In-process Quality Assurance (IPQA) monitoring systems for its DMG MORI Qualified Products (DMQP) programme. This will enable DMG Mori to build all of its LASERTEC Additive Manufacturing machines 'PrintRite3D Ready', and offer this integrated solution as a factory option.

This official supplier designation further solidifies an agreement between the two companies in 2020, wherein DMG Mori selected Sigma Labs as its preferred melt pool monitoring system for its LASERTEC Laser Beam Powder Bed Fusion (PBF-LB) machines.

"This continuous invention will lead to increasing sales numbers for the PrintRite3D system. We expect high customer interest in this Melt Pool Monitoring system, as it offers a great possibility to deeply monitor the process quality by the customer," stated Friedemann Lell, Managing Director at DMG Mori Additive GmbH.

The DMQP programme aims to generate synergies out of machines, peripherals and accessories via combined technological knowledge from partners who have been awarded the premium seal of quality for their products.

"It is an honour to be selected to participate in DMG Mori's DMQP programme, significantly expanding and deepening our partnership," stated Mark K Ruport, president and CEO, Sigma Labs. "Manufacturers around the world will now be able to source the integrated solution from DMG Mori directly and be assured that it meets the highest standards of quality and support. This relationship allows Sigma Labs to leverage the vast sales and support capabilities of DMG Mori and expand our global reach."

Dr Guido Adam, Head of Design, DMG Mori Additive, concluded, "Implementing Sigma Labs' Melt Pool Monitoring Solution PrintRite3D into the DMQP programme for our LASERTEC SLM machines is an important step in providing best in class industry solutions to our customers. This is an important milestone for our cooperation and the implementation of the PrintRite3D system into our DMQP programme is a strong sign not only for Sigma Labs, but also for our customers – and it will not be the last."

www.dmgmori.com
www.sigmalabsinc.com

DMG Mori's AM machines will be 'PrintRite3D Ready', with Sigma Labs' technology offered as an integrated factory solution (Courtesy DMG Mori)

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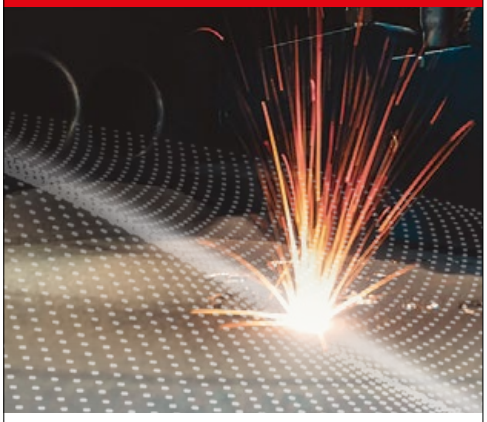
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AdvancedTek made distribution partner for EOS metal AM machines

AdvancedTek, St. Paul, Minnesota, USA, a provider of polymer Additive Manufacturing technologies and complementary solutions, reports that it has been made a distribution partner for EOS metal AM machines and will market the range across Minnesota, Wisconsin, Iowa, Nebraska, North Dakota, and South Dakota.

EOS GmbH, headquarted in Krailling, Germany, offers AM solutions for both metal and plastic. Its metal AM machines are based on the Laser Beam Powder Bed Fusion (PBF-LB) process which the company refers to as Direct Metal Laser Sintering. EOS's material portfolio currently includes more than twenty alloys and over seventy validated processes suited to a range of industries such as aerospace, automotive, medical, tool and turbomachinery.

"The metal printing industry offers a growing range of solutions, but, at the end of the day, our customers are looking for the reliability, repeatability and reputation that EOS has brought to the table since 1989," stated Matt Havekost, vice president of Sales, AdvancedTek. "We are committed to partnering with companies that can help drive real applications and real benefit to their operations with well vetted solutions and materials from established manufacturers."

AdvancedTek states that it will offer the full line of EOS metal AM machines including the small and medium EOS M 100 and EOS M 290, and the larger production platform systems EOS M 300-4, and the EOS M 400 Series.

Andrew Snow, senior vice president at EOS North America, commented, "While industrial 3D printing is still relatively new for many organisations, the acceptance and adoption of metal Additive Manufacturing in industries such as space tech, medical, and tooling industries continues to accelerate. Key to this acceleration are organisations that have a deep understanding of how best to apply AM technology, and that is why I am so thrilled with our new partnership with AdvancedTek."

www.advancedtek.com
www.eos.info

AdvancedTek will offer the full line of EOS metal AM machines including the EOS M 400 Series (Courtesy EOS GmbH)

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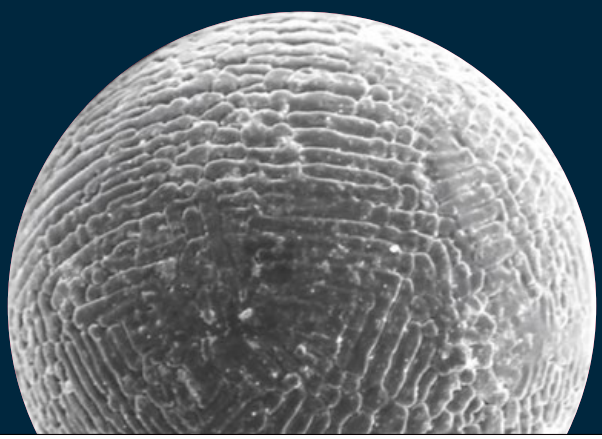

Aerojet Rocketdyne completes facility expansion to ramp up production of RS-25 engines for NASA

Aerojet Rocketdyne, Los Angeles, California, USA, has completed a $59 million expansion of its Los Angeles facility in order to support the production of new-generation RS-25 main engines, which feature metal additively manufactured components, for NASA's Space Launch System (SLS), which aims to send astronauts to the Moon by 2024.

The expansion includes renovations to existing buildings and an additional 2,787 m^2 of manufacturing space, four new Laser Beam Powder Bed Fusion (PBF-LB) machines, and new testing and storage facilities that include nondestructive inspection equipment and a new horizontal vacuum furnace for brazing exotic engine materials.

NASA's SLS will launch crews of up to four astronauts aboard the agency's Orion spacecraft. Together, SLS and Orion are the foundational hardware elements of NASA's Artemis programme, which aims to put the first woman and first person of colour on the Moon. Each SLS first stage will be powered by four RS-25 engines generating more than two million pounds of combined thrust.

"This expanded facility will serve NASA's human exploration requirements for decades to come," stated Eileen P Drake, Aerojet Rocketdyne CEO and president. "We've added state-of-the-art manufacturing capabilities and other features to produce large RS-25 engine components more efficiently and economically."

www.rocket.com

The cutting ribbon ceremony marked the completion of Aerojet Rocketdyne's facility expansion. Left to right: Jim Maser, Sr, vice president of Space at Aerojet Rocketdyne; Johnny Heflin, Manager of NASA's Space Launch System Liquid Engines Office; Eileen P Drake, Aerojet Rocketdyne CEO and president; Congressman Brad Sherman (D-CA); Dr Paul McConnaughey, Senior Advisor, NASA Human Exploration and Operations Mission Directorate; and Fernando Vivero, Aerojet Rocketdyne Los Angeles Site Lead (Courtesy Aerojet Rocketdyne)

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Tescan releases micro-CT system for quality assurance of AM parts

Tescan Orsay Holding a.s., Brno, Czech Republic, has released its UniTOM HR, reportedly the first dynamic micro-CT system to offer sub-micron-resolution 3D non-destructive imaging for static studies and high temporal resolution for uninterrupted 4D dynamic CT experiments.

UniTOM HR is suited to both industrial and academic applications that need micro-CT imaging to visualise a sample's internal structure and also want to gain a deeper understanding of a sample's behaviour under certain environmental conditions. This is especially useful for failure analysis and quality assurance of additively manufactured parts.

UniTOM HR can characterise newly developed materials at what is said to be the highest possible micro-CT spatial resolution, a requirement for sub-micron scale static 3D imaging. It can also provide researchers with a better understanding of how these new materials, and functional components created from these materials, will behave under changing conditions through real-time, not time-lapse, visualisations. This capability is said to set UniTOM HR apart from other micro-CT instruments on the market.

"Tescan's dynamic micro-CT portfolio brings fast dynamic CT imaging from the cutting-edge synchrotron to the mainstream laboratory," stated Marijn Boone, Product Manager. "UniTOM brings together the most sought-after micro-CT capabilities, giving researchers a versatile solution that covers a broad range of 3D imaging and in-situ applications, handles a variety of sample shapes and sizes, and enables 4D time-resolved dynamic experiments."

Tescan has released the UniTOM HR, said to be the first micro-CT system to offer sub-micron-resolution 3D non-destructive imaging for static studies (Courtesy Tescan Orsay Holding a.s.)

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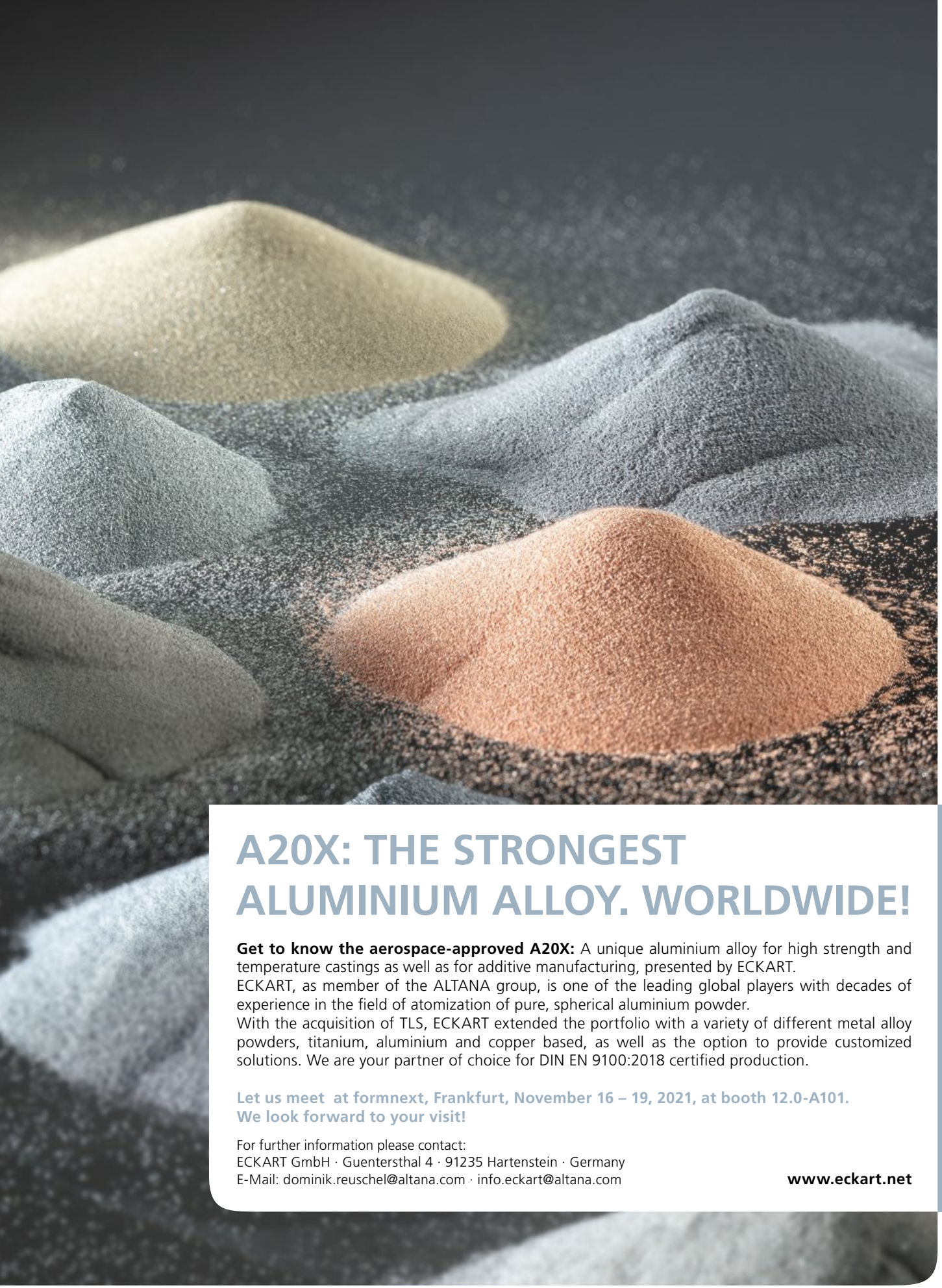

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Alex Cappy appointed vice president and CEO of Hubs

Protolabs, Maple Plain, Minnesota, USA, has named Alex Cappy the new vice president and CEO of Hubs effective October 1. Hubs is a leading online manufacturing platform that provides engineers with on-demand access to a global network of premium manufacturing partners. It was acquired by Protolabs in 2021.

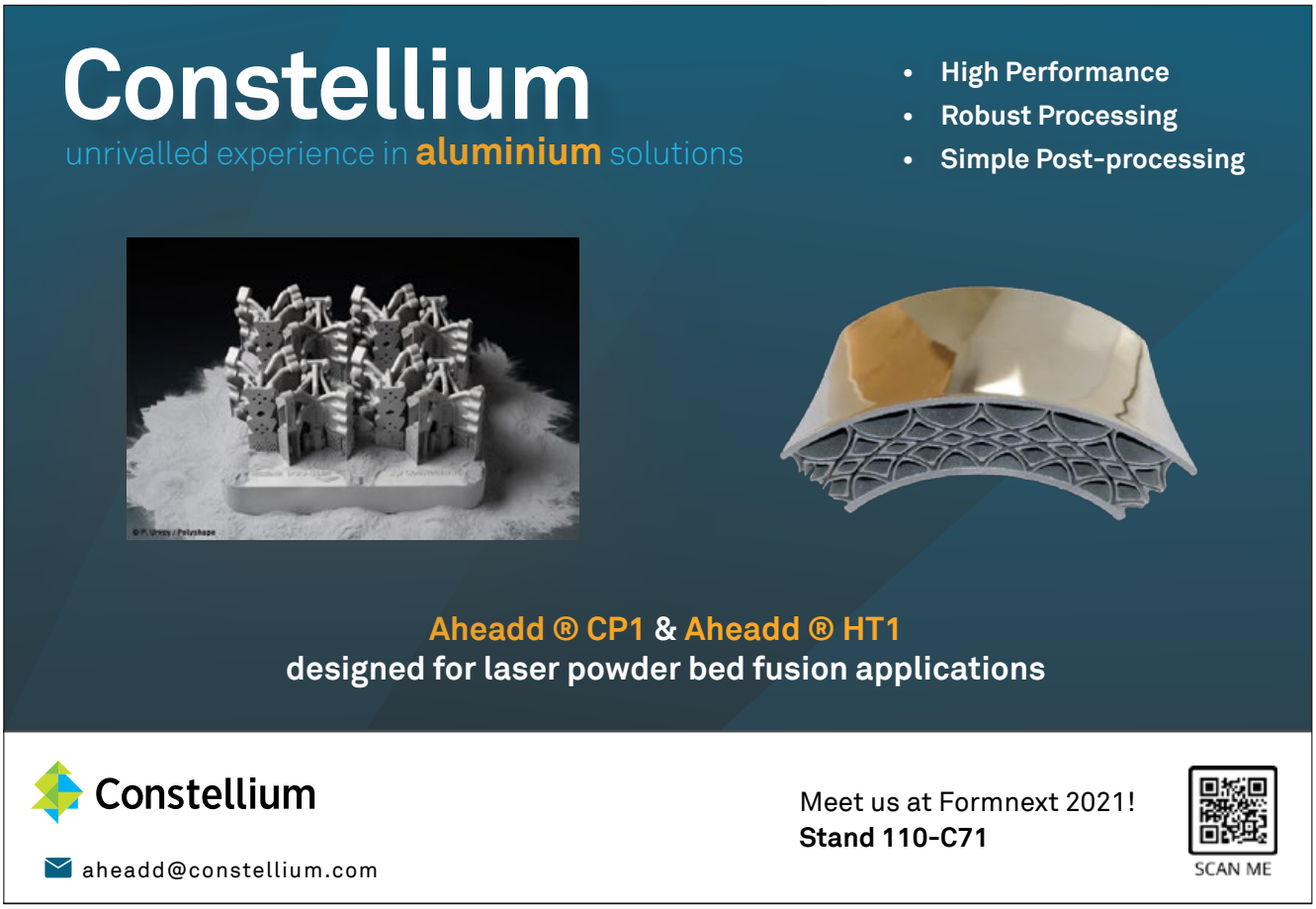
Cappy previously held the role of Chief Operations Officer at Hubs since 2019 where she oversaw the growth and performance of the company's manufacturing partner network, all order fulfilment processes, and customer- and supplier-facing support teams. As part of the transition, Cappy will also be joining the Protolabs executive leadership team. Her predecessor, Bram de Zwart, will take on the role of Head of Innovation at Hubs.

Prior to Hubs, Cappy's experience spanned startups, scale-ups, supply chain, and digital innovation with large corporations. She was an early employee in Uber's UK business, where she led the UKI Operations team and was responsible for taking the market through a phase of exponential growth. Cappy's other scale-up experience includes Deliveroo (food delivery) and ofo (bike-sharing). She has also worked with a number of large companies while she was a consultant with McKinsey & Company, based in the NYC, London, and Amsterdam offices, and as a supply chain analyst with Gartner. Cappy holds a BA from Vanderbilt University and an MBA from Wharton.

"I'm excited to welcome Cappy to the Protolabs leadership team and congratulate her on her promotion to vice president and CEO of Hubs," stated Rob Bodor, CEO of Protolabs. "Cappy has played an instrumental role in Hubs success and I am confident that will continue with her expanded responsibilities. I also want to thank Bram for his vision and leadership of Hubs over the past eight years. It is remarkable what Hubs has become under his guidance, and I look forward to continuing to work with Bram in his new role."

Cappy commented, "I am thrilled to take on this new role with Hubs, as we head into our next phase of growth as part of the Protolabs family. In my time with Hubs, I have been consistently impressed with the innovation and hustle our team has shown, and know it will enable us to continue to do great things. Now, paired with Protolabs, we are uniquely positioned to be the strongest player in the digital manufacturing space. I can't wait to see what the future holds!"

www.hubs.com
www.protolabs.com



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Kennametal offers its most corrosion-resistant tungsten carbide grade for AM

Kennametal Inc., Pittsburgh, Pennsylvania, USA, has launched KAR85-AM-K, its most corrosion-resistant tungsten carbide grade for metal Additive Manufacturing. KAR85-AM-K is reported to combine the wear performance of conventional tungsten carbide with the design flexibility of AM to produce high-performance parts for oil and gas, power generation and other demanding applications.

Combined with Kennametal's Binder Jetting (BJT) Additive Manufacturing capabilities, KAR85-AM-K is said to provide corrosion and wear resistant properties comparable to conventional CN13S grade. The company stated that components made with the new material are already in field trials with select customers.

"Kennametal is leading the way in tungsten carbide Additive Manufacturing by combining the superior wear and corrosion resistance of our new KAR85-AM-K grade with deep expertise in binder jet 3D printing," said Jay Verellen, General Manager, Kennametal Additive Manufacturing. "With this new grade, we're delivering the best of both worlds for our customers — the highly desirable material properties of conventional tungsten carbide with the design flexibility of additive — for high performance components that go the distance in the most demanding applications."

The new grade composition features a proprietary blend of cobalt, nickel, and chromium for improved corrosion resistance compared to standard cobalt-based tungsten grades. It is Kennametal's second commercial carbide grade developed for use in its BJT processes and the latest addition to the business's portfolio of high-performance metal powders optimised for AM.

Kennametal Additive Manufacturing, the company's AM business unit within its Infrastructure segment, offers comprehensive solutions, from raw material to finished part. The business develops carbide, cobalt, nickel and iron powders, including Stellite™ alloys, optimised for specific Additive Manufacturing processes. At Kennametal's research and development, prototyping and production centre in Latrobe, Pennsylvania, the business utilises Laser Beam Powder Bed Fusion (PBF-LB) and BJT technologies, combined with post-processing capabilities, to produce fully finished components for customers.

www.kennametal.com

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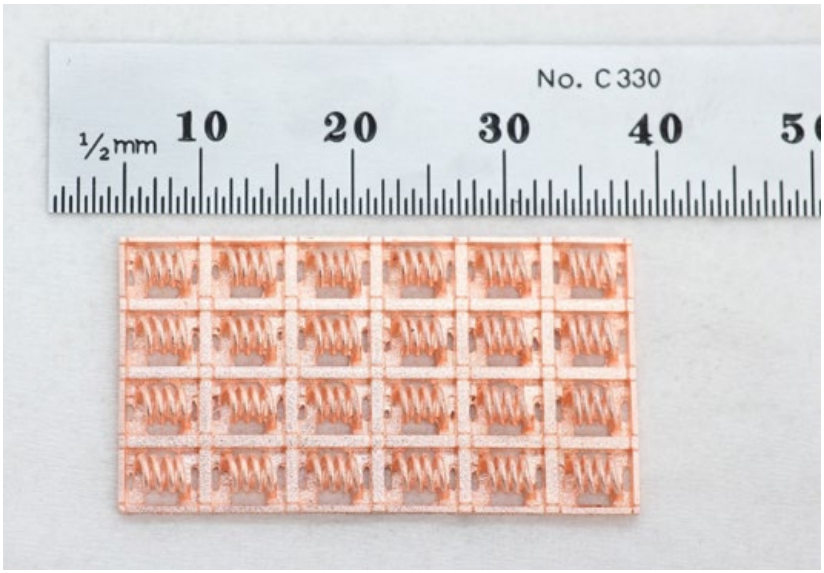
Holo launches high-resolution PureForm MicroAM platform

Holo, a metal Additive Manufacturing company headquartered in Newark, California, USA, has launched PureForm™ MicroAM, a high-resolution Additive Manufacturing platform capable of processing copper, stainless steel and other metals.

Based on a Vat Photopolymerisation (VPP) process, PureForm MicroAM can produce parts with features measuring less than 50 µm, enabling a wide range of applications including electrical components, jewellery, and medical and dental devices.

"Traditional manufacturing approaches, such as Swiss CNC, moulding and casting, are either too costly for volume production or cannot produce complex parts with such fine features," stated Hal Zarem, Holo's CEO. "PureForm MicroAM enables our customers to access parts at a lower cost and produce geometries that cannot be made any other way."



Micro inductor coils additively manufactured in a twenty-four piece array. Twenty such arrays can be additively manufactured simultaneously on one Holo PureForm AM machine (Courtesy Holo)

Holo introduced its PureForm technology earlier this year, and is ramping up its production facility in the San Francisco Bay Area, where it has capacity to produce tens of

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thousands of parts per month. PureForm MicroAM is already said to have unlocked capabilities for customers in the electronics industry, producing fine-featured micro inductor coils built with 400 µm strands, and in high-end custom jewellery.

Simon Evans, Senior Manager, Diamond Centre Wales, commented, "We've been blown away by the resolution and surface quality of the parts Holo can produce, and are excited to explore the direct metal printing of jewellery with them. Leveraging the design freedom of additive and the fine features of PureForm will allow us to create truly unique, custom pieces for our clients that couldn't be made using other manufacturing processes."

Other AM applications that have been enabled by PureForm MicroAM include stainless steel biopsy scoops used in medical applications, with sharp point features down to 20 µm and dental abutments with additively manufactured functional threads that hold a 200 µm pitch.

Arian Aghababaie, co-founder and Chief Strategy Officer, Holo, added, "We are excited to continue to offer new capabilities to our customers, enabling us to support a host of new MicroAM applications, from surgical equipment and dental, to micro-electronics, micro-robotics, consumer electronics and jewellery."

A ring and setting designed by Diamond Centre Wales that takes advantage of the design innovations enabled by PureForm (Courtesy Holo)

Series B investment

In addition to introducing its Pure-Form MicroAM, Holo has added two new investors, Lam Capital and Atreides Management, to its Series B investment round. The round included participation from existing investors Prelude Ventures, Tao Capital Advisors and Lightspeed Venture Partners.

Upon the closing of its latest financing round, Holo states that it plans to grow significantly in 2021 and 2022, doubling the size of the company, accelerating the development of its 3,000 cm^3/hr high throughput production system and continuing to expand its materials portfolio.

Spun out of Autodesk in 2017, Holo was co-founded by the team that developed and led Autodesk's Ember Additive Manufacturing product.

www.holoam.com

Advertisers' index & buyer's guide

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Optomec adds 7000 series aluminium to its list of qualified alloys

Optomec Inc, Albuquerque, New Mexico, USA, has added 7000 series aluminium to its growing list of qualified alloys for use in its LENS metal Directed Energy Deposition (DED) Additive Manufacturing machines.

Manufacturers in many industrial and aerospace segments require 7000 series aluminium, as it possesses the highest strength of all the aluminium series alloys and is commonly used in high-stress parts such as aircraft landing gear components. The new alloy capability is enabled by Optomec's latest laser optics solution – now standard in all of its LENS machines – that allows the size and profile of the laser-heated region to be remotely adjusted for a particular alloy. This is said to be an industry first.

Different metals and alloys require different sets of process parameters, referred to as process recipes. Depending on the alloy, it can take months of experimentation to optimise a recipe for a new alloy, including powder screening, process development and tuning, sample production, mechanical testing, metallurgical analysis, etc.

In an effort to save time and development cost, Optomec offers qualified process recipes for a wide range of common alloys including basic steels; titanium; Inconel and other superalloys; corrosion-resistant alloys; wear coatings; thermal barrier coatings; thermal-conduction alloys such as copper; and these new aluminium alloys, including 7000 series.

Recipes are available for a range of manufacturing scenarios, including thin-walled, high-resolution and bulk deposit versions, as 'starter recipes', or it can develop part-specific production recipes for specific end-user geometries upon request. Further, Optomec is developing 'Print Libraries' that include build geometry for specific common LENS applications, such as turbine blade repair.

"We can develop new material recipes much faster now," stated Lucas Brewer, head of Optomec's Applications Engineering Group in Albuquerque. "Our new deposition head technology is really the key to getting the DED process to print these new alloys in a repeatable way for our production customers. It's opened up a ton of new applications for metal Additive Manufacturing."

www.optomec.com

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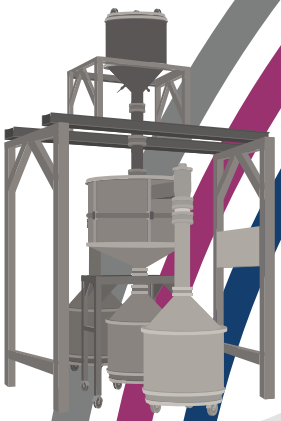

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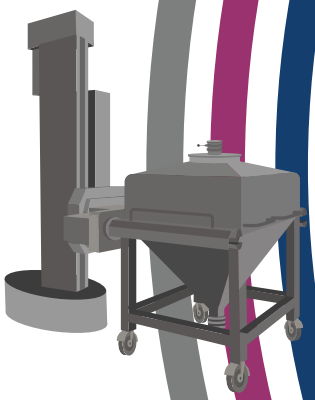

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Desktop Metal qualifies Ti6Al4V and 316L stainless steel

Desktop Metal, Inc, Burlington, Massachusetts, USA, has qualified the use of titanium alloy Ti6Al4V for its Studio System 2™ and 316L stainless steel for its Shop System™.

The Studio System 2 is a Material Extrusion (MEX)-based AM machine aimed at low-volume, pre-production and end-use applications. The company believes that it is the first company to make the material commercially available for MEX.

Ti6Al4V is the most widely used titanium alloy due to its high tensile strength, corrosion resistance and biocompatibility. With a high strength-to-weight ratio, Ti6Al4V is considered an ideal material for high-performance production applications in industries such as aerospace and defence, automotive, and oil and gas. In addition, its biocompatibility makes it particularly desirable in medical applications, such as for surgical devices and implants.

"Titanium has been a challenging material for bound metal 3D printing because it is both extremely reactive in powder form and difficult to sinter," stated Jonah Myerberg, co-founder and CTO of Desktop Metal. "We are excited to be the first to commercialise the most common titanium alloy, Ti6Al4V, for 3D printing through our Studio System 2 solution, opening the door to more accessible production of high-performance titanium parts."

Tensile properties include 730 MPa yield strength, 845 MPa ultimate tensile strength, and 17% elongation. These mechanical properties exceed those set by ASTM F2885-17 standards for MIM surgical implant applications.

Desktop Metal's Shop System is a metal Binder Jetting (BJT) machine designed for use in machine shops. Known for its corrosion resistance, high ductility, and excellent mechanical properties at extreme temperatures, 316L stainless steel is an austenitic stainless steel that is well suited to demanding environments and applications, such as parts exposed to marine, pharmaceutical, or petrochemical processing, food preparation equipment, medical devices, surgical tooling, and consumer products such as jewellery.

"The launch of 316L for the Shop System is a part of an aggressive and extensive materials roadmap to broaden our AM 2.0 portfolio and address a rapidly expanding set of use cases for our print platforms," added Myerberg. "We are fully focused on developing opportunities for our customers to produce parts competitively with conventional manufacturing, and we are excited to be able to extend our binder jetting technology to meet this need and address key existing and emerging killer applications for 316L in the market."

www.desktopmetal.com

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- Others

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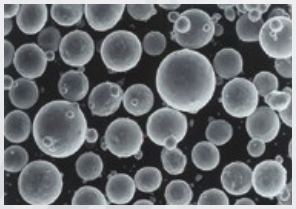

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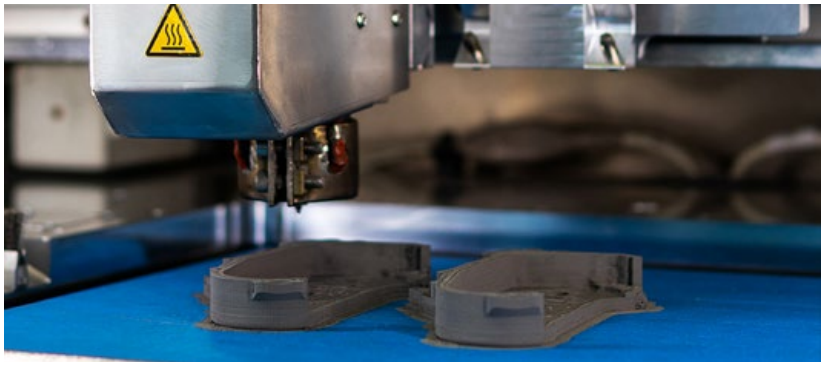
AIM3D offers new, quicker multi-material extruder



The CEM-E2 extruder allows manufacturing rates of up to 220 cm³/h with a 0.4 mm nozzle (Courtesy AIM3D)

AIM3D GmbH, a spin-off company of the German University of Rostock, has released a new generation of print heads for its Material Extrusion (MEX) process, which it calls composite extrusion modelling (CEM). The new CEM-E2 extruder is a multi-material Additive Manufacturing print head that can process metal (version 'M'), ceramics ('C') and plastics ('P'). The new extruders are reported to offer improvement in accuracy, enabling a higher surface quality and better mechanical properties in the component. Extrusion speed has been increased by more than 200%, with manufacturing rates of up to 220 cm³/h with a 0.4 mm nozzle now possible.

"The material feed, as well as an optional water cooling system and an improved holder for the quick-change system, are all new developments," stated Clemens Lieberwirth, CTO. "The patented CEM-E2 extruder with its parameters tailored to specific materials sets new standards in the CEM processes."

The appeal of CEM technology lies in the use of an AM machine for multiple materials. In addition, cost savings can be achieved by dispensing with filaments in favour of conventional pellets used. The most significant benefit, however, is said to be in the reduction in component build times through the direct use of pellets.

AIM3D is currently developing larger pellet AM machines in order to be able to manufacture larger parts and achieve even higher build rates. The launch of these is planned for Formnext 2021 in Frankfurt, Germany.

www.aim3d.de

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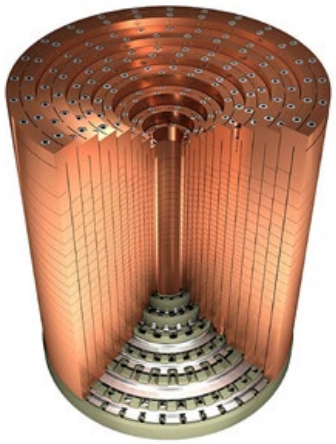
Safina's copper powder used in one of the world's strongest magnets

Over its 100-year history, Safina, Vestec, Czech Republic, has established a strong position in the processing and manufacturing of precious and non-ferrous metal products such as thermocouple wires, PGM wires, plates and tubes, spray targets, laboratory supplies, chemicals, metal powders and more.



A Safina customer credits its copper powder quality with the success of a 35 tesla magnet (Courtesy CNRS/ Bertrand Maclet)

Now, with the company's adoption and development of cold spray Additive Manufacturing, it is enabling its customers to produce high-power magnets. There are reported to be only four companies in the world able to operate with steady high magnetic fields, and one of them is a customer of Safina based in France. This customer is reported to have achieved a record induction of a magnetic field of more than 35 tesla, making it one of the strongest magnets in the world.

The internal electro-magnet was made of fourteen polyhelices, allowing a very high magnetic field in a series of parts which have to support thermal and mechanical constraints (up to 440 MPa and 170°C). With cold spray Additive Manufacturing it is possible to achieve higher properties than possible with forging (with forging, there is a limitation of yield strength and electrical conductivity). The higher properties allow the installation to increase the available magnetic field for researchers.

Such a high magnetic field is made possible by running up to 30,000 A per cm² in the helices, with AM enabling a cooling system to be integrated. It is also possible to tune several properties, such as yield strength and electrical conductivity, with different heat treatments.

Safina helped the company develop a bespoke copper powder based on very specific customer requirements. It was the ability to supply a metal powder from the alloy, in such a high quality, which was said to enable the customer achieve such a high magnetic field induction.

The magnet has since been used by research institutions and universities for various physical experiments, such as understanding the processes of magnetic fields in space.

www.safina.cz

Cumberland Additive receives $5 million investment from Hunting

Hunting PLC, an international energy services group, has announced its investment of $5 million in Cumberland Additive Holdings LLC (CAH), Pflugerville, Texas, USA, to become a 27% holder in the company. The parties agreed to certain customary minority rights and obligations in connection with the investment, including representation on its board of directors.

Cumberland offers Additive Manufacturing design services and production of parts in both metal and polymer materials using Powder Bed Fusion (PBF) technology. The company holds AS9100D and ITAR accreditations, supporting customers in the aerospace, defence, space, oil & gas and energy sectors which demand strongly quality assured components to operate in high-performance environments.

Cumberland occupies a 2,800 m² facility at its Texas location and is in the process of establishing a second facility in Pittsburgh, Pennsylvania, which is intended to improve supply chain efficiency. Hunting's investment allows it access to the fast-growing AM sector, which is increasingly being adopted by many of the group's current oil & gas clients, while also providing opportunities for Hunting to enter new sectors complementary to the group's current customer profile.

Dawne Hickton, chair and Lead Investor of Cumberland, stated, "The investment by Hunting will assist CAH in achieving its growth ambitions, while providing new customer opportunities through their global operating footprint."

www.cai-3d.com
www.huntingplc.com

KAM expands to include twenty-one AM machines

Keselowski Advanced Manufacturing (KAM), Statesville, North Carolina, USA, has added a third SLM 280 from SLM Solutions, Lübeck, Germany, expanding its fleet to include twenty-one Additive Manufacturing machines.

Including the three SLM 280 machines, KAM also has an SLM 800 Quad Laser machine, two EOS M 400-4s, one EOS M 290, thirteen EOS M 280 models and a GE Concept Laser M2. The company's material options include aluminium 6061, AlSi10Mg, Ti6Al4V, maraging steel, stainless steel 17-4PH & 316L and Inconel 625 & 718.

The company also offers a full complement of three to seven-axis CNC machining, CT/X-ray, full metrology and an on-site laboratory.

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FARSOON TECHNOLOGIES

CSIRO develops low-cost titanium wire from scrap for use in AM

Australia's national science agency CSIRO, based in Melbourne, has announced that it has developed a novel process for turning inexpensive alloy waste into a high-value wire product suitable for the Additive Manufacturing market. The research team has used the process to produce titanium wire, and states that it is the first in Australia to produce wire with this method.

Dr Robert Wilson, CSIRO Team Leader, explains that the researchers used low-cost titanium alloy waste particulates, such as machining swarf, to produce a wire that can be used to make additively manufactured parts for applications in the aerospace, biomedical, defence, marine, automotive, construction and consumer goods sectors. "The result is a product that is significantly cheaper than titanium wire made by conventional processes," stated Dr Wilson.

The wire is being fine-tuned for use in large-format Additive Manufacturing such as Sciaky's wire-based Directed Energy Deposition (DED) technology, which it refers to as Electron Beam Additive Manufacturing – processes that melt the wire to form beads that stick together to create a layer of metal material that is then built up to form the part. CSIRO explains that there is a lucrative market for 2.5 mm to 3 mm titanium wire as feed for this type of wire-based AM process, and the cheaper wire generated from recycled sources can also be used to produce metal powders for AM.

The patented wire extrusion process, which is optimised using computational modelling, is being demonstrated to produce 50 kg of titanium wire at a pilot scale. The team is working to scale this up to 100–300 kg pre-commercial volumes over the coming months.

Richard Newbigin, Director of the Australasian Wire Industry Association, said Australia is well represented in various types of wire manufacturing but, until now, has lacked sovereign capability in wire production for AM. He noted, "Currently, Australian additive manufacturers have to source their titanium wire offshore, but this new capability will change that."

Barrie Finnin, CEO of AM company Amaero International, agrees that locally-produced titanium alloy wire and powders offer a valuable local capability for Australia's growing AM sector. Finnin said, "This technology has the potential to put Australia on the map as a competitive supplier of aerospace-grade titanium alloy wire for Additive Manufacturing and will greatly impact on our global competitiveness. Even better, the end product will be comparable to what is currently available overseas, but much cheaper because it is using waste product."

This research is supported by the Australian Science and Industry Endowment Fund.

www.csiro.au

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BASF's Forward AM opens AM tech centres in Shanghai and Detroit

BASF's Forward AM has opened two new Additive Manufacturing Technical Centers (AMTC) in Shanghai, China, and Detroit, Michigan, USA. Established in cooperation with Xuberance, an AM design company, the new Chinese facility is located in the Shanghai Lingang Songjiang Science Park and aims to serve as a hub of expertise for solutions and materials for the Asian AM market. The USA facility has been formed in cooperation with Michigan State University, and will serve the North American AM market.

In China, the cooperation between Forward AM and Xuberance was supported by an investment of BASF Venture Capital in Xuberance. This investment was made in the hope of strengthening BASF's place in the AM sector, enabling Xuberance to further accelerate its own growth in the Asia-Pacific region.

"The establishment of the new AMTC in Shanghai marks an important step for us, as we are now able to offer customers in Asia-Pacific a perfectly integrated service – from consultancy, through our high-performance materials, to direct component printing and great design services for successful 3D printing," stated François Minec, Managing Director, BASF 3D Printing Solutions. "We are confident the AMTC will become a key hub for Additive Manufacturing in this region, strengthening our capability to co-innovate with our customers."

The cooperation between Forward AM and MSU is complemented with an investment by BASF Corporation in the Scale-up Research Facility (SuRF) space. This investment is said to be strengthening BASF's strategy in Additive Manufacturing and its pursuit toward more sustainable industrial solutions. The facility is expected to enable shared resources that combine education and industry to drive the industrialisation of AM in the Americas.

"By collaborating with Michigan State University, we create a unique combination of science and industry expertise – ideal conditions to drive innovation in Additive Manufacturing together with our customers," added Minec.

www.forward-am.com

BASF Forward AM opens new Additive Manufacturing Technical Center in Shanghai in Cooperation with Xuberance (Courtesy BASF)

Shell uses AM to enable digital warehouse for spare part management

Global energy company Shell has reported on its use of Additive Manufacturing to optimise repair and replacement strategies, as well as enabling a digital warehouse approach to spare part management. Capable of reducing costs, delivery time and the carbon footprint of spare parts, Shell said it is working with industry leaders to advance the adoption of AM for the energy sector.

In 2011, Shell began using a metal laser-based AM machine to fabricate unique testing equipment for laboratory experiments at the Shell Technology Centre Amsterdam (STCA), the Netherlands. Today, Shell has approximately fifteen metal, ceramic and polymer AM machines located at its technology centres in Amsterdam and Bangalore, India.

The company explains that, although it has the capability to additively manufacture spare parts in-house, it will aim to source AM components from an original equipment manufacturer (OEM) qualified to supply the parts. When an OEM is not available, and in compliance with intellectual property (IP) laws, Shell will reverse engineer the part and then have a commercial supplier produce it from a 3D model. Only in an emergency case, and when IP is not an issue, will Shell additively manufacture spare parts in-house.

Shell states that its Additive Manufacturing strategy aims to develop a digital warehouse which stocks all the information required to additively manufacture components when needed, in partnership between Shell's technical authority, OEMs and local partners. A digital warehouse enabled by local eco-systems would present true lead time reduction, responsible use of resources and progress for the local communities where Shell operates.

At manufacturing sites, access to AM services reduces the need to stockpile components with teams only needing to additively manufacture the replacements needed, saving both time and money. Shell believes that its approach to AM is paving the way to reduce the need for holding and maintaining a large inventory of spare parts, which reduces cost and waste. Furthermore, using the technology to manufacture a part closer to where the it is then to be used reduces the emissions associated with transportation. It also helps to create shorter and more effective supply chains, supported by high-skilled local capabilities.

www.shell.com

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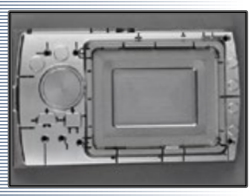

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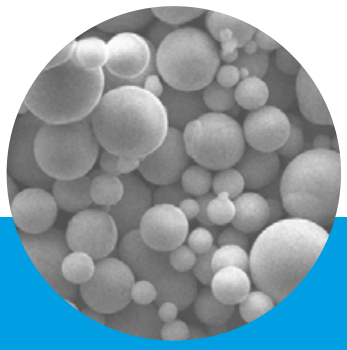

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Prima Additive's new AM machines on show at Formnext 2021

Prima Additive, the Additive Manufacturing division of Prima Industrie Group, headquartered in Turin, Italy, will showcase its new AM machines and technology at this year's Formnext, taking place November 16–19.

On show will be the Print Genius 150 Double Wavelength, a new addition to Prima Additive's 150 series of Laser Beam Powder Bed Fusion (PBF-LB) AM machines. Reported to make this machine unique is the innovative configuration of the laser sources: a 300 W infrared laser and a 200 W green laser, which can work alternately on the same work area. This makes it possible to select the best wavelength for optimising the material's absorption of the laser radiation. For instance, you can choose IR radiation for steel alloys, titanium, nickel, chromium-cobalt, or green radiation for pure copper, aluminium or other highly reflective materials. The Print Genius 150 Double Wavelength features a build volume with a diameter of 150 mm and a height of 160 mm.

Also on display will be the company's Print Genius 250, targeted at high-productivity metal AM applications. The Print Genius 250 PBF-LB machine has a 500 W single-mode dual laser, and provides a build volume of 258 x 258 x 350 mm.

The latest development from Prima Additive for Directed Energy Deposition (DED) AM will also be on show. The Laserdyne 811 DED is a flexible solution, supporting additive, welding, drilling and cutting 3D and 2D components on a single machine. With a working volume of 1100 x 800 x 600 mm, the machine can be equipped with the company's REAL_DED (REal-time Adaptive Laser beam for Direct Energy Deposition) laser deposition head. Developed and patented by Prima Additive, this allows increased performance and efficiency of the deposition process, and allows the end-user to adapt the laser beam spot dimensions in real-time during the build process.

www.primaadditive.com

The Laserdyne 811 DED enables AM, welding, drilling and cutting on a single machine (Courtesy Prima Additive)

The Print Genius 150 has a 300 W infrared laser and a 200 W green laser (Courtesy Prima Additive)

The Print Genius 250 has a 500 W single-mode dual laser and a build volume of 258 x 258 x 350 mm (Courtesy Prima Additive)

Additive Industries appoints Dave Emmett North American sales director

Additive Industries, Eindhoven, the Netherlands, has appointed Dave Emmett as its new Director of Sales and Business Development for North America. In his new role, responsibilities will include driving strategic customer relationships, building the North American sales team, and developing new business initiatives that focus on growth in the key market verticals of aviation, space & defence, high tech, energy, and industrial.

Formerly a Technical Sales Leader at GE Additive, Emmett has spent the last twenty-five years in various business management roles at leading technology companies such as BAE Systems and Renishaw.

"I am really excited to be joining this dynamic company with so many innovative concepts that show vision and room for growth," stated Emmett. "Existing customers with repeat orders for more MetalFAB1 machines is a testament to the product, the process and the service delivered today. In this immature industry, process variability is one of our challenges."

www.additiveindustries.com

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Tekna reports solid financial results for Q2 and half-year 2021

Tekna Holding AS, Sherbrooke, Québec, Canada, reported a solid second quarter 2021, with revenues rising 95% to CAD $7.4 million (Q2 2020: CAD $3.8 million), amid growth in recurring powder sales and a growing customer portfolio.

Revenues for the second quarter reached CAD $7.4 million, an increase of CAD $3.6 million from Q2 2020. Both business segments – materials and systems – recorded substantial gains, over 100% and 75% respectively, compared to the second quarter 2020. This performance is attributable to the recovery of the markets following the COVID pandemic, the growth in recurring powder sales and the growing customer portfolio.

Tekna announced two major new contracts in the period: a multi-year joint development agreement with leading Korean chemical company LG Chem to develop new materials that will improve the storage capacity and the cycle stability of lithium-ion batteries, and a three-year agreement for Additive Manufacturing titanium powder with Airbus. Subsequent to the quarter, Tekna announced a ten-year AM supply agreement with a leading EU jet engine & aerospace component OEM.

In May, Tekna announced that it had accepted an invitation from the National Center for Advanced Materials Performance to participate in a major aerospace qualification programme. Parts produced with Tekna's powder material qualified under this programme will automatically pass the initial design phase and analysis by the FAA, US Department of Defense (DoD), and the National Aeronautics and Space Administration (NASA).

"Tekna extended positive revenue growth momentum into the second quarter, posting a 95% increase year-on-year, while materials revenue more than doubled in the period," stated Luc Dionne, Tekna Holding's recently-appointed CEO. "I am proud to say that we have already secured 88% of the company's full-year revenue target. While we are exercising a reasonable level of prudence in our spending, Tekna's focus remains on the top line, setting up the necessary infrastructure and resources to scale the Company and achieve its growth ambitions."

"The favourable market conditions that we have observed in the first six months are expected to continue throughout the year, and Tekna's ambition to grow 2020 materials revenues of CAD ~$13 million to a run-rate of CAD ~$22 million in 2021 is well within reach," Dionne concluded.

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Solukon adds ultrasonic excitation for improved depowdering

Solukon Maschinenbau GmbH, Augsburg, Germany has added ultrasonic excitation capabilities to its entry-level depowdering machine, the SFM-AT200. This new feature aims to completely depowder more challenging geometries, such as medical components with lattice structures, including those with particularly narrow internal channels or porous structures.

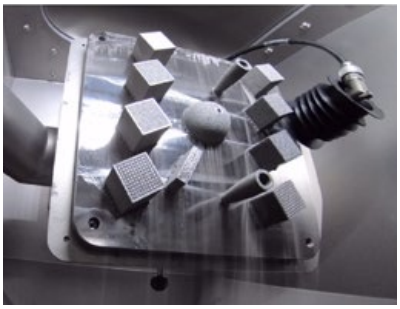
Electric frequency excitation in the ultrasonic range makes the powder flowable – allowing the powder to flow out of very small channels within seconds. In combination with the fast inertisation of the system, components can be reproducibly cleaned within a few minutes.

For testing the new excitation capability, Solukon collaborated with the medical technology experts from the Swiss m4m Center, located in Bettlach, Switzerland. Recently certified with the ISO 13485:2016 standard for medical devices, the centre is an authorised consulting partner for Additive Manufacturing of medical devices, such as implants or joint prostheses.

The Swiss m4m Center provided medical components for testing the new ultrasonic excitation within the Solukon SFM-AT200. In equivalence to the American standard ASTM F33F, these parts have extremely fine internal channels and cavities, making them ideal for testing frequency excitation under real conditions.

The reported results revealed that the ultrasonically excited SFM-AT200 completely depowders the test components within a few minutes.

"Frequency excitation further shortens the already short process time of the SFM-AT200 when cleaning medical components. Now, powder flows out of lattice structures, too. Automatic depowdering with the SFM-AT200 is a real door-opener for validated post-processing," stated Nicolas Bouduban, CEO of the Swiss m4m Center.



Ultrasonic excitation aims to completely depowder components with particularly narrow internal channels or porous structures (Courtesy Solukon)

Frequency excitation will be available as an option for the SFM-AT200 from autumn of this year.

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Phillips introduces hybrid AM system

Phillips Corporation, Hanover, Maryland, USA, has announced a new hybrid Additive Manufacturing machine combining traditional machining with a Directed Energy Deposition (DED) Additive Manufacturing process. The new Phillips Additive Hybrid integrates subtractive CNC machine tool technology from Haas Automation, headquartered in Oxnard, California, with an AM laser head manufactured by Meltio, based in Linares, Spain, and is said to offer an affordable solution to producing and repairing metal parts.

The hybrid system uses wire-based DED to build or repair a part, with the machine tooling stage enabling components to be finished on a single platform. Meltio's DED process also enables different materials to be used on the same part for the best design, weight and strength.

"Meltio is proud to welcome Phillips Corporation as a Haas hybrid integration partner," stated Brian Matthews, Meltio's Chief Technology & Innovation Officer. "Hybrid manufacturing offers the benefits of both additive and subtractive processes in one machine, providing cost and complexity advantages that have not been accessible before."

The Phillips Additive Hybrid system brings together CNC machine tooling from Haas with DED AM from Meltio (Courtesy Phillips Corporation)

Alan M Phillips, Phillips' CEO, added, "The commercial and federal industrial supply chains have accelerating interest, applications and demand for 3D printed parts. The Phillips Additive Hybrid solution integrated with the Meltio Engine is an optimal fit for customers seeking to add exceptional capability to their subtractive tools while also entering or expanding upon their Additive Manufacturing capability – all in one machine."

www.phillipscorp.com
www.haascnc.com
www.meltio3d.com

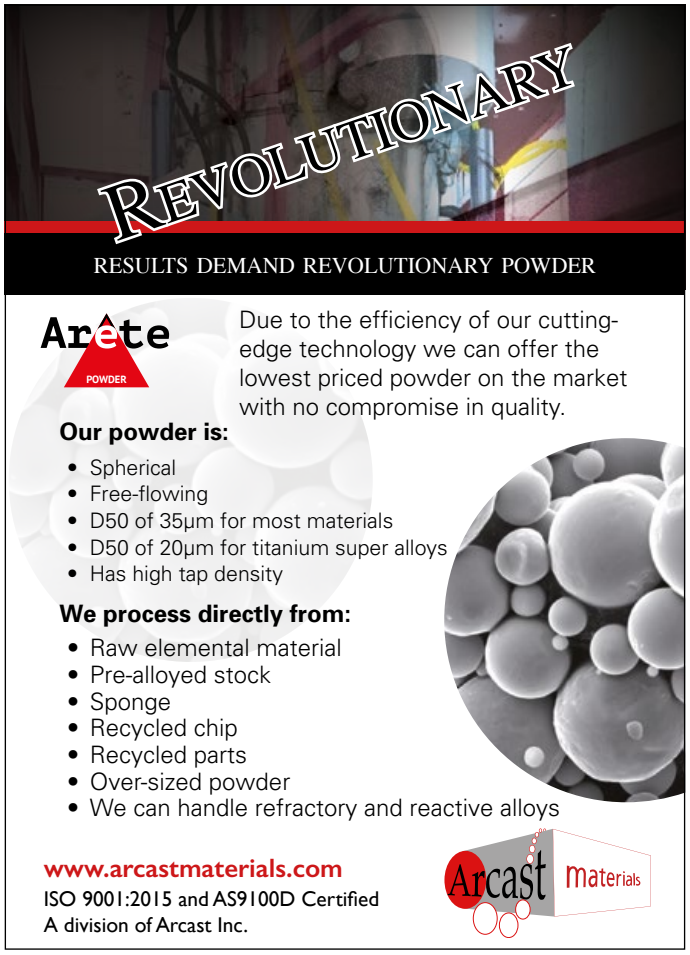
ITS installs additional HIP system at its Bilbao facility

Isostatic Toll Services Bilbao SL (ITS Bilbao), Spain, reports that it is installing a second AIP52-15H Hot Isostatic Pressing (HIP) system, scheduled for commission in November this year. It joins the facility's first AIP52-15H HIP system which was installed and operational for the official opening of the facility in January 2020.

With a hot zone of Ø1114 x 2550 mm and a maximum pressure of 103 MPa, the system will provide ITS Bilbao with a full redundancy capacity for sensitive HIP strategic components. Just eighteen months since its opening, ITS Bilbao states that it is working with customers from three different continents in four different industries.

As part of its facility launch phase, ITS Bilbao has developed a solid local supply chain for high tech goods and services, received approval from key Jet Engine Manufacturers and has been awarded Nadcap approval for the aviation industry. ITS Bilbao explains that these achievements mean it is technically and commercially ready to double production capacity in order to prepare for a post-COVID-19 surge in demand.

www.isostatictollservices.eu



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Ponticon's pontiMAT process enables rapid alloy development

Ponticon, Wiesbaden, Germany, will showcase its pontiMAT system, a process that supports the development of metallic alloys for use in Additive Manufacturing, at Formnext 2021. The pontiMAT process is said to enable users to rapidly produce and test samples of a wide range of application-specific materials, using minimal resources.

The new system is based on Extreme High-Speed Laser Metal Deposition (EHLA) technology, a high-speed Directed Energy Deposition (DED) process conceived and developed into a market-ready product by Ponticon in close cooperation with the Fraunhofer Institute for Laser Technology (ILT), Aachen, Germany, and the chair for Digital Additive Production (DAP) at RWTH Aachen University. In addition to being able to combine an extremely wide and diverse range of alloying elements, the pE3D system employed enables the molten material to solidify at specific rates within a very wide range, namely from 100 K/s to 10 million K/s. Thus, the microstructural features can be influenced within unprecedented limits.

The system can be very helpful in speeding up the development of alloys for specific applications. Here, it can be used to quickly additively manufacture samples for metallurgical analysis, reputedly enabling hundreds of alloying variants per day to be processed into samples and tested. It's in this way that the new system dramatically reduces the effort otherwise involved in conventional sample melting and analysis methods.

"When our customers use our pontiMAT system in the development of new, application-specific AM alloys, they can achieve some 50% performance improvement from their products – not just 5% or 10%," stated Tobias Stittgen, Managing Director of Ponticon GmbH.

The EHLA process in detail

In contrast to conventional laser deposition methods, the EHLA melts the metal powder before it reaches the surface of the substrate, on which it is deposited in successive layers. A central element of the system is the laser head with the integrated powder nozzle. The head is designed so that the light emitted by a laser of several kW capacity is focused a few millimetres above the surface. The metal powder is fed into the laser beam by means of a nozzle specifically designed for the EHLA system.

Different alloying materials can be mixed in virtually any combination. For this, up to eight powder feeders are available for up to eight different metallic elements or pre-blended alloys. This makes the system suitable for systematic analysis and testing of high-entropy alloys and their specific properties.

In order to achieve high relative velocities between the deposition head and the AM component, the head – including the laser optics and the powder nozzle – is fix-mounted, while the plate that serves as the substrate for the end component is arranged on a movable tripod below the nozzle. The linear kinematics specially designed for this process make it possible to achieve very high acceleration rates and process speeds while still manufacturing with the highest precision.

Operation of the pE3D system necessitates extreme mechanical stability. Because of this, the system is mounted on a structure made of 200 mm-thick granite plates surface-ground with a tolerance of just 5 µm. The AM process is precisely controllable by means of finely adjusted key parameters such as the laser power, laser beam diameter, mass flow of the powder and moving velocity of the substrate carrier.

www.ponticon.de

Metal powder melts before reaching the surface (Courtesy Ponticon)

Samples used in the development of new alloys for specific AM applications (Courtesy Ponticon)

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Uprise 3D offers metal, ceramic and composite AM on new machine

Uprise 3D Technology Co Ltd, based in Shenzhen, China, is an Additive Manufacturing company established in 2017 by graduates of the Powder Metallurgy Research Institute of Central South University. Based on technology developed in 2015 whilst at the university, Uprise 3D has continued to advance its metal and ceramic Material Extrusion (MEX) process and now offers a range of Additive Manufacturing machines and material options suited to prototyping, tooling and manufacturing applications.

Under Professor Xiong Xiang, a renowned material scientist at the university, the founders of the company, Wu Min and Liu Ye, developed a MEX process they named Powder Extrusion Printing (PEP). The process is a combination of AM and Metal Injection Moulding (MIM), where pellets are extruded to form a green part that is subsequently debound and sintered to form a final component.

After several years of development, with the support of angel funding, Uprise 3D has more than thirty patents and its machines are now in their third generation. In addition to metal and ceramic feedstock pellets for its AM machines, the company is now also offering metal and ceramic filament for Fused Filament Fabrication (FFF) machines.

The company's newest AM machine, the UPS-250, incorporates two independent nozzles and can extrude metal or ceramic materials to form complex structures, combining two different metals, two different ceramics or a metal and a ceramic to form a composite part. The UPS-250 has a build plate of 250 × 250 × 250 mm and a deposition speed of 10-100 mm/s.

The UPS-250 incorporates two nozzles and can extrude metal or ceramic materials (Courtesy Uprise 3D)

The UPS-250 can extrude layers of between 0.05 and 0.3 mm, with a nozzle diameter of between 0.3 and 0.8 mm. It incorporates an automatic feeding configuration and automatic nozzle cleaning operation.

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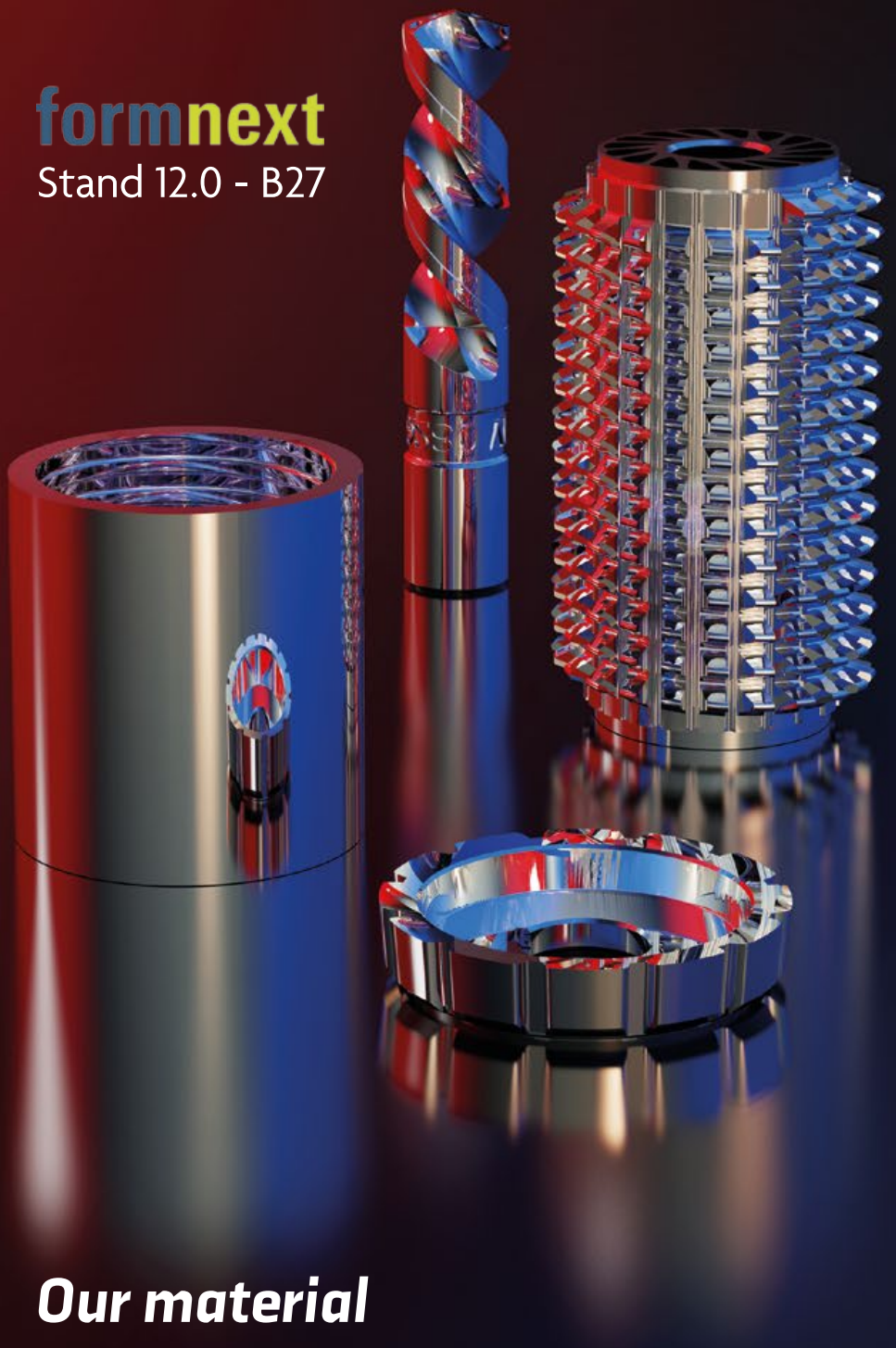

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COMPONENTS

TWI adds Titomic's TFK 1000 for cold spray AM project

Titomic Ltd, Melbourne, Australia, has received a £1.2 million order from TWI, Cambridge, UK, to supply a TKF 1000 Additive Manufacturing machine. The purchase is funded by the Aerospace Technology Institute, a UK government-industry programme established to support R&D in the UK's aerospace sector, and will form the basis of TWI's overarching Cold Spray Additive Manufacturing Project.

The TKF 1000 is built around Titomic's Kinetic Fusion (TKF) cold spray Additive Manufacturing technology. The machine will reportedly allow TWI's industrial members to join a portfolio of projects under the umbrella of the Cold Spray AM Project, as they develop and validate manufacturing opportunities.

"This is a significant milestone for Titomic," stated Herbert Koeck, CEO of Titomic. "TWI are recognised as a leader in metals research for manufacturing applications and with their strong membership portfolio, this acquisition highlights the importance of the TKF System as a manufacturing technology. We are excited to be working with TWI and look forward to continued growth opportunities in the UK."

The TKF 1000 is said to offer a number of advantages, particularly when considering fabrication from materials that are typically challenging to process by fusion-based approaches (such as those that suffer from oxidation, solidification cracking, anisotropic grain growth, etc). It was added that the UK aerospace sector will gain a strategic advantage from the system's ability to work with a wide range of metals and the potential to create large components in a short space of time, leading to cost reductions, reduced lead and down-times, and simplified supply chains.

Dr Henry Begg, Section Manager, TWI, added, "TWI are excited to expand our cold spray capability significantly with the acquisition of the TKF 1000 system. Having been active in cold spray research for the past fifteen years, we will now be able to perform larger and more complex fabrications and – working closely with Titomic and our wide industrial membership base – develop the potentially revolutionary opportunities this technology brings."

"Complementing our existing facilities for laser, arc and electron beam additive manufacture, the TKF 1000 offers a fundamentally new approach to fabrication, bypassing some of the challenges associated with solidification and opening up the possibility of multi-material builds."

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Powder blends with specific custom-made properties for AM

Scientists from the Chair Digital Additive Production (DAP) and the Steel Institute (IEHK) at RWTH Aachen University, Germany, have been working on an approach to test and modify the properties of additively manufactured steels. Currently, the selection of customised alloys for Laser Beam Powder Bed Fusion (PBF-LB) is limited, explain the researchers. However, alloys that are composed especially for this process would lead to optimum production and application-adapted mechanical and microstructural component properties. The production of such specific PBF-LB alloys using powder blends is, therefore, a promising approach, where pre-alloyed, already-established powder materials are specifically influenced in their chemical composition by the addition of elementary powders.

DAP and IEHK believe that 'geometry for free' and 'complexity for free' are the core messages of AM – even more is possible, however, since microstructural and mechanical component properties can also be adapted to later application requirements through targeted compositions of the powder material. For this purpose, PBF-LB uses pre-alloyed powder materials currently. Even if these materials are already established in some powder-based AM processes, they are not specifically developed for PBF-LB and have a corresponding optimisation potential. This is where the so-called Rapid Alloy Development (RAD) comes in: Pre-alloyed powder materials are used, among other things, as a starting base and are purposefully modified by adding elemental powders in order to be efficiently optimised for PBF-LB processing – powder blends are created.

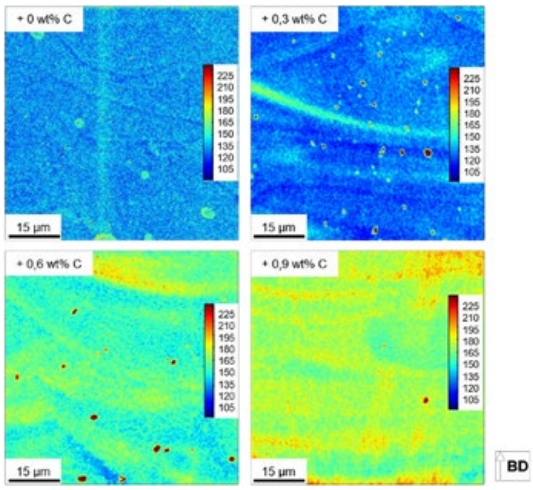
In the application example of the DAP and IEHK, the researchers modified the properties of a pre-alloyed steel powder (X30Mn22) by precisely adjusting the carbon content (C). Carbon has a major influence on the processability of the material in the PBF-LB process as well as the tensile strength and elongation at break of the additively manufactured components. To investigate the properties of different powder compositions, powder blends consisting of X30Mn22 powder and carbon powder of different proportions were qualified for the PBF-LB process (up to 1.2 wt% C); a relative density of >99.8% was achieved for all compositions.

After successfully qualifying PBF-LB for processing the powder blends, further samples were manufactured for the analysis of microstructure and mechanical properties. An electron beam microanalysis showed that the carbon was evenly distributed in the matrix and, thus, transitioned into the alloy. In addition, the scientists compared the behaviour of the samples produced from powder blends with the known properties of the samples made from pre-alloyed steel powder of the initial composition. Tensile tests for the analysis of the mechanical properties proved the successful adaptation of the powder material properties: the tensile strength, as well as the elongation at break, vary according to the addition of the amount of carbon.

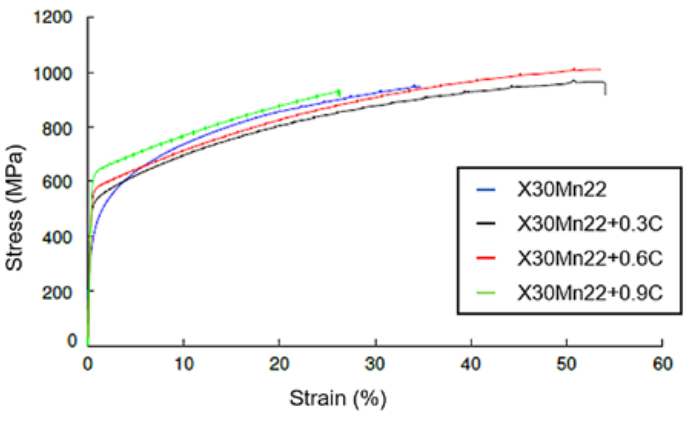
DAP and IEHK state that the results of its application development show that the RAD approach of using powder blends is a promising approach for a fast and resource-efficient qualification and development of PBF-LB-optimised alloys. In addition, the chemical alloy composition can be adjusted by means of this approach in order to specifically influence and reproduce the microstructural and mechanical properties of the components to be additively manufactured.

In the future, the mechanical behaviour of actual components made from PBF-LB-optimised powder blend alloys are up for more detailed investigation. In addition, their properties are compared with those of components made exclusively from pre-alloyed powder in order to identify further potential benefits.

www.dap-aachen.de
www.iehk.rwth-aachen.de



Electron beam microanalysis of the carbon content in the as-built state of the various alloys



Stress-strain diagram of the investigated compositions (Courtesy RWTH DAP/IEHK)

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SOLUTIONS

Study reviews the status of additively manufactured lattice structures

Researchers at the University of Limerick, Ireland, have undertaken a study to establish the current status and opportunities for metal lattice fabrication. Given the prevalence of Additive Manufacturing, and its flexibility in producing complex structures with intricate geometry, the fabrication of lattice structures via the AM process has gained considerable attention in recent years, and can offer performance gains in a growing number of applications.

Designers and researchers have explored, and are still exploring, different strategies to optimise the mechanical properties of these structures. In a paper titled 'Compressive Behaviour of Additively Manufactured Lattice Structures: A Review', published in the journal *Aerospace*, PhD Aeronautical Engineering Candidate Solomon O Obadimu and Senior Lecturer Dr Kyriakos I Kourousis, both at the University's School of Engineering, reviewed both metallic and non-metallic lattice structure related literature, focusing on the compressive properties and performance.

Lattice structures are composed of repeating unit cells connected by a series of struts and nodes in a three-dimensional space. In addition to their high impact energies absorption, they offer improved strength to weight ratio, the authors explain. Hence, continuing research and development in AM lattices necessitate understanding their compression mechanics, giving AM designers and researchers sufficient information to make informed decisions when designing lattice structures for AM, ensuring that safety is not compromised.

The authors asked questions such as what factors influence the mechanical performance of these structures, what is the current state of AM lattice fabrication, and are there still opportunities in metal lattice fabrication? The study provides a summary of progress to date in AM lattice structures, with a focus on their compressive performance.

Their findings revealed the following key insights, amongst others:

- The most commonly utilised lattice structure model is the body-centred cubic (BCC) structure (Fig. 1)
- In terms of optimisation techniques, for metallic lattices, the focus is only on improving design features. For example, adding vertical members (Fig. 2a), such as the BCCZ lattice model and increasing radii corners of a lattice strut (Fig. 2b), such as the GBCC lattice model. On the other hand, for non-metallic optimisation techniques, the focus is on improving process parameters, such as layer height and print angle
- Triply periodic minimal surface (TPMS) and topology optimisation (TOP) are the most utilised lattice optimisation methods for metallic structures. The former is based on mathematical algorithms, while the latter is based on engineering judgement
- Lattice morphology, including cell size and shape, significantly govern the compressive behaviour, as well as the energy absorption capability of lattices. Consequently, even small changes in the morphology can influence the overall behaviour of the structure.
- In terms of challenges, the literature revealed the following, amongst other findings:
- Research efforts are only geared around Powder Bed Fusion (PBF) for metal lattice fabrication and Material Extrusion (MEX) for fabricating polymer lattices
- The repeatability of AM process and reducing fabrication induced irregularities remain a challenge
- Although finite element simulations have been reported to be in good agreement with experimental results, AM researchers, however, warn that both the former and the latter can

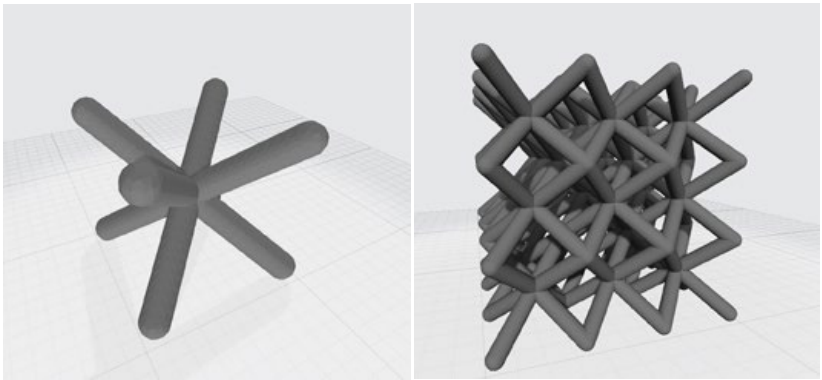

Fig. 1 The most commonly utilised lattice structure model is the body-centred cubic (BCC) structure (Courtesy S Obadimu, University of Limerick)

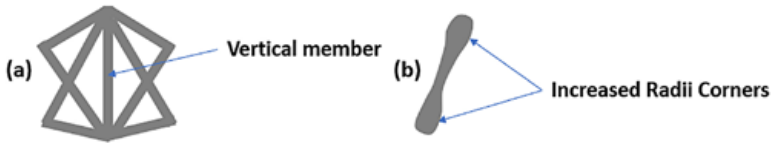

Fig. 2 Lattice optimisation techniques (Courtesy S Obadimu, University of Limerick)

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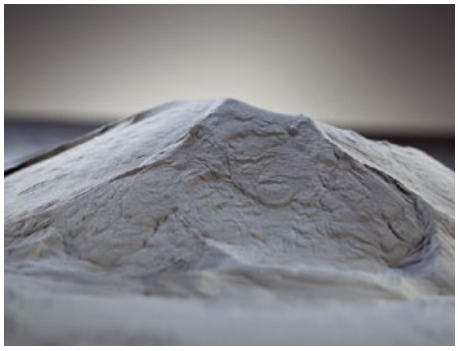





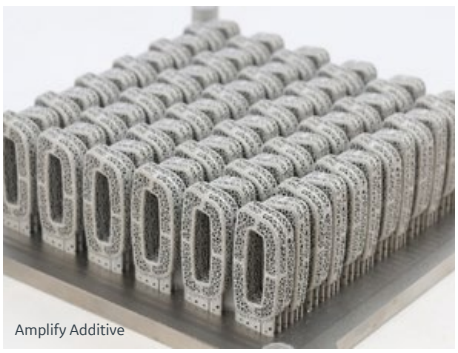
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underestimate actual in-service mechanical performance of lattices

- Regarding the most commonly utilised AM methods for lattice fabrication, based on the literature reviewed, as shown in Fig. 3, Powder Bed Fusion and Material Extrusion AM methods top the list, the former at 51.92% and the latter at 36.54%. Also, Material Jetting (MJ), Binder Jetting (BJT) and Vat Photopolymerisation (VPP) accounted for 5.77%, 3.85% and 1.92%, respectively.

In conclusion, the authors stated that the challenges highlighted above present an opportunity to further conduct AM related research, especially exploring the fabrication of metal lattice structures via the MEX processes, as well as exploring optimisation strategies by building upon the body of knowledge from PBF metal fabrication.

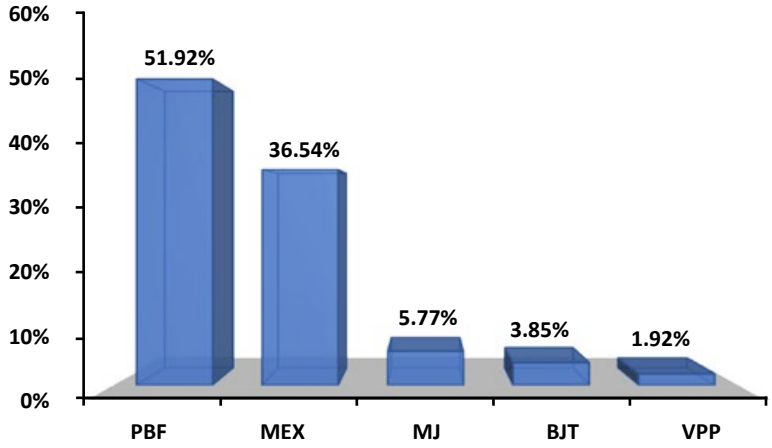

Fig. 3 Methods identified for the Additive Manufacturing of lattice structures (Courtesy S Obadimu, University of Limerick)

The full article of this study can be viewed and downloaded for free: Obadimu, S O; Kourousis, K I Compressive Behaviour of Additively Manufactured Lattice Structures: A Review. *Aerospace 2021*, 8, 207. https://doi.org/10.3390/aerospace8080207

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Markforged releases second quarter 2021 results

Markforged, Watertown, Massachusetts, USA, has announced the results from its second quarter ending June 30, 2021. The figures are said to reaffirm previously provided guidance for a 2021 total annual revenue of $87.6 million, gross profit margin of 58% and adjusted EBITDA loss of $37 million.

"We are pleased with our results as we look to continue to build momentum for the remainder of the year," stated Shai Terem, president and CEO. "The Digital Forge is helping solve critical manufacturing and supply chain challenges for our customers. We launched new key products and software updates this quarter as part of our strategy to meet the growing demand for our solutions. Our recent debut on the New York Stock Exchange energised and motivated our talented and hard-working team, and I look forward to seeing what we will accomplish together in the remainder of 2021."

Revenue increased by 44.1% to $20.4 million in the second quarter of 2021, up from $14.2 million in the second quarter of 2020. Gross profit grew 60% to $11.9 million in the second quarter of 2021, from $7.5 million in the same quarter of the previous year. Gross margins expanded to 58% in the second quarter of 2021 compared to 53% in Q2 2020.

EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortisation) was ($10.7) million in the second quarter of 2021. Adjusted EBITDA was ($8.9) million in the second quarter of 2021 compared to ($4.7) million in the second quarter of 2020. Adjusted EBITDA includes non-recurring litigation; audit, legal and other expenses associated with the SPAC transaction; and other transitional 2021 public company expenses of $0.9 million and $0.3 million for the three months ending June 30, 2021 and 2020 respectively.

In the second quarter, Markforged launched products aimed at enhancing the Digital Forge to enable customers to better solve manufacturing and supply chain problems directly at the point of need. Metal X Gen 2, Next Day Metal and X7 Field Edition aimed to improve the speed, user experience, and allow users the ability to additively manufacture anywhere. The introduction of the FX20 – the company's biggest, fastest, and most sophisticated AM machine – is intended to move the Digital Forge into robust production of high-strength, higher-performance parts for those operating in demanding and regulated industries like aerospace, defence, and automotive.

www.markforged.com

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World's largest additively manufactured shipboard fitting produced by AML3D

AML3D Limited, Edinburgh, Australia, has reported that Keppel Technology and Innovation (KTI) recently received a verification certificate from DNV's Global Additive Manufacturing Technology Centre of Excellence in Singapore for a metal additively manufactured deck-mounted Panama Chock, said to be the world's largest AM shipboard fitting to receive verification from the classification society.

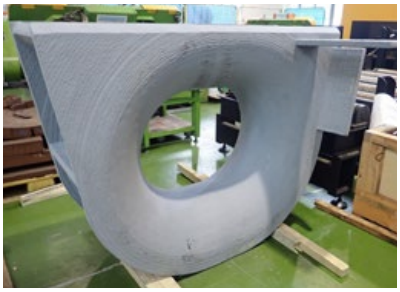
Traditionally manufactured through casting, Panama Chocks are large shipboard fittings welded to the ship and used for towing and mooring. For the new Panama Chock, KTI partnered with AML3D and used the company's Wire Arc Manufacturing (WAM®) technology, a form of Directed Energy Deposition (DED), to build the 1,450 kg component.

Francois van Raemdonck, Managing Director of KTI, stated, "KTI has been working on this project with Keppel O&M, DNV and AML3D since 2019, and we are proud to achieve this endorsement. Keppel is transforming the way it harnesses technology and KTI is supporting this by collaborating with Keppel business units to innovate and create value. This is in line with Keppel's Vision 2030, which includes leveraging advanced technologies to drive growth."

Aziz Merchant, Executive Director of Keppel Marine & Deepwater Technology, the technology arm of Keppel O&M, added "Keppel O&M is constantly exploring new technologies to stay ahead in the industry and Additive Manufacturing has the potential to increase the efficiency of shipyard operations. The 3D printing of the Panama Chock shows that large components can be made available with shorter lead times and with equal standards of quality and performance. We are encouraged by the verification and we look forward to exploring how AM can be implemented on a wider scale."

The Panama Chock was subject to extensive testing by DNV's Singapore Laboratory and Marinelift Testing & Supply Pte Ltd. Singapore, where researchers and testing engineers used advanced microanalysis instrumentation to generate high-quality microstructural information and images. In addition, the mechanical and non-destructive testing were assessed and compared against established marine grade cast material.

The use of ER70S-6 wire feedstock, combined with AML3D's WAM process, resulted in a material yield strength twice that of the original cast material. Additionally, various non-destructive testing and evaluation methods showed the Panama Chock was produced with acceptable internal soundness. The part was proof load tested to 20% higher load than its design working load, and following the successful load test, non-destructive and destructive testing, the results were reviewed by all parties before the final verification statement was issued.



The deck mounted Panama Chock in DNV's Singapore laboratory (Courtesy DNV)

AML3D Chief Executive Officer, Andrew Sales, commented, "We're proud to have been able to partner with KTI and demonstrate the advantages of our patented Wire Additive Manufacturing (WAM) capabilities in the creation of the world's largest 3D printed Panama Chock. Additionally, we are equally as excited to see this WAM printed component receive official verification by DNV. This now offers a quality assurance pathway for a wide range of components that can follow a similar validation process. It is a fantastic achievement by DNV, KTI, the AML3D team and our other partners in this project. Working with KTI's vision for implementing AM has been a further endorsement for our own business model and we're excited for the future."

Throughout the production and testing processes, there was close collaborative engagement between DNV, KTI and AML3D. Factors such as functional specifications, safety, testing procedures and acceptance criteria were all subjected to scrutiny by experts.

Brice Le Gallo, Regional Director, Asia Pacific Energy Systems at DNV concluded, "It's pleasing to see further advances within the offshore and marine industry with this development for the world's largest 3D printed shipboard fitting. Creating trust is critical for the acceptance of 3D printed parts, and DNV's certificate plays an important role in ensuring that this is the case."

www.kepcorp.com | www.dnv.com
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The Panama Chock underwent successful testing, being comprehensively function tested to 20% above its design load (Courtesy DNV)

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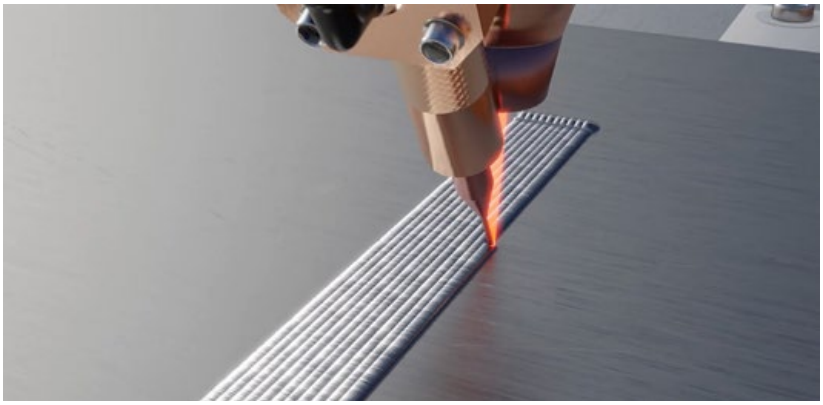
TWI installs novel wire-feed head for Additive Manufacturing of tool dies



TWI intends its wire-feed head for Directed Energy Deposition to find uses in coatings, freeform AM and the remanufacture & repair of parts (Courtesy TWI)

TWI, Cambridge, UK, has recently installed and integrated a novel wire-feed head for wire-based Directed Energy Deposition (DED), referred to by the company as wire laser metal deposition (w-LMD), in its KUKA robot cell. The head was designed and developed by Hybrid Manufacturing Technologies (HMT), Moira, Leicestershire, UK, as part of InnovateUK project FastWireAM.

Wire-based DED is an Additive Manufacturing technique which uses a laser beam to generate a molten pool of material onto a substrate. It then feeds wire feedstock – either coaxially or through a side-feed – into the melt pool to deposit a continuous bead of material. This deposited material is then built up layer by layer to produce the desired part.

The design of the head installed at TWI offers the simplicity of a side-feed set-up, whilst still allowing for stable effective-omnidirectional deposition of material. The system can also achieve a deposition rate of between 0.5-4 kg/hr, depending on the material and geometry requirements.

Current work is focused on evaluating the stability and flexibility of the deposition process and developing a process window for a novel low-alloy tool steel feedstock developed by Epoch Wires. The company, alongside its FastWireAM partners, has already shown a use potential for the wire-based DED head by this feedstock as a coating for an automotive tool die provided by potential end-user DGWeld.

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Markforged begins trading on New York Stock Exchange

Markforged, Watertown, Massachusetts, USA, commenced trading on the New York Stock Exchange on July 15, following the company's previously announced merger with one, a special purpose acquisition company sponsored by A-star and founded and led by Kevin Hartz. Markforged common stock will trade under the ticker symbol 'MKFG' and 'MKFG.WS' for Markforged warrants.

Markforged has received approximately $361 million of gross proceeds before transaction expenses, including a $210 million PIPE from Baron Capital Group, funds and accounts managed by BlackRock, Miller Value Partners, Wasatch Global Investors, and Wellington Management, as well as existing Markforged shareholders M12 – Microsoft's Venture Fund and Porsche Automobil Holding SE.

As part of the merger, the existing management team, led by Shai Terem, Markforged president and CEO, will continue to operate the business. Kevin Hartz and Carol Meyers, venture partners at Glasswing Ventures, LLC, will join Markforged's Board of Directors. Alan Masarek, most recently CEO of Vonage, will join the board as chairman.

In order to mark the occasion, Markforged additively manufactured its own version of the bell that has been rung to open each day's trading at the New York Stock Exchange since the 1870s. Created using Markforged technology, the bell is comprised of materials including 17-4 stainless steel, onyx reinforced with carbon fibre, copper and more.

"Today is a proud moment for the entire Markforged team and a significant milestone in our mission to reinvent manufacturing today so our customers can build anything they imagine tomorrow," stated Terem. "As a publicly traded company, we will continue to focus on executing our ambitious product roadmap and further accelerating innovation, expanding customer adoption, and capitalising on the strong secular trends in Additive Manufacturing, allowing us to bring our platform to even more manufacturing floors around the world for mission-critical use cases. Looking ahead, we have some exciting products in our pipeline as we move from accessible end-use parts to robust production. I couldn't be more excited about our talented team and the opportunities in this next chapter."

Hartz added, "Being a publicly traded company will enable Markforged to build new relationships as a critical partner to even more leading global manufacturers, leveraging its expanded platform and proceeds from the transaction to accelerate its impact and growth. I am excited to join the board of directors and to work alongside a group of talented and diverse directors. I look forward to contributing to the team as Markforged continues to scale and this nascent industry matures and transforms modern manufacturing in the coming years."

www.markforged.com
www.a-star.co

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Zeiss introduces new AM parameter qualification solution

Zeiss Group, headquartered in Oberkochen, Germany, has introduced ParAM (Parameter for Additive Manufacturing), a new parameter qualification solution. Using a unique test design and evaluation workflow, Zeiss ParAM is said to offer a versatile solution for multiple applications. Examples include evaluating parameters to build defect-free parts with a change in powder quality or a degree of recycling, developing build parameters for thicker powder layers, qualification of a build envelope, evaluating or compensating for a laser performance in multi-laser systems, and creating a parameter to produce deformation-free parts. One, or a combination, of these parameters is said to help reduce the build failure rate and make AM processes reliable, while reducing the cost per part.

Zeiss and Oak Ridge National Laboratory (ORNL), Oak Ridge Tennessee, USA, have been collaborating at the Manufacturing Demonstration Facility – a Department of Energy national user facility at ORNL – on the development of a novel, fully automated solution to comprehensively evaluate a set of parameters in less than twelve hours.

"Our goal is for the user to start with a design of experiments, print coupons and evaluate best print parameters from the design of experiments plan in the same day, so they are ready to print parts the next morning," stated Pradeep Bhattad, Product Manager for Zeiss ParAM.

Ryan Dehoff, section head for secure and digital manufacturing at ORNL, commented, "Currently, only

Additive Manufacturing sample on a build plate (Courtesy Zeiss Group)

a handful of alloys are qualified for printing and the majority of these are used in conventional manufacturing. However, there is tremendous benefit in developing and qualifying novel alloys specifically designed for Additive Manufacturing. The current challenge is the qualification process, and technologies that can accelerate the development of new materials are critical."

www.zeiss.com

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Impact Innovations demonstrates cold spray AM for rocket engines

Impact Innovations, Rattenkirchen, Germany, has set up a collaborative project with Airborne Engineering (AEL), a UK company specialising in propulsion system design and testing, to analyse the suitability of cold spray Additive Manufacturing for use in the manufacture of commercial rocket engines.

New commercial rocket engines require fast, low-cost AM processes, giving sufficient flexibility to react to the changing demand of launches. In the past few years, significant attention has been given to Powder Bed Fusion (PBF) due to its design freedom and prevalence on the market. However, PBF techniques can present challenges for combustion chamber manufacturing, such as limited build chamber dimensions, limited materials, and a resultant high surface roughness (particularly in the cooling channel walls), which can significantly reduce efficiency.

The Cold Spray AM process has the potential to overcome these limitations, and offers a potential solution to manufacture combustion chambers with superior properties without build chamber size restrictions. To test this, AEL designed a combustion chamber demonstrator with an inlet manifold according to Impact Innovations guidelines. The regeneratively cooled liner is a high-strength Cu alloy, and the outer jacket material is Inconel.

The demo sample is reported to have proven that the CSAM process is suitable for manufacturing combustion chambers. The following advantages compared to other AM processes were identified:

- No protective atmosphere required
- Simple joining technique of dissimilar materials/alloys
- Negligible thermal stress
- No cooling channel surface roughness issues
- Access for inspection during production steps
- Ability to re-work/repair areas for prototypes
- Ability to join additional parts without welding (e.g., injector head, actuator mounts)
- Powder is only required for the material to be deposited, rather than in PBF processes where it is required to fill the entire build volume
- Buy-to-fly ratio close to 1

A full-size combustion chamber, as shown above, is under fabrication at Impact Innovations (Courtesy Impact Innovations)

To demonstrate the dimensional flexibility of the process at Impact Innovations' spray-lab, the spray lathe allows to manufacture components up to Φ1500 mm diameter, 2000 mm length at max component weight of 1500 kg. A full-size combustion chamber is under fabrication at Impact Innovations and is intended to be fire tested soon at the AEL site.

The mechanical properties of the combustion chambers are very critical, and depend on the materials used. A special cooling channel demo sample was manufactured to determine the mechanical properties of the high-strength Cu alloy and Inconel.

The second important aspect is the deposition rate, which has a significant effect on costs. The CSAM process developed by Impact Innovations has a deposition rate of 10 kg/h for Cu-alloy and 6.7 kg/h for Inconel, which is said to be 20x faster than PBF.

www.impact-innovations.com

To demonstrate Cold Spray AM's efficacy for rocket engines, a demo sample with the inlet manifold was manufactured. The regeneratively cooled liner is a high-strength Cu alloy, and the outer jacket material is Inconel (Courtesy Impact Innovations)

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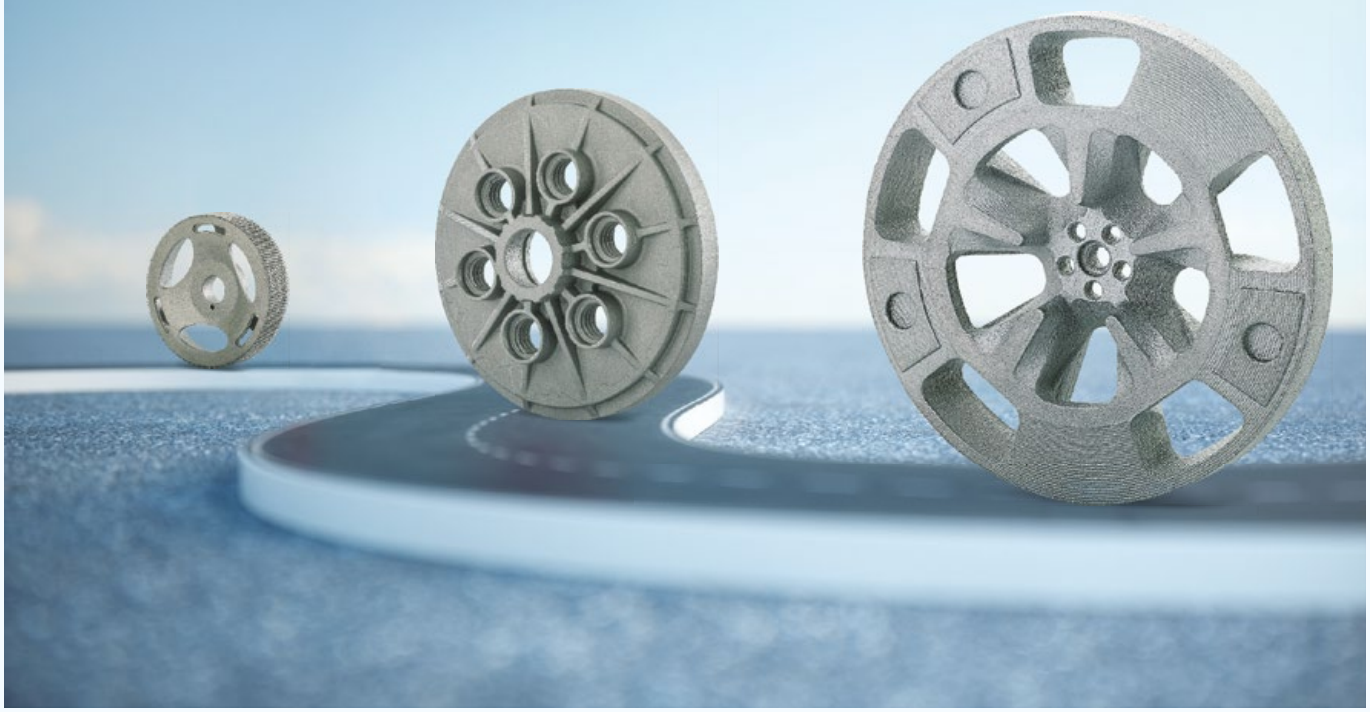

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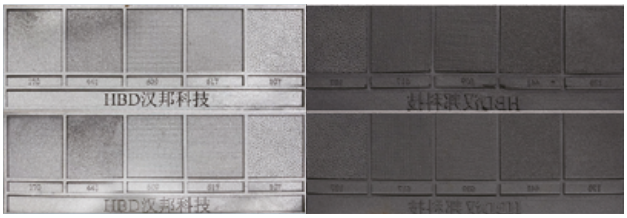
HBD Metal 3D Printer Accelerates Shoe Sole Mold Rapid Manufacturing

Development Status of Shoe Mold Industry
Shoe mold manufacturing is one of the precision traditional processing application. The complete process is: 2D\3D drawing design → wooden mold making → casting → mold making → texturing → sandblasting → electroplating/spraying teflon protection treatment, in the entire manufacturing of the industry chain, a lot of labor and high costs are required to comply with the strict requirements of environmental protection. Since 2015, domestic SLA manufacturers have begun to use light curing technology to replace traditional wood mold processing, after several years of continuous iteration and update of technology, the industry application has achieved good results, cost advantages and the appearance of finer surface textures, but it still needs casting cooperation to complete.

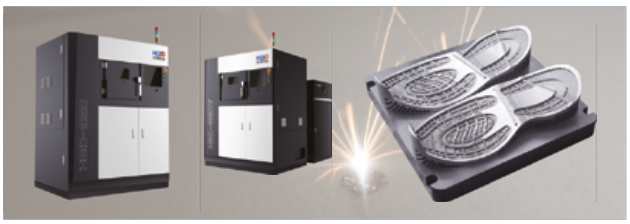
By using SLM/DMLS technology for direct metal printing, eliminating complicated processes such as wooden molds, casting, and texturing, achieves faster product delivery, a better three-dimensional pattern presentation, and more environmentally friendly manufacturing methods. Metal 3D printing shoe molds have become the focus of attention of major shoe mold manufacturers, with test involved and application promotion, which will inevitably set off a revolution and innovation in the shoe mold industry.

Printing rubber sole (parts)

Aluminum alloy test digital pattern + Molded plastic parts



Using this shoe model case for data testing, the total weight of the sample is 4.5 kg (a pair of shoe soles), the printing time is 39 hours on HBD-350T machine, the comprehensive printing cost is apprx. 238USD/Kg, leadtime in 5-7 days/set.



HBD has studied and explored the application of the shoe mold industry since 2019, after continuous printing tests, effect analysis and adjustments, and with repeatedly demonstrated and comprehensive cost-effective analysis, we launched the HBD-350/350T metal 3D printer with exclusive shoe molds printing processing package, which specifically to solve the professional demands of the shoe mold industry, and to meet the production needs of customers.

https://en.hb3dp.com

Materialise releases Magics module for automated AM preparation in dental labs

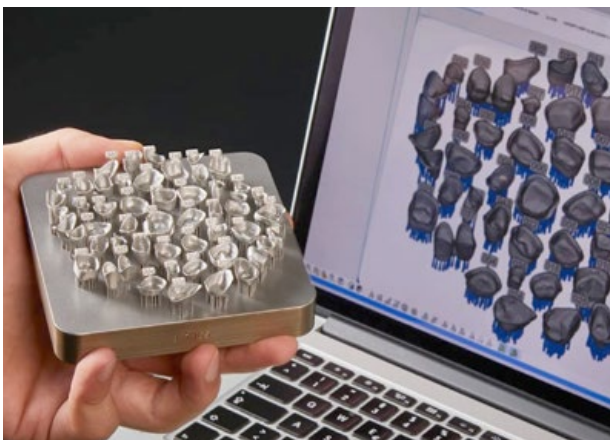
Materialise NV, Leuven, Belgium, has introduced the new Dental Module for its Magics software. This addition is designed to enable dental labs to fully optimise and automate their Additive Manufacturing preparation workflow for dental applications. With dentistry becoming more digitised, the Dental Module aims to provide dental labs with the easy-to-use tools required to ensure a scalable AM process.

"3D printing has become well established within dentistry," stated Volker Schillen, Market Innovation Manager at Materialise. "Today, many dental labs have their own printers and create custom parts for dental restoration daily. Their next goal is optimising the workflow so dental specialists can reduce the amount of time spent manually preparing designs to be printed. With automated tools, specialists can instead use this time on other valuable responsibilities, such as meeting with patients."

The Magics software offers a range of features that allow users to fix, repair, and edit 3D files before manufacturing. After uploading dental CAD designs to the platform, the user clicks a button, from which the software automates all the required Additive Manufacturing preparation steps, such as labelling, nesting, and generating support structures. The Dental Module offers an automatic manufacturing preparation for common additively manufactured dental applications such as crowns, bridges, and partial bases.

The module also provides advanced control over processing steps through customisable processing profiles. Users can also utilise Magics to further refine automatically generated results or process applications not supported by the Dental Module in a tailored manner, if necessary.

www.materialise.com



The new Dental Module of Materialise's Magics software offers an automatic manufacturing preparation for common AM dental applications such as crowns, bridges, and partial bases (Courtesy Materialise)

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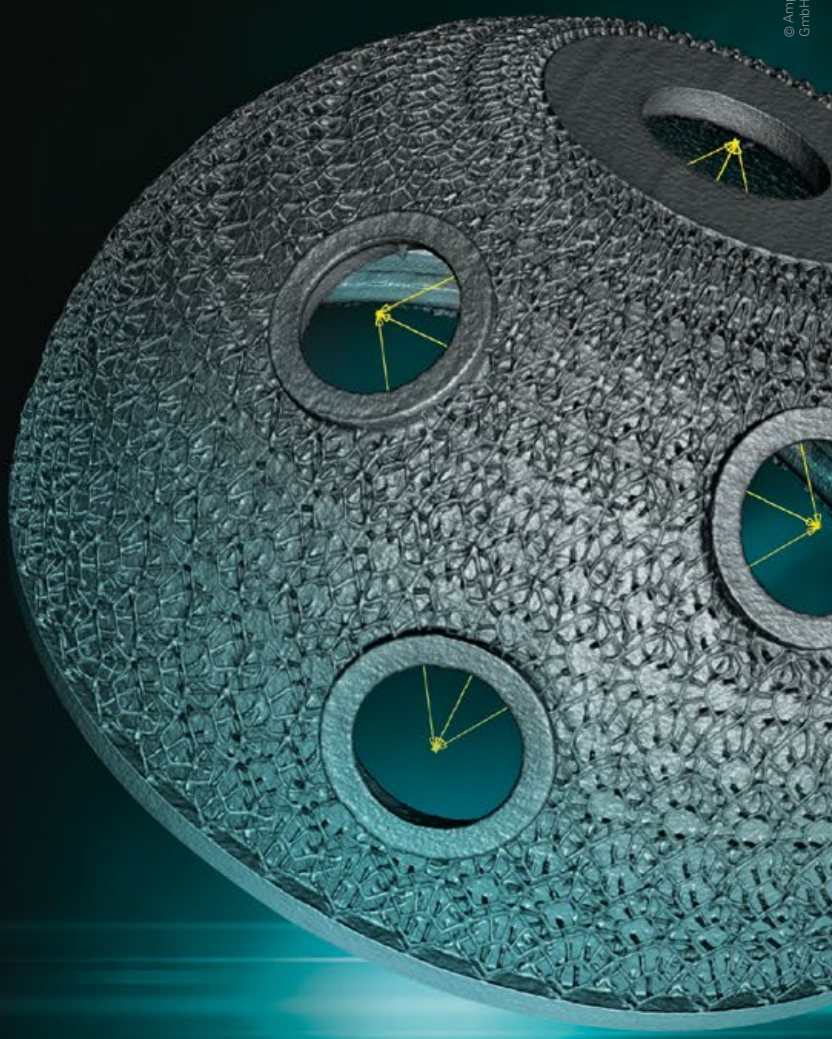

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CT volume of a 3D-printed hip cup orthosis scanned by YXLON FF35 CT

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Epeire 3D releases new AM machine for titanium components

Epeire 3D, a start-up Additive Manufacturing machine maker based in Haubourdin, France, has released the Epeire T-Titane®, its newest machine intended for small to medium industrial production runs.

Based on the company's pellet extrusion technology, a form of Material Extrusion (MEX), the T-Titane uses titanium MIM feedstock to additively manufacture the part, followed by a debinding and sintering stage.

The T-Titane joins the company's T-MIM machine for stainless steel, Inconel, copper and aluminium processing, as well as its T-600 for polymer materials. It comes installed with a titanium and titanium alloy head which offers an accuracy within a 50 µm tolerance, a repeatability of +/-100 µm and flow rate of up to 2,500 cm^3/hour.

With a build chamber of 500 x 450 x 500 mm, the T-Titane is said to open a wide range of manufacturing applications, including automotive, medical, sports and mould production.

www.epeire3d.com

The Epeire T-Titane utilises TA6V, Ti, or TA5S2 to produce parts within a 50 µm tolerance (Courtesy Epeire 3D)

3D Systems expands materials range with Scalmalloy and M789

3D Systems, Rock Hill, South Carolina, USA, reports that it has added Certified Scalmalloy (A) and Certified M789 (A) to its materials portfolio in order to facilitate demanding industrial high-strength, corrosion-resistant parts for Additive Manufacturing applications in sectors such as aerospace, motorsports & automotive, semiconductor, energy, and mould making. This addition will enable the use of the materials on 3D Systems' Direct Metal Printing (DMP) platform (a Laser Beam Powder Bed Fusion (PBF-LB) based process). The company states that it has worked with the material manufacturers APWorks and voestalpine Böhler Edelstahl to certify the materials, and customers are now able to work with the company's Application Innovation Group (AIG) to certify these materials for use with its DMP Flex 350 and DMP Factory 350 AM machines.

Scalmalloy®

Scalmalloy is a high-strength aluminium alloy that has a tensile strength of 520 MPa and yield strength of 480 MPa, significantly stronger than the reference material AlSi10Mg. The high strength is said to make it ideal for additively manufacturing weight-efficient, load-bearing components.

Ideal applications in the aerospace sector include passive RF components (such as filters, waveguides, etc.) and lightweight structural components. In the motorsports and automotive sector, applications include metal structural components (suspension brackets, transmission casings), energy and fluid management. In the semiconductor market, components include fluid flow systems (manifolds) and thermal management (such as cooling nozzles and wafer tables).

Parts produced using Scalmalloy can be chemically cleaned during post-processing which removes surface residue to deliver a final part with optimal surface finish.

"Adding the capability to additively manufactured parts from Scalmalloy to our portfolio is an important step forward; especially for our aerospace customers," stated Dr Michael Shepard, vice president, Aerospace & Defense Segment, 3D Systems. "Scalmalloy has a very attractive strength-to-weight ratio and is more amenable to 3D printing than many conventional high-strength aluminium alloys. These performance attributes make it ideal for aerospace applications and we are excited to see how our customers will use 3D printed Scalmalloy components to continue to push the envelope with their innovation."

M789 (Böhler M789 AMPO)

M789 allows 3D Systems' customers to produce high-strength moulds and tooling that can not only be hardened up to 52 HRC, but are also free of cobalt. The company has attained certification of M789 for its DMP platform through collaboration with its partner GF Machining Solutions, addressing customers' requests for hard, corrosion-resistant tooling steel for advanced applications.

The resulting parts are ideal for long-term use, able to withstand both the rigours of repetitive manufacturing processes as well as use in regions with high humidity. Ideal applications for this material include mould inserts with conformal cooling, drill bits and cutting tools, as well as automotive tyre moulds, drive train parts and axle components.

Kevin Baughey, Segment Leader, Transportation & Motorsports, 3D Systems, commented, "Our customers in the automotive industry are increasingly relying on Additive Manufacturing to advance and accelerate their innovation. Having M789 as part of our metal 3D printing solution delivers greater accuracy to our automotive customers. This is enabling them to use the technology for applications that require higher fidelity and thinner walls, like die inserts with conformal cooling and tire tread moulds, and providing them a competitive advantage."

www.3dsystems.com

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ExOne and Maxxwell Motors develop Binder Jetting process for copper winding in electric motors

The ExOne Company, North Huntingdon, Pennsylvania, USA, has announced that it is collaborating with Maxxwell Motors, a startup based in Tennessee, USA, to develop a unique copper e-winding design for its innovative axial flux electric motors which can be used in electric cars as well as a range of other heavy-duty vehicles and industrial devices.

The companies explain that they have successfully proven a new concept for the binder jet Additive Manufacturing of a high-efficiency design in copper that eliminates many of the challenges that come with traditional manufacturing. Additional development and testing are now underway.

Optimised copper windings and rotors in electric motors are among the factors enabling the automotive industry's transition to hybrid and pure electric power vehicles. However, current methods of manufacturing the windings are costly, inefficient, and limit designs in a way that also limits their performance.

ExOne and Maxxwell have successfully proven a new concept for Binder Jetting a high-efficiency copper e-winding design that eliminates many of the challenges that come with traditional manufacturing of copper coils for electric motors (Courtesy The ExOne Company)

Founded in 2018 and based on a vision of improving how electric motors are designed and manufactured, without rare-earth magnets, Maxxwell holds nine US and global patents and has launched two products: a 10 kW air-cooled motor generator and a 150 kW liquid-cooled motor.

The company is led by chairman Gary Wells, the former CEO and current board member of Wells' Dairy, maker of Blue Bunny and other ice cream brands, and CEO Michael Paritee, a former General Motors executive who managed several advanced vehicle programmes and has guided technology firms for more than a decade.

"When we 3D print it, a lot of the challenges just go away, and we can actually improve the performance of the motor itself," stated Paritee. "At Maxxwell, we're taking the most sustainable, and Additive Manufacturing, point of view as possible to truly improve efficiency, reduce waste and optimise performance."

Maxxwell's goal is to binder jet winding assemblies as a monolithic piece, eliminating the need for coil wrapping, bending, tooling, and welding of individual parts together. When produced with Binder Jetting, the final part would reportedly require less manufacturing steps and energy utilisation, as well as less material waste to produce – also resulting in components that are more efficient and deliver improved performance.

John Hartner, ExOne's CEO, added, "The ExOne team is proud to work with both traditional manufacturers and visionary startups working to change the world with innovative concepts such as these. As the automotive industry enters a new era of electrification, our world-class team of engineers stands ready to help solve some of the most pressing challenges with our binder jet 3D printing technology."

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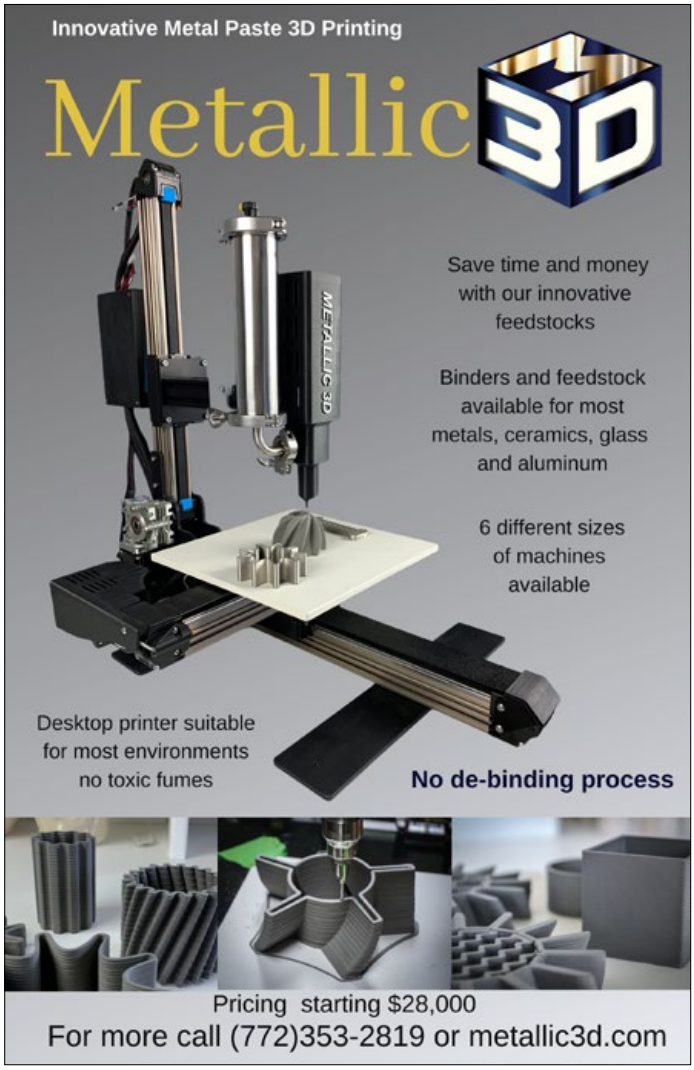

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Researchers at University of Wolverhampton develop improved copper-silver alloys for AM

In a project initiated by the increasing demand for heat transfer materials and devices suitable for Additive Manufacturing, researchers at the University of Wolverhampton, West Midlands, UK, have developed additively manufacturable copper-silver alloys that demonstrate superior strength and heat transfer performance in comparison to those that are currently available. The study was led by the Additive Manufacturing of Functional Materials (AMFM) research group, part of the University of Wolverhampton's Centre for Engineering Innovation and Research (CEIR).

Highly reflective materials such as silver and copper are known to be challenging for laser beam AM processes. However, establishing the ability to utilise such materials was significant due to the potential enhancements offered by silver and copper alloys in enabling the next generation of aerospace, automotive and biomedical devices. Silver and copper exhibit exceptional thermal properties in comparison to other metals; silver has the highest thermal conductivity and thermal diffusivity performance properties of any metal, followed closely by copper. The high reflectivity and desired thermal conductive properties, however, create challenges for laser AM due to laser energy reflection and heat dissipation hindering material meltpool generation.

The research at Wolverhampton showed that the copper-silver alloys significantly outperform additively manufactured pure silver, pure copper and all commercially available copper materials evaluated. The research team – whose expertise comprise AM material and process development – have been investigating combining functional materials with developments in design tools and AM to create high-performance additively manufacturable alloys and devices that show potential for healthcare, automotive, aerospace, and renewable energy applications.

"Thermal management is challenging for many sectors, and even small improvements in heat transfer can have a significant impact on reducing material waste while increasing component reliability and life," stated Dr Arun Arjunan, Director of the CEIR. "Additionally, emerging systems – such as those in electric vehicles (EVs), radio-frequency systems, high-power light-emitting diodes, solar cells and solid-state laser light sources – all have significant heat dissipation requirements and, therefore, innovative materials and advanced manufacturing technologies are essential to create effective thermal management devices of such systems."

Copper coil with TPMS heat exchanger. Manufactured from high purity copper on an EOS M290 machine (Courtesy University of Wolverhampton)

John Robinson, lead researcher, added, "My previous role as DMLS Development Manager oversaw the metal 3D printing department and associated material and process development activities where we were developing laser processing parameters for gold, platinum and silver alloys. While much of my work was aimed specifically at jewellery and watch applications, I saw significant demand for sterling silver for thermal management applications."

"While industrial collaborative projects restricted the development of industrial silver-based alloys at that time, the industry demand for enhanced thermal performance materials and complex structures continued after joining the University of Wolverhampton, initiating research in this area," Robinson continued. "As

Copper-silver alloy gyroid TPMS structures for investigating EV thermal management and impact protection crashworthiness. Designed in nTopology and manufactured on an EOS M290. Left to right: Cu, CuAg10, CuAg20 (Courtesy University of Wolverhampton)

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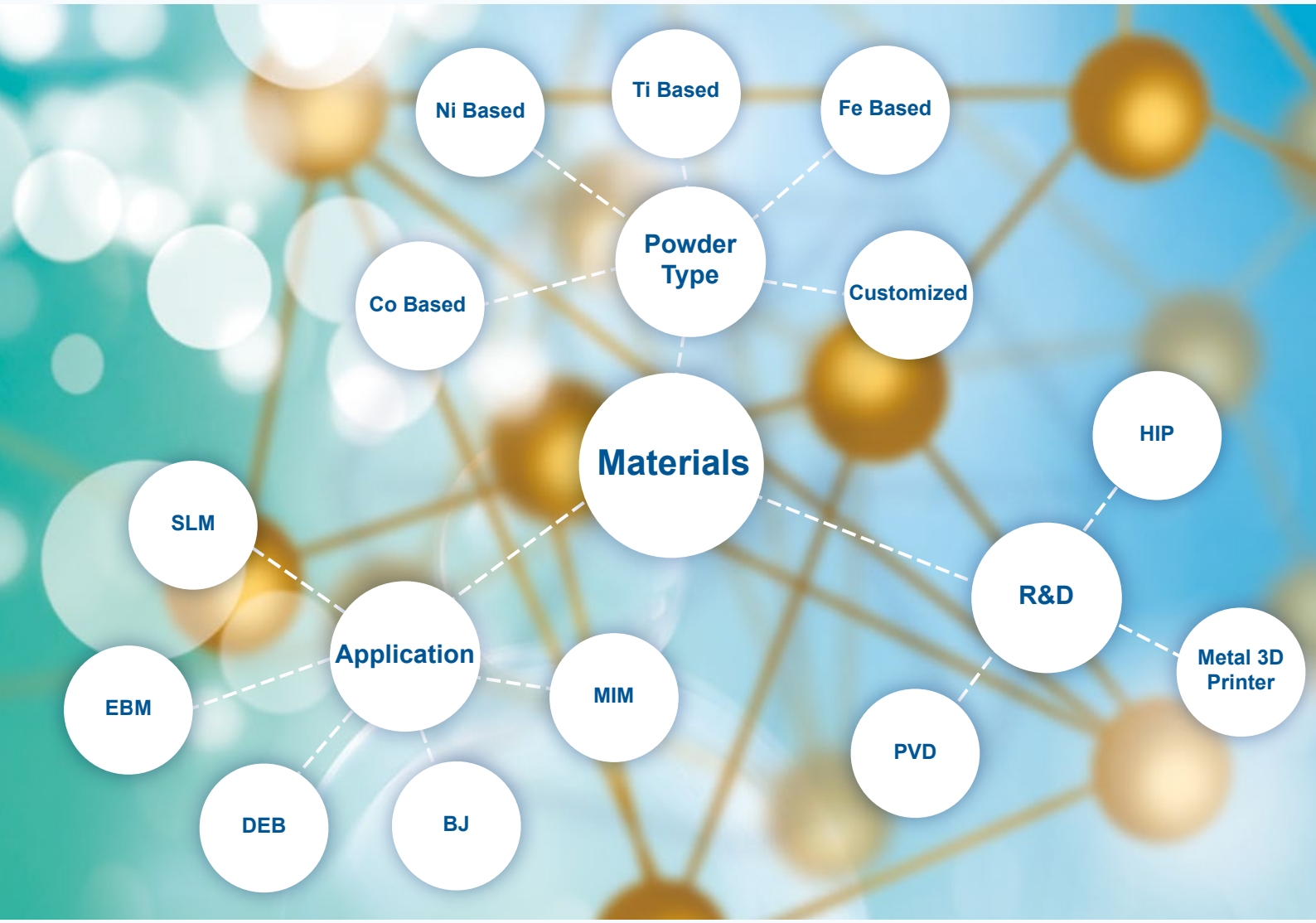

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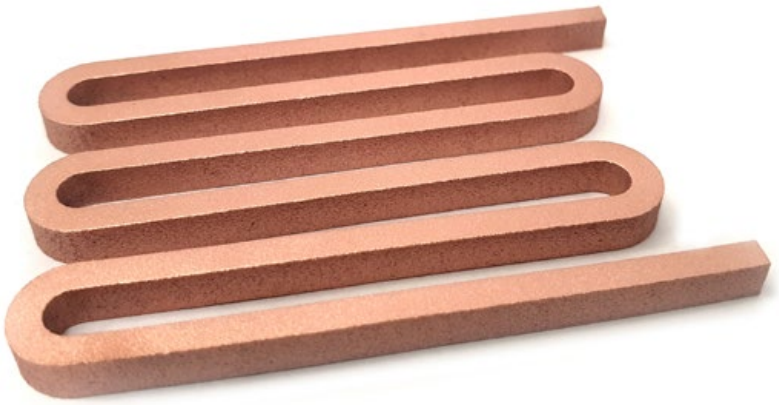

IEC electrical conductivity geometries for future studies investigating electrical conductivity and electromagnetic applications. Manufactured from high purity copper on an EOS M290 machine (Courtesy University of Wolverhampton)

sterling silver is essentially a copper-silver alloy with 92.5% silver content, it is relatively expensive in comparison to copper and other available 3D printing metal materials. However, for high-value applications such as aerospace and space, the enhanced performance may warrant the cost."

Copper-silver alloys with 30% silver content demonstrated 84%, 100% and 106% higher yield strengths in comparison to commercially available copper, commercially pure copper, and copper-chromium-zirconium, respectively, while ultimate tensile strength was 91%, 62% and 82% higher. Thermal diffusivity was also shown to increase by 6.2% with the addition of silver, demonstrating the potential for the development of high-performance copper-silver alloys for heat transfer and thermal management applications.

Dr Ahmad Baroutaji, study co-author and Mechanical Engineering Course Leader, stated, "This is really the first step for the AMFM research group in custom 3D printed thermally-conductive materials, and research has already begun on 3D printing of materials with exceptional electrical conductivity properties suitable for fabricating induction and electrical windings for electromagnetic applications and electric machines."

"Furthermore," he continued, "with the team's expertise in predictive modelling and crashworthiness complementing our material and manufacturing knowledge, other research projects are already investigating the potential for triply periodic minimal surface (TPMS) structures incorporating thermal management and impact protection for battery in EVs."

Future planned studies also involve working with collaborators to establish additively manufactured high-purity copper and silver with enhanced IEC electrical conductivity for electromagnetic applications.

All results reported have been peer-reviewed and published in the paper 'Mechanical and thermal performance of additively manufactured copper, silver and copper–silver alloys,' John Robinson, Arun Arjunan, Ahmad Baroutaji and Mark Stanford, 2021, in the Proceedings of the Institution of Mechanical Engineers, Part L: *Journal of Materials: Design and Applications.*

https://journals.sagepub.com/doi/full/10.1177/14644207211040929

www.wlv.ac.uk

EPMA Club Projects on combination of AM and HIP open to industry

The European Powder Metallurgy Association (EPMA) in partnership with RWTH Aachen University, Germany, is in the preliminary stages of establishing two new Club Projects looking at the combination of Additive Manufacturing and Hot Isostatic Pressing (HIP). Research work will be carried out at the Institute for Materials Applications at the RWTH University, and the partners are now seeking industry members to support the projects.

The EPMA is active in a number of research and development Club Projects, which are financed by, and restricted to, a small number of project members. The aim is for research institutes and industry to work together on key areas of interest, as defined by the project members.

The first proposed Club Project centres around the influence of argon on the impact toughness of AM-HIP materials. While argon limits for PM-HIP materials already exist, argon limits for AM-HIP materials are not yet defined. The research will look to assessed the limits for argon in AM-HIP materials, and identify how toughness relates to the Ar content before and after HIP.

The second project will focus on using nitrogen as an alternative shielding gas in the AM-HIP approach. Work will question if nitrogen pores can be completely closed by HIP, and what the influence of nitrogen is on the microstructure. Parts produced will undergo fatigue testing and fracture analysis.

Anyone interested in joining either of these Club Projects should contact Kenan Boz at the EPMA or Anke Kaletsch at RWTH University.

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AM rudder component wins sailing gold at Olympics

The Australian sailing team recently won a gold medal at the Tokyo Olympics in the 470 sailing class, using a boat equipped with a rudder suspension additively manufactured using Fehrmann Alloys' AlMgty aluminium alloy.

The rudder suspension was produced for Hamburg boatyard Ziegelmayer, a leader in the production of sailboats in the 470 class. Ziegelmayer required parts with good strength, high ductility and corrosion resistance, which would be produced initially as prototypes, then in series production following the test phase. Suitability of the material for both AM and sand casting was part of the requirement, and the parts were required to have the same mechanical properties in both their additively manufactured and cast forms.

AlMgty aluminium alloy can be used for metal Additive Manufacturing, sand casting, pressure casting and mould casting, with the mechanical properties of the material said to remain very similar in all processes.

AlMgty is reported to offer tensile strength of 355 MPa, yield strength of 220 MPa, and elongation of 19% as-built. It is resistant to corrosion and anodisable, and does not rely on expensive alloying components such as scandium.

Australia won a gold medal at the Tokyo Olympics using a boat equipped with a rudder component additively manufactured using AlMgty aluminium alloy (Courtesy Fehrmann Alloys)

Because only widely available components are used to make the alloy, there is also less risk of supply problems due to low availability or extraction conditions that are hard to control, again as with scandium.

Ziegelmayer was Fehrmann Alloys' first customer for AlMgty, with the shipyard's initial order announced in November 2019. Following the production of a prototype run, tests on boats in different sailing conditions around the globe proved the parts' excellent corrosion resistance and mechanical strength.

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GE Aviation reaches milestone with 100,000 fuel nozzle tips

GE Aviation's Auburn, Alabama, USA, facility recently shipped its 100,000th additively manufactured fuel nozzle tip, a true milestone for the company and the AM industry. When the facility began producing these fuel nozzles in 2015, it was the industry's first mass-manufacturing site for production of aircraft engine parts using AM.

These fuel tips are made for the LEAP engines, a product of CFM International, which entered revenue service in 2016 and surpassed 10 million flight hours earlier this year; each engine has eighteen or nineteen fuel nozzles, depending on the specific model. This fleet provides operators with 15% better fuel efficiency than previous generation engines.

"We opened the industry's first site for mass production using the Additive Manufacturing process, and to achieve this milestone affirms our plans and investments were on target," stated Eric Gatlin, Additive General Manager for GE Aviation. "There is a bright and exciting future for this technology."

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Hawk Ridge Systems and Razorleaf launch strategic partnership

Hawk Ridge Systems, Mountain View, California, USA, a provider of 3D design, manufacturing and Additive Manufacturing solutions, has launched a strategic partnership with consulting and systems integrator Razorleaf Corporation, Stow, Ohio, USA, to deliver high-quality services and support for Dassault Systèmes' 3DEXPERIENCE implementations.

Razorleaf offers comprehensive consulting, professional services, and proprietary software products focused on gaining business efficiencies around PLM, design automation, integration, model-based strategies, and test automation. The company will be an extension of the Hawk Ridge Systems Professional Services team for 3DEXPERIENCE Enovia customers, providing consulting, implementation, managed services and help desk support.

"Standing up Enovia environments can be challenging for our customers using SolidWorks data on the 3DEXPERIENCE platform, so we are pleased that our clients will benefit from the deep expertise of Razorleaf's technical team," stated Jon Toews, Director of Product Strategy, Hawk Ridge Systems. "We researched the 3DEXPERIENCE ecosystem for a partner that had proven success implementing the platform, and Razorleaf stood out as a leader. Their long-standing history working with Dassault Systèmes solutions, their data management capabilities in mixed product environments, and their OnPoint implementation methodology was something we wanted to extend to our customers."

Eric Doubel, Razorleaf CEO, commented, "Partnering with Hawk Ridge Systems is a great fit for our organisation. During our partnership discussions, we discovered that we are aligned in the same markets and initiatives for PLM. Our goal is to help clients start using the 3DEXPERIENCE platform to realise their technology investment and bring their products to market faster. Driving adoption of technology is what makes the difference in a successful implementation; the challenge is establishing the strategic technology roadmap for the implementation and then executing to that plan. We look forward to working with Hawk Ridge Systems as they help their customers achieve their PLM goals."

www.hawkridgesys.com
www.razorleaf.com

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Amace Solutions launches ALM-400 metal AM machine

Amace Solutions Pvt Ltd, an Ace Micromatic Group company based in Bangalore, India, has launched the ALM-400 metal AM machine designed to suit serial production applications for prototype and end-use manufacturing. With over four decades of experience in the machine tools sector and with a global footprint in over fifteen countries, Ace Micromatic Group is one of the largest and most comprehensive machine tool groups. The company reports that many of its existing customers are looking to adopt AM in order to stay competitive and relevant.

The ALM-400 has a build volume of 410 x 410 x 450 mm and features a dual-laser system with full scan field covered by the two high-powered 1 kW lasers. The machine can additively manufacture a wide range of materials, such as stainless steels aluminium alloys, maraging steels, Inconel, titanium alloys and more. The ALM-400 can additively manufacture parts with layer thicknesses varying anywhere between 30 µm to 120 µm, and for improved precision in axes positioning and serviceability, all axes are controlled by servo motors.

A key feature of the new machine is said to be the innovative multi-blade recoating system, designed to enhance productivity. Incorporated in the ALM-400 is a powder management system, in-situ inspection of part dimensions, automatic filtration system, user friendly data display on the Graphical User Interface (GUI) and the remote monitoring and control.

"The ALM-400 has been designed keeping high productivity in focus," stated TP Sridhar, CEO and Director, Ace Designers Ltd. "With some of the unique features of the machine, ALM-400 will meet and exceed the expectations of additive machine users. With enhanced user experience and intuitive feedback, the machine is convenient to operate and troubleshoot."

Amace Solutions has launched the ALM-400 metal AM machine designed to suit serial production (Courtesy Amace Solutions Pvt Ltd)

www.am-ace.com

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Bluclad and Progold merge to serve luxury market

Progold uses Additive Manufacturing to produce unique jewellery designs (Courtesy Progold SpA)

Bluclad SpA, a Florentine electroplating company active in the fashion and luxury market, and Progold SpA, Vicenza, Italy, an Additive Manufacturing alloy provider in the high-end jewellery sector, have signed an agreement to merge their business activities. The merger is intended to lead to the creation of an integrated platform serving leading brands in the luxury and jewellery sectors via the sharing of the two companies' institutional knowledge.

"We are delighted with the conclusion of this collaboration and integration agreement between Bluclad and Progold," stated Marco Eruli, chairman and CEO of Bluclad, and Leandro Luconi, Technical Director. "Although operating in different sectors of the luxury market, our companies are perfectly complementary, and the integration between the two companies will certainly lead to the creation of a global player and reference point also in the sector of components for high-level alloys and master alloys."

Damiano Zito, Progold CEO, added, "Our business models are perfectly matched and form the basis of the strategic decision taken. We will face the future by bringing our customers to exploit the value that Bluclad will pour into the galvanic product line created specifically for the goldsmith sector. We are confident that our customers will be as satisfied as we are with this addition to our core offering. This is the beginning of a new phase of growth for Progold, a dream shared with four friends whose valuable support has enabled the company to become a leader in its reference market twenty-five years later and to be ready today to seize this opportunity."

The integration was supported by Gioconda, the Italian branch of LBO France, an independent operator and reputedly one of the most significant private equity players in Europe with €6.3 billion of capital raised. The company was already the majority shareholder of Bluclad through its Small Cap Opportunity fund.

"Bluclad and Progold are a classic example of companies in which we are enthusiastic about investing, thanks to a strong and cohesive management team, a market leadership position, a strong orientation towards growth and innovation," commented Arthur Bernardin, Managing Director of Gioconda. "The integration of Progold (that will be subject to bank approval and all law-related authorisations) is part of a strategy of constant support for growth, like in the implementation of extraordinary operations such as this one, and fits perfectly into the market trend that sees the fashion world increasingly pervading jewellery. We are, therefore, thrilled to have created a unique operator in its reference market, capable of supplying the most innovative products in the sector."

www.bluclad.it
www.progold.com

Xometry adds Binder Jetting from ExOne to Instant Quoting Engine

Xometry, Inc, Gaithersburg, Maryland, USA, has announced the availability of instant quoting on metal Binder Jetting (BJT) in its Instant Quoting Engine. Parts will be made through Xometry's partner The ExOne Company, North Huntingdon, Pennsylvania, USA.

"We're thrilled to add another 3D printing process to our Instant Quoting Engine in partnership with ExOne," stated Bill Cronin, Chief Revenue Officer, Xometry. "Our customers can now get quotes on affordable, high-strength metal additive parts in just seconds. The new capability is the latest example of the flexibility of our platform and our drive to expand the manufacturing processes offered through our marketplace."

John Hartner, ExOne's CEO, added, "Whether customers are interested in low or high volumes, our technology offers a fast and affordable option in a wide range of metals. That includes X1 Metal 420i™, a steel-bronze matrix that is one of the most affordable and durable 3D printed metals on the market today."

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Romar Engineering to expand metal AM capabilities with AUS $5.8M grant from Australian Government

Manufacturing company Romar Engineering, New South Wales, Australia, has been awarded a AUS $5.8 million Modern Manufacturing Initiative (MMI) grant to grow its Australian-designed fluid and motion control solutions.

The grant is reported to be the largest of four allocated to manufacturers working in the aerospace sector under round one of the Integration and Translation streams of the MMI, a AUS $1.3 billion Federal Government initiative designed to position Australia as a globally recognised, high-quality and sustainable manufacturing nation. The four companies – Romar Engineering, EffusionTech, Titomic and Q-CTRL – will share nearly $14 million in funding.

Romar Engineering serves the aerospace, medical, mining and defence sectors with custom manufacturing solutions that include Additive Manufacturing, medical device manufacturing, elastomers, silicone, micro moulding and precision moulding. The company plans to leverage a more diverse metal AM offering in the Australian market with GE Additive and Romar's custom sealing solutions.

Its current in-house metal AM capabilities and development focuses include computational design for Laser Beam Powder Bed Fusion (PBF-LB) AM with nTopology; metal AM of IN718 and Ti 6-4 with a GE Additive M2 Series 5, SS316 and industry-specific tool steel to follow; parameter development capability for part-specific performance optimisation; design for hybrid metal AM with Siemens NX; working closely with Autodesk for more deposition flexibility/freedom, and more.

The AUS $5.8 million grant will fund eighteen new positions in the company's advanced manufacturing department. The company is currently preparing to install a new GE Additive metal AM machine, adding to its existing DMG Mori Lasertec 65 3D 5-axis synchronous laser deposition, welding and milling machine. The Lasertec is said to be the only one of its kind in Australia and one of only three installed in commercial settings globally. Romar will also invest extensively in the most advanced design and build preparation software to enable it to extract maximum value from its investments in advanced manufacturing technology.

"These grants will help bolster Australia's reputation in the growing global civil space industry and build on the important work being led by our Australian Space Agency," stated Christian Porter, Minister for Industry, Science and Technology. "From satellites to componentry in sensors and even rocket engines, Australian manufacturers are drawing on our existing advanced manufacturing expertise to launch into new exciting local and global markets."

Porter concluded, "This funding is about creating more opportunities to grow our local space industry, unlocking further investment and delivering the skilled jobs we need now and for the future."

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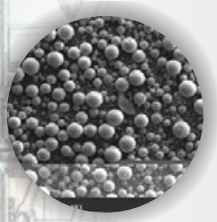

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EOS adopts Oqton manufacturing platform for AM production efficiency

EOS GmbH, headquartered in Krailling, Germany, has chosen to adopt the manufacturing operating system from Oqton, San Francisco, California, USA, at eight of its global production facilities, including over one hundred Additive Manufacturing systems, as well as ancillary equipment. The two companies have been in partnership since 2020, following an extensive investigation by EOS into platforms best suited to support its connecting, tracking, optimising and automating goals.

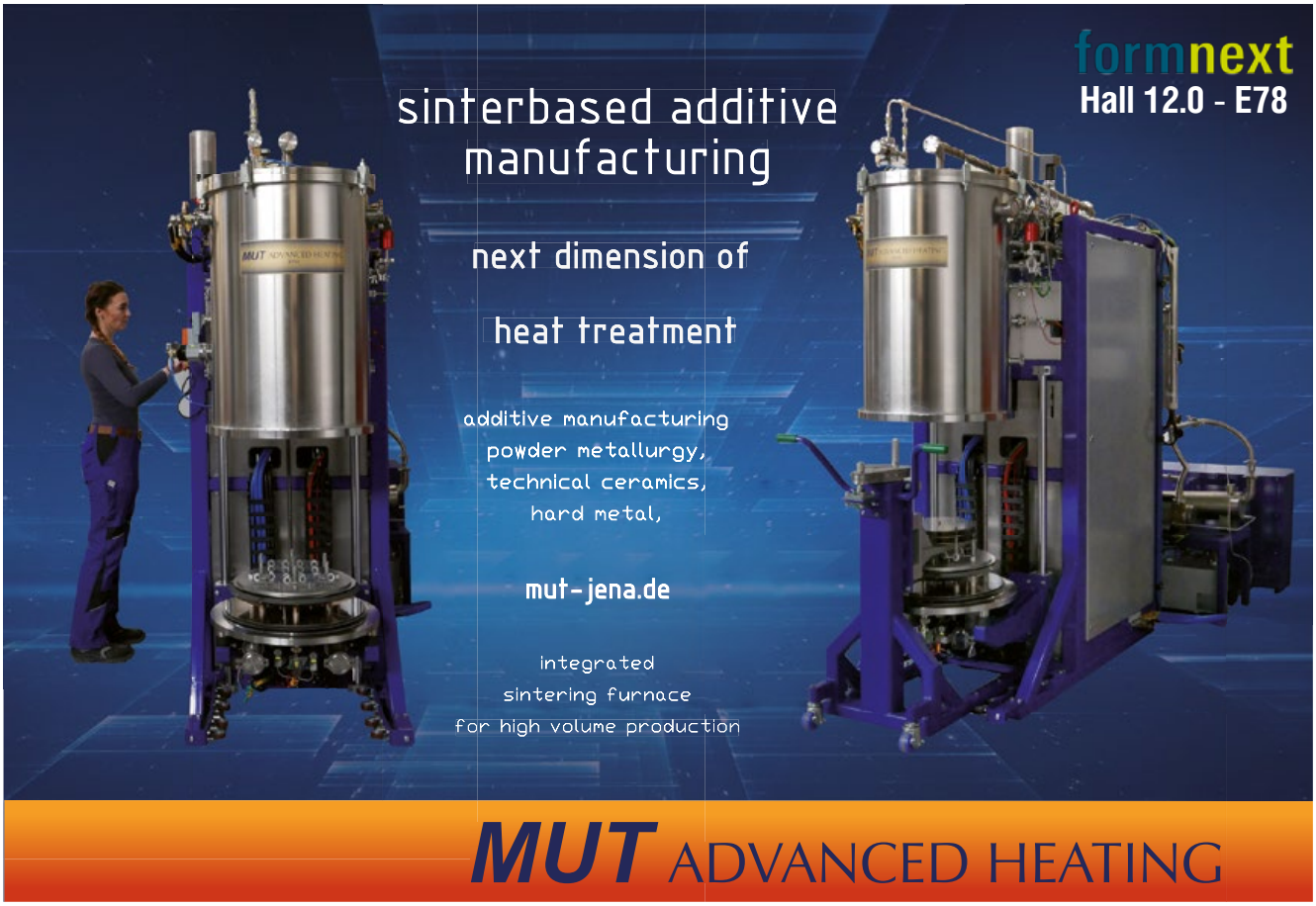
"The decision to implement the Oqton platform at EOS was based on the strengths that we identified – specifically, that Oqton can integrate all of our factory equipment (the industrial 3D printers, periphery equipment, and post processing)," stated Trevor Kirsten, Head of Digital Manufacture at EOS. "This greatly improves our planning and efficiency both with the machines and personnel. And because Oqton provides good machine connectivity we can monitor machine states in real time and send print files from the MES directly to the 3D printer."

He continued, "In addition, the low-code approach of Oqton allows us to easily tailor workflows and dashboards [and] the platform is interoperable with other software systems, which is also very beneficial for us. Oqton has proven itself to be very customer-focussed and agile by functionality, and creates new features very quickly in response to EOS inputs."

Widespread benefits from the Oqton platform have already been reported both internally and for EOS's clients, who saw optimised production capabilities. The company's goal in adopting the platform was to increase efficiency and productivity across multiple geographical locations, and to use internal available production capacity in the best possible way.

"At Oqton, we are delighted to be working with one of the pioneers of Additive Manufacturing, and to bring added value to this impressive company," added Ben Schrauwen, CEO, Oqton. "Additive Manufacturing has proven itself to be a truly disruptive technology and the benefits are well documented – however, we all know that there are still challenges to resolve when it comes to AM facilitating production at scale. Oqton was founded to resolve these core issues, and we are now able to demonstrate that effectively and consistently, as the results at EOS show."

www.oqton.com
www.eos.info



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Accenture and 3YOURMIND partner on bringing distributed manufacturing to factory floor

Accenture, Dublin, Ireland, and 3YOURMIND, Berlin, Germany, have announced a partnership to implement a distributed manufacturing platform through machine connectivity at the Accenture Industrial Internet of Things Center in Garching, near Munich, Germany.

Distributed manufacturing as a solution in terms of supply chain disruption is at the heart of the post-pandemic debate: this model involves a digital network of decentralised manufacturing sites, spread across multiple locations and connected by digital technology.

The model leverages the Industrial Internet of Things (IIoT) to drive digital transformation forward. Industrial IoT uses a network of apps or sensors to collect production data from machines and push it into software to turn that data into valuable information about the efficiency of manufacturing operations. When it comes to Additive Manufacturing, machine connectivity is at the forefront of IIoT, as it enables the transfer of data across globally connected manufacturing networks.

With machine connectivity, operators now have a complete view of the shop floor with live machine data, enabling production monitoring, performance analysis, and identification of predictive maintenance and machine status in real time.

Within Accenture Industry X Innovation Centers, Industry X is intended to act as a wholesale digital transformation in terms of both the things manufactured and and the way these are made. But with the rapid pace of change, transformation is impossible without innovation. To overcome this, Accenture has introduced the Industry X Innovation network, which can help companies harness, rapidly implement and scale the latest digital technologies and services.

Accenture assists companies in driving ongoing digital transformation, new growth and heightened customer experiences. Whether the goal is transforming operations, reinventing products, improving customer and worker experiences, or realising new business models, IX Innovation Centres are built as ideal places to explore new business opportunities and bring them to fruition.

Accenture has various industry centres worldwide to experiment with new technologies and new processes; one of its centres in Munich is the seat of an experimental project to develop the future Industry 4.0-driven shop floor. The goal of this project is to implement the basis of a successful distributed manufacturing model and spread the business model on all the centres.

3YOURMIND's Agile MES platform will be used to optimise scheduling, transparency and quality assurance tracking along the AM production chain at Accenture's IIOT Innovation Center (Courtesy Accenture)

The main focuses in fully realising this distributed manufacturing goal are:

- Collecting and analysing all part requirements and data from different machines and different locations
- The ability to incorporate varied manufacturing technologies and machines in one central platform
- The ability to prioritise, track and schedule parts for production in real time from different locations
- Monitoring and analysing the results locally and globally

3YOURMIND intends to leverage its experience in software and machine connectivity to overcome these challenges to connect the entire IoT centre shop floor, thereby optimising production flow.

In order to collect and analyse the data from different sources and locations, the Agile MES (Manufacturing Execution System) platform will be used to optimise scheduling, transparency and quality assurance tracking along the AM production chain, from manufacturing to post-processing. Agile MES can process multiple machine 'languages' in a standardised way, allowing the data to be collated for easier analytics. The platform will not only pull data from AM machines, but is intended to be used to reflect real-time production information from engineers and designers.

This real-time machine data also allows engineers to track production progress, regardless of the technology or physical location, with specific data points captured to provide documentation for an audit trail of a successful production. The machine manufacturers that opt to be part of this network will make it easier for their customers to use a smaller subset of software systems and increase production by streamlining processes. With this more transparent AM environment, management and operators may be able to improve analytics through the entire process, from customer management to production, and make more informed decisions.

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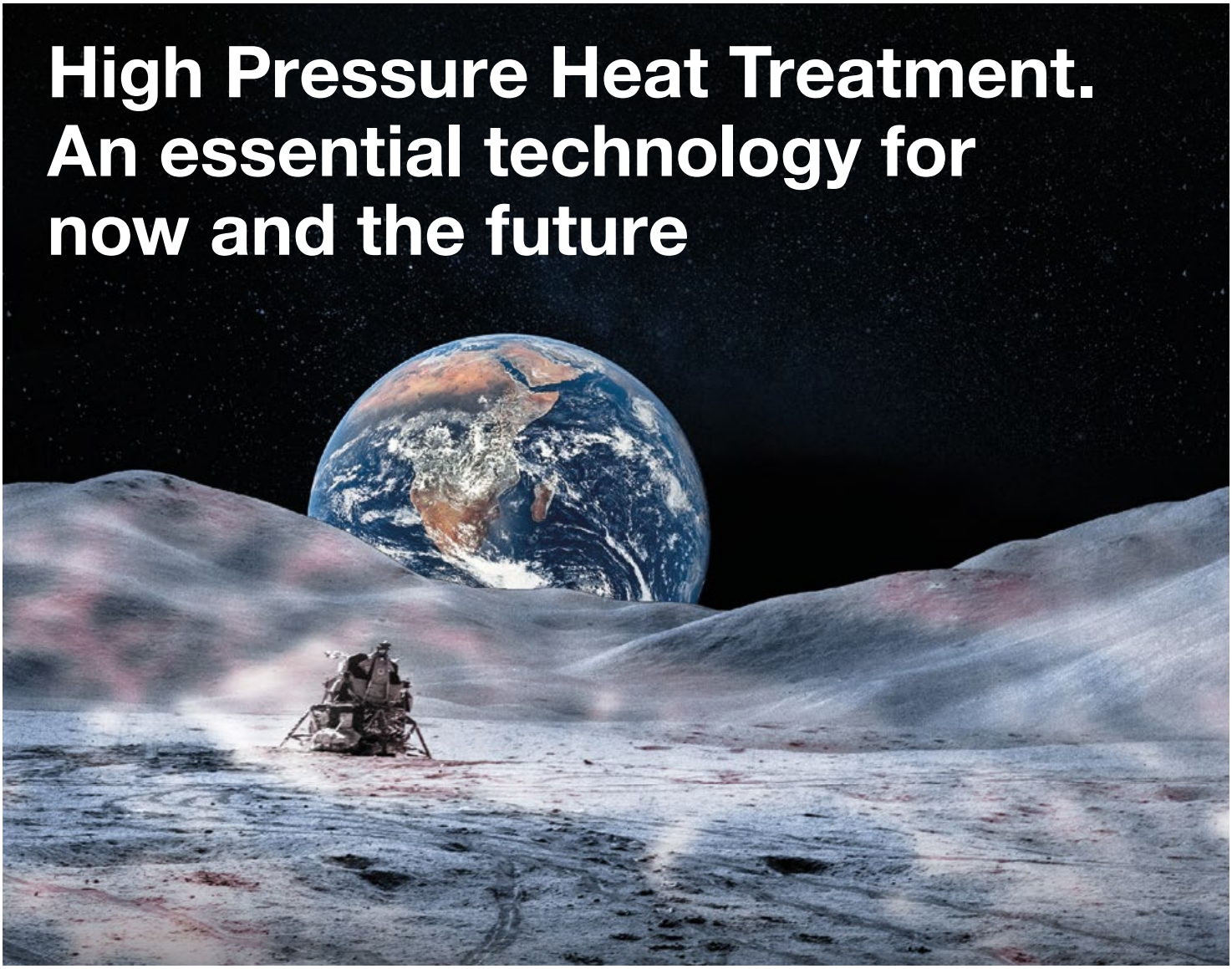

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Titomic USA acquires design and manufacturing company Tri-D Dynamics

Titomic USA, Inc, the US subsidiary of Titomic Limited, Melbourne, Australia, has completed its acquisition of Tri-D Dynamics Inc, effective July 9, 2021. Tri-D is a Silicon Valley-based design and manufacturing company described as developing 'smart pipe infrastructure' for the 21st-century economy.

Tri-D aims to upgrade infrastructure by embedding electronics directly into metal structures to outfit them with digitally connected technology. The smart-pipe product developed by Tri-D is set to be fully commercialised when combined with the licensed TKF process.

Deepak Atyam, Alex Finch and Jesse Lang, Tri-D's founders, are experienced innovators with skill sets encompassing cold spray technology, composites and rocket engine design. These skill sets are expected to complement Titomic's commercialisation plans for its Cold Spray Additive Manufacturing (CSAM) technology, a form of powder-based Directed Energy Deposition (DED). Atyam, Finch and Lang will join Titomic USA, Inc, as key employees, focusing on the company's initiatives in the defence, aerospace and oil and gas industries.

Titomic USA, Inc, expects to benefit from Tri-D's existing product portfolio and contracts within a range of industries, including clean technology, oil and gas and surveying. Additionally, the availability of Titomic commercial and technical employees on the ground in North America is expected to accelerate Titomic's local presence, as well as broadening its service offering and product portfolio in the region.

Herbert Koeck, Titomic CEO, commented, "We are delighted to welcome Deepak, Alex and Jesse to the Titomic team. The acquisition of the Tri-D business is an important part of our US strategy into the defence and aerospace industries where there is a strong need for the cost and performance advantages which our market-ready solutions with best-in-class CSAM technology provide. The team from Tri-D will add Silicon-Valley innovation and dynamics to develop novel and disruptive applications in line with our growth strategy."

www.titomic.com
www.triddynamics.com

AML3D and Lightforce extend titanium AM body armour trials

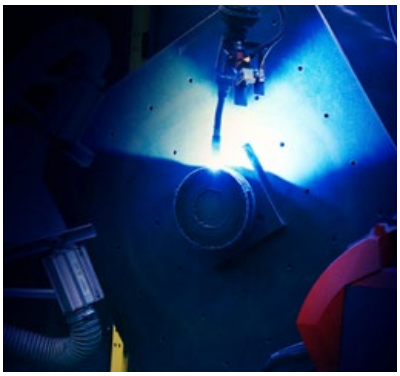
AML3D Limited, Edinburgh, Australia, has reported the extension of Stage 2 trials for the development of next-generation 'made-to-fit' titanium body armour prototypes with Lightforce Australia Pty Ltd, a developer and manufacturer of defence solutions. Results of the first phase of the Stage 2 testing identified additional opportunities across the ballistics range and testing plate parameters, leading the initial testing phase to be expanded to accommodate this broader range.

AML3D's Wire Arc Manufacturing (WAM®), a Directed Energy Deposition (DED) process, has been used to additively manufacture the titanium body armour prototypes with significantly lower emissions and less waste than traditional manufacturing techniques such as forging or casting. Once the full range of detailed testing is completed and assessed, Lightforce will be focused on the commercialisation and business opportunities for the product range.

The global armour market is reportedly demanding customisable 'made-to-fit' solutions, whereby the torso of a soldier is scanned and the armour then produced for that soldier's specific requirements. The companies expect their offering to be a disruptor in an industry that is forecast to exceed more than US $3.5 billion by 2028.

AML3D states that once it has completed the additional titanium body armour test plates, they will undergo the same rigorous repeatability testing under various conditions and will be assessed on their ballistic performance. Production and testing are expected to be completed by Q3 2022.

Andrew Sales, Managing Director of AML3D, commented, "The global body armour market is massive and growing, so it is important that we cement a foothold in this market. It is a real credit to our team that their work on the early-stage prototypes of next-generation 'made-to-fit' titanium body armour has resulted in AML3D moving to the next stage of manufacturing and testing with Lightforce."



AML3D's WAM technology is being used to produce the body armour (Courtesy AML3D)

"We have the in-house capability and capacity to take on the commercialisation of 'made-to-fit' titanium body armour, and are confident that the quality of our prototypes in this next round of manufacturing and testing will deliver further successful results. This latest development follows a strong year for AML3D as we move from early-stage development of our business model to a company with sustainable and material revenue growth."

http://lightforcegroup.com.au
www.aml3d.com

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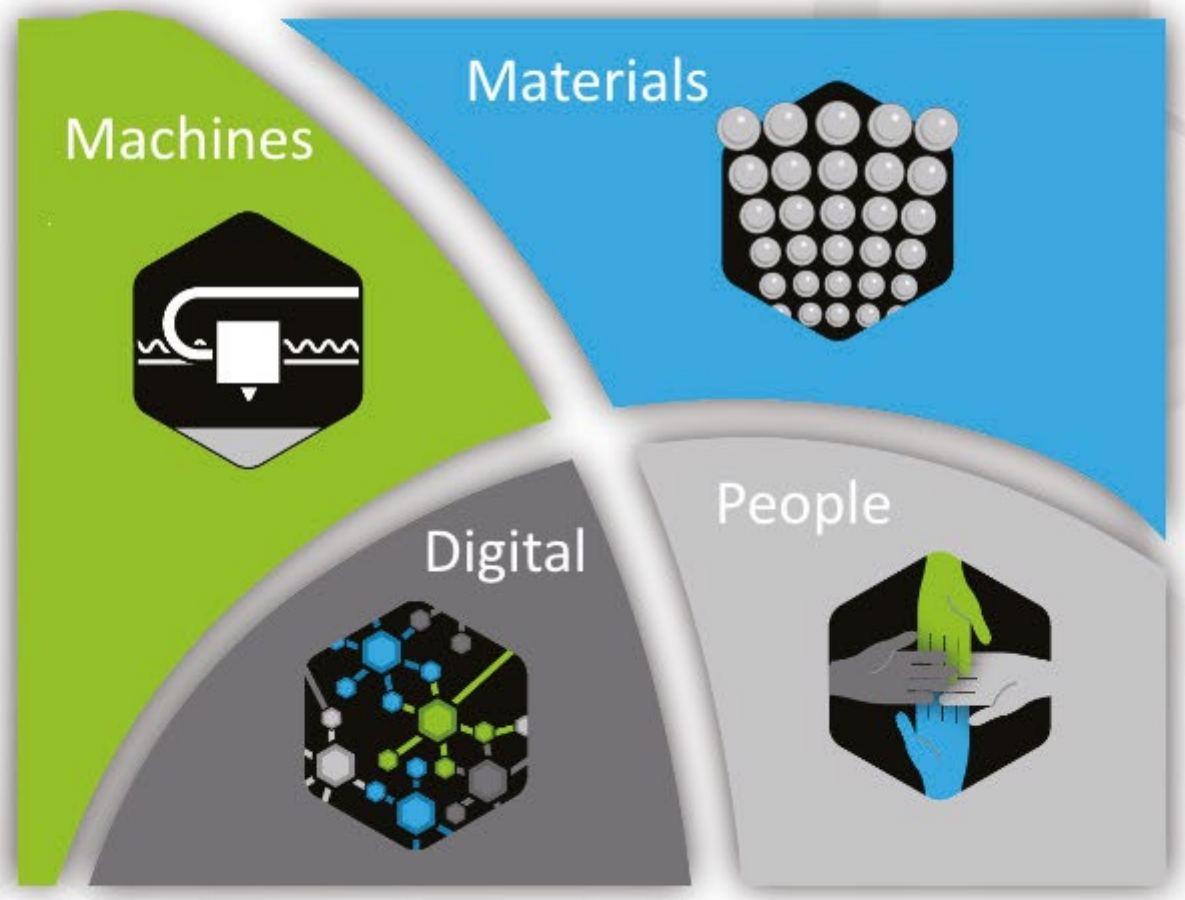
Industrializing Advanced Manufacturing



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Fabric8Labs raises $19M to commercialise its novel metal AM process

Fabric8Labs, San Diego, USA, has closed a $19.3 million Series A financing round, led by Intel Capital with syndicate partners including Lam Capital, TDK Ventures, SE Ventures, imec.xpand, Stanley Ventures, and Mark Cuban. The funding is expected to enable Fabric8Labs to accelerate the commercialisation of its Additive Manufacturing technology and to create new applications across multiple markets, including semiconductor packaging, electronics, medical, thermal management and RF components.

Fabric8Labs' patented process rapidly fabricates complex metal parts at the atomic level, enabling high feature resolution and enhanced material properties. The unique approach eliminates the need for expensive metal powders and post-processing, and the system operates near room temperature, thus minimising total energy consumption compared to more commonly used machines.

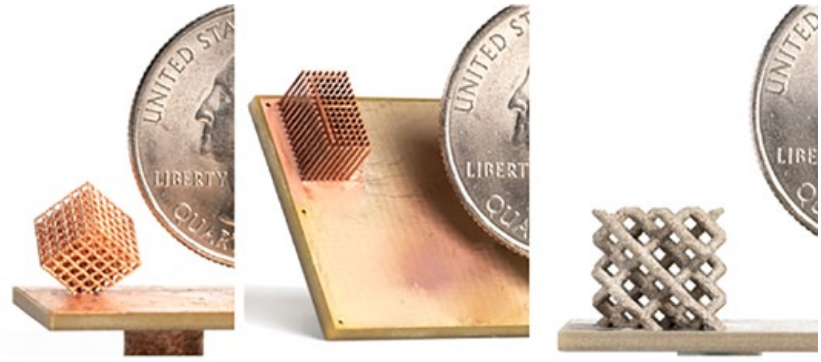
"The capability to additively manufacture using multiple metals with high precision is highly compelling," stated Jennifer Ard, Managing Director at Intel Capital. "Fabric8Labs' technology offers a unique option for future electronics applications."

Fabric8Labs is focused on accelerating more widespread adoption of AM and has developed an IP portfolio that addresses the hurdles faced by customers. The company is currently in collaboration with key strategic partners to demonstrate its process in lucrative high-volume applications, leveraging mature technologies already proven at scale.

"We are thrilled to be supported by this syndicate of industry-leading investors, who recognise the disruptive potential that Additive Manufacturing presents," added Jeff Herman, co-founder and CEO of Fabric8Labs. "Our process represents a fundamental shift in Additive Manufacturing technologies, enabling high-volume manufacturing of parts at the atomic level via an energy efficient process that utilises low-cost commodity metal salts. We are very excited to demonstrate, with the support of our investors, how our process will shape the future of manufacturing."

Grant Allen, General Partner at SE Ventures, a participant in the Series A funding round, concluded, "We are very optimistic about Fabric8Labs' potential across a range of energy and industrial applications. From thermal management to fine-featured electrical connectors, and spanning data centres, e-mobility, and other power products, we have just started to scratch the surface of Fabric8Labs' technology use cases."

www.fabric8labs.com



Fabric8Labs' patented process rapidly fabricates complex metal parts at the atomic level, enabling high feature resolution and enhanced material properties (Courtesy Fabric8Labs)

MIMplus Technologies adds Headmade's Cold Metal Fusion

MIMplus Technologies GmbH & Co. KG, Ispringen, Germany, part of the OBE Group, is expanding its offering for industrial metal Additive Manufacturing through a partnership with Headmade Materials GmbH, Würzberg, and its sinter-based Cold Metal Fusion (CMF) technology. CMF uses a titanium feedstock, processable on standard polymer Laser Beam Powder Bed Fusion (PBF-LB) machines, to manufacture a green part which is debound and sintered to obtain a fully dense metal part.

MIMplus already uses AM in-house for a wide range of products. However, compared to other AM technologies, CMF is said to offer greater freedom of design and lower production costs, as well as scalability of production from prototype to series manufacturing.

"We evaluated many sinter-based metal 3D printing technologies, but the Cold Metal Fusion technology from Headmade Materials, in the end, offered us the best combination of part quality, economic production and an effortless integration into our production environment," stated Harald Boeck, Managing Director of MIMplus.

Christian Fischer, Managing Director of Headmade Materials, added, "We are proud of this cooperation and are pleased that MIMplus implements our Cold Metal Fusion technology as the next logical step into industrial metal 3D printing."

www.headmade-materials.com
www.mimplus.de

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Linde and EOS leverage ADDvance O_2 precision technology for aluminium study

Linde, a global industrial gas specialist headquartered in Guildford, Surrey, UK, and EOS GmbH, headquartered in Krailling, Germany, partnered to conduct a study into the influence of oxygen in the process chamber, and its effect on the critical properties of the aluminium alloy AlSi10Mg. Results of the study, conducted in 2020, could be fundamental in advancing optimal, repeatable and reliable Additive Manufacturing of the alloy.

Linde's Additive Manufacturing oxygen monitoring technology – ADDvance® O_2 precision – has been credited as being instrumental in achieving the unequivocal and highly accurate results not only by Linde's AM engineering team, but that of the EOS team.

"EOS is one of the world's leading technology suppliers in the field of industrial 3D printing of metals and polymers, so to be selected to jointly work with them to progress the future of aluminium alloy printing is testament to our atmospheric gas and materials expertise," stated Pierre Forêt, Senior Expert Additive Manufacturing, Linde. "We are delighted that our ADDvance O_2 precision monitoring technology has made such a big contribution to accurately measuring those all-important oxygen levels."

An EOS AM machine equipped with Linde's oxygen monitoring technology (Courtesy Linde)

The EOS Direct Metal Laser Sintering process, otherwise known as Laser Beam Powder Bed Fusion (PBF-LB), usually takes place under an argon or nitrogen atmosphere, established by purging high purity gas into the build chamber. This replaces the relative ratio of ambient air until reaching an oxygen concentration below 1000 ppm.

Even after the most rigorous purging of the build chamber atmosphere, it is possible for minor impurities to still remain present. Extremely small variations in oxygen levels can impact the mechanical properties of alloys sensitive to oxygen – including process-induced aging of the metal powder.

As part of the Linde-EOS investigation into gas interaction with EOS Aluminium AlSi10Mg powder, ADDvance O_2 precision was selected to provide continuous analysis of the gas atmosphere. Recognising O_2 concentrations as low as 10 ppm, ADDvance O_2 precision initiates an automatic purging process to maintain optimal atmospheric conditions.

The study

Twenty-one build jobs were performed on the EOS M 290 system, with varying residual oxygen concentrations (ranging from 1000 ppm to 5000 ppm) within the process gas atmosphere. Three oxygen sensors were placed at different locations within the chamber: one on top of the process chamber, one in the recirculation filter system, and the other in the ADDvance O_2 precision system, which was closest to the powder bed and calibrated to an oxygen level of 500 ppm to guarantee precise measurement.

The ADDvance O_2 precision was initially set on analysing mode, only tracking the oxygen level, and was later set on control mode by taking over the regulation of the oxygen level within the process gas.

To establish a benchmark, the first three building jobs were undertaken using EOS's standard conditions (oxygen levels under 1000 ppm). With the help of the precise sensor in the ADDvance O_2 precision, more exacting measurements could be carried out, with deviations between that sensor and the EOS M 290's sensors then mapped.

In addition to boosting the accuracy of oxygen level readings, when the ADDvance O_2 precision was set to control mode to regulate the atmosphere, it delivered much greater consistency in the oxygen levels.

"For EOS, a consistent and reliable gas atmosphere, as well as accuracy of oxygen gas readings, is vital for us because it is vital for our customers," stated Dr Astrid Rota, Head of Metal Process Technology, EOS. "Some industries require not only the most advanced printing systems generating best material quality, but also need to record highly detailed data which is where the ADDvance O_2 precision really delivers."

On completion of the study the following findings were confirmed:

- The EOS M 290 with the EOS Aluminium AlSi10Mg powder and process parameters enable a high-quality, reproducible final part
- An oxygen content below 1000 ppm needs to be maintained during processing to prevent increasing the number and size of pores and ensure high part density and required mechanical properties
- Powder aging is reduced by keeping the O level below 1000 ppm which enables more frequent reuse of the powder
- The position of the oxygen sensor influences the measurement, with a sensor placed near to the powder bed giving optimal measurement

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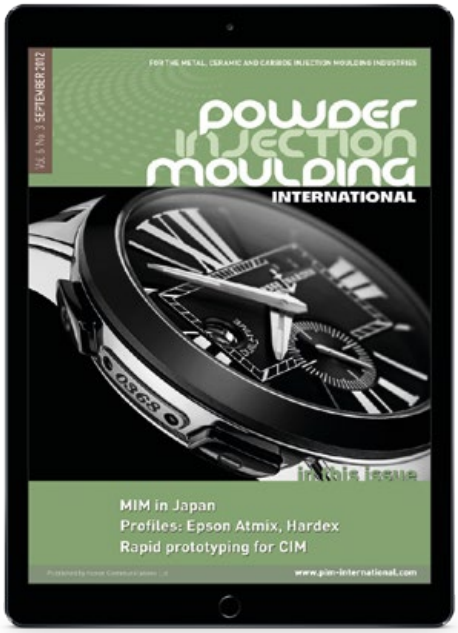

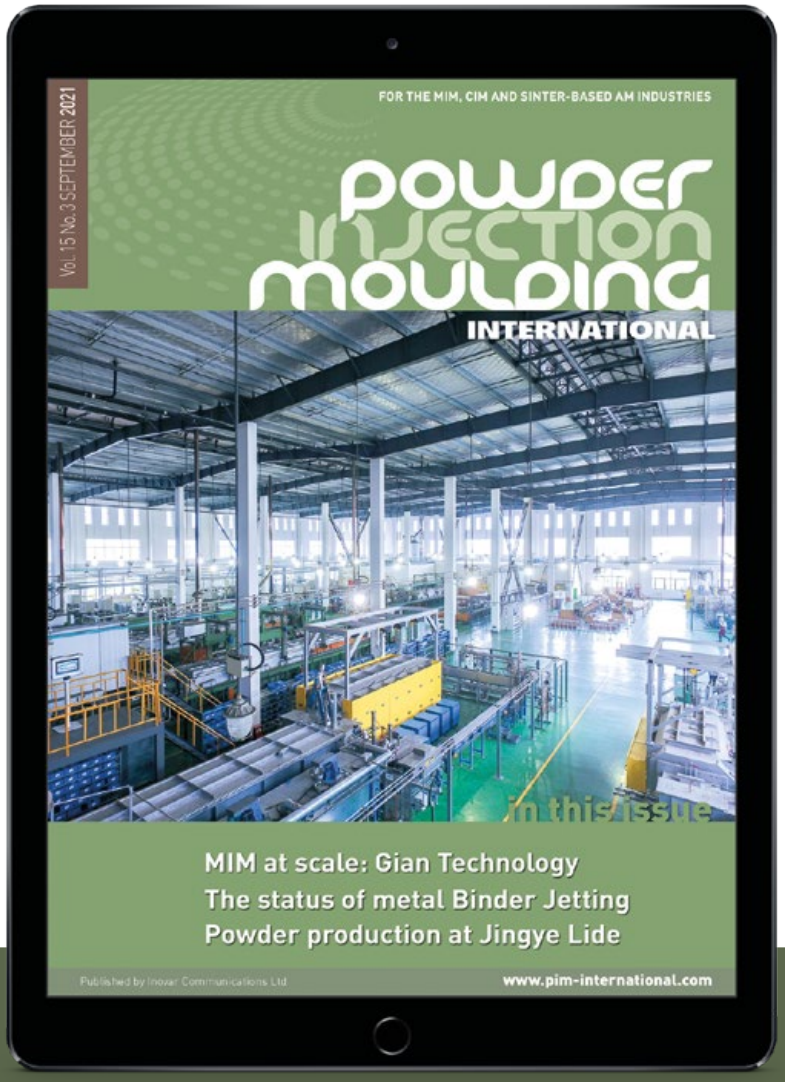

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Metal AM in hydraulics: Aidro's Valeria Tirelli on opportunities, applications, and joining Desktop Metal

A technology such as Additive Manufacturing relies heavily on industry champions to drive awareness, promoting the capabilities and potential of the process within their circle of influence. In the hydraulics industry, AM has no greater champion than Aidro srl's Valeria Tirelli, whose wide-reaching advocacy belies the company's modest size. Luca van der Heide interviewed Tirelli for *Metal AM* magazine and discussed the company's story, why the hydraulics sector is so well suited to AM, and, of course, the recent acquisition of Aidro by Desktop Metal.

Hydraulics, a long established sector within mechanical engineering and crucial to a huge range of industrial applications, has been largely unchanged in its practices and processes, which appear to have evolved little over the past decades. Valeria Tirelli, CEO of Aidro srl, fondly remembers how, in 2018, one of the sector's leading magazines, *Hydraulics and Pneumatics*, when celebrating its 70th anniversary, presented a seventy-year-old advertisement for hydraulics components on one page, and a present-day advertisement on the next. "After seventy years, all components have more or less the same shape," she said. "Although they have undergone changes in sophistication, the products are essentially the same."

This seems to suggest that hydraulics would be, perhaps, immune to innovation, especially innovations pertaining to the manufacturing process itself – and it is certainly true that there is, even to this day, a great deal of resistance towards a transition away from legacy processes. However, the last few years have shown that new, increasingly popular technologies such as Additive Manufacturing can, by fulfilling specific needs in a wide range of applications, solve long-recognised problems while empowering the hydraulics sector to adapt to the needs of an ever-evolving, ever-demanding global market.

In this article, we explore the benefits of AM in hydraulic systems, presenting applications, and addressing, based on Aidro's experience, the biggest concerns regarding the use of AM in the hydraulics sector.

Fig. 1 Valeria Tirelli, CEO of Aidro Srl, has become a high-profile advocate for Additive Manufacturing in the hydraulics sector (Courtesy Aidro)

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Fig. 2 A hydraulic block for a marine application, designed by Aidro and additively manufactured in 316L stainless steel for Fidema Group. The use of AM allowed a reduction in the number of hydraulic fittings that regularly leaked hydraulic fluid, a reduction in the overall dimensions, and the creation of a design optimised for the narrow space available. The arrangement of the cylinder control ports is customised according to the body orientation, not 'in-line', but with 90° exits (Courtesy Aidro)

Why introduce AM to the hydraulics sector?

Aidro introduced its very first Fused Deposition Modelling (FDM) Additive Manufacturing machine in 2015, and used this technology – a filament-based Material Extrusion (MEX) process – to produce fixtures, fittings and prototypes from polymers. This proved a more cost- and time-efficient alternative to using external manufacturers. "This was our priority, and the most attractive feature of 3D printing at the time," says Tirelli, "because it allowed us to cut costs and long waiting times, and, especially, to customise tools each time, depending on our particular needs."

However, as Aidro progressively discovered the benefits of the technology, the company began to consider expanding the use of AM from manufacturing in-house equipment to manufacturing finished products. Five years ago, after having initially experimented with polymeric prototypes, the firm decided to purchase its first Laser Beam Powder Bed Fusion (PBF-LB) machine for metal AM.

"At the time, the big players in hydraulics did not seem to have any additively manufactured components on the market," said Tirelli. "Apart from a few case studies from a handful of universities, there were no examples to measure ourselves against. Naturally, our biggest concerns were with the mechanical qualities of the technology. Sure, AM promised the freedom to design more optimised components. But were the components going to cope with such a demanding application?"

After a long trial period, during which Aidro worked alongside the Politecnico Milano to test and research the technology, the company decided there was enough evidence to support the technology as a reliable production method for fluid power components. From an initial phase of prototyping, the company went on to produce its own valves using metal AM, some of which have now become fully validated and are in series production. "This gave us the go-ahead to start thinking out of the box," Tirelli explained, "and really push beyond the boundaries of traditional mechanical operations."

Despite the company's relatively small size, Aidro's innovative designs did not go unnoticed, quickly attracting the attention of some of the major players in the industry. These, according to Tirelli, were usually very large companies with very specific needs that had not, thus far, been satisfactorily met by conventional production methods. "Companies that had been struggling with a certain design and had already been on the lookout for new solutions were naturally intrigued by the possibility of redesigning an application in an entirely customisable way, according to their exact specifications," she stated. "This, we realised, was the greatest appeal of the technology:

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the possibility to completely redesign objects in view of special applications, and, in particular, to create objects of a high complexity and that could fulfil precise requirements of shape, material, weight, compactness, and performance."

Today, as a consequence of the demands of large corporations and new application areas, Aidro has undergone an out-and-out process of transformation, both of internal production processes and of its quality assurance systems. Tirelli expanded, "Having to deal with sectors with very high quality standards, such as the aeronautical and oil & gas sectors, we had to improve our entire quality management system to EN/AS 9100. At the same time, the fact that our expertise was being acknowledged by other sectors sparked our enthusiasm to become promoters of Additive Manufacturing – not only by talking about it, but by showing physical objects and their real applications."

Applications in the hydraulics industry: What can AM achieve?

Hydraulic components are found in all machines that make use of fluid power, either to move or to perform specific functions. For this reason, the range of applications is extremely wide, from agricultural and construction machines, aircraft, ships and any other large mobile machinery, to industrial machines such as those for injection moulding, machining and so on. Each application area has specific demands and, thus, approaches AM technologies for specific purposes, depending on which advantages of the technology best suit the sector and its relative applications. Additive Manufacturing, in addition to offering the freedom to design and customise components, introduces a wide array of improved features that are bound to resonate to different extents with different sectors.

The main benefits of additively manufactured hydraulic components in the context of their most common applications are as follows:

Fig. 3 Testing of the hydraulic block shown in Fig. 2 which, thanks to the optimisation of the design, enabled a weight reduction from 3.8 kg of the conventional part to 0.63 kg for the AM part (Courtesy Aidro)

"Additive Manufacturing, in addition to offering the freedom to design and customise components, introduces a wide array of improved features that are bound to resonate to different extents with different sectors..."

Curved channels and reducing the number of components

By adding metal layer-by-layer rather than machining it from a block, AM makes it possible to optimise internal channel design, replacing 90° intersections with optimised bends. In traditional hydraulics, valve intersections are created by drilling a hole on one side and another on the other side of the block. But, thanks to the use of specialised AM software and simulations of fluid dynamics, AM machines are able to produce curved

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Fig. 4 An EOS M 290 PBF-LB machine at Aidro (Courtesy Aidro)


Fig. 5 Manual post-build operations include separation of parts from the build plate and support removal (Courtesy Aidro)

channels, facilitating the flow and completely eliminating pressure drops. At the same time, this eliminates the need for auxiliary caps and plugs in the manufacturing process, removing the risk of leakage and presenting the two-fold advantage of optimising performance while preventing any potential damage to the environment.

"Curved channels improve the flow of the whole system," stated Tirelli, "eliminating points of deceleration – what we call pressure drops. This is because with AM, I can design in parallel with fluid dynamics. We have software that runs simulations in real time. We can, for example, design a channel in which liquid will flow, run our FEA [Finite Element Analysis] and, if I have areas of slowdown, or any other undesired result, we simply go back to modify the design and run the simulation again. When we're dealing with components containing fluids, the interrelation between simulation software and studies of fluid dynamics is essential."

Another important benefit for design is the possibility to combine multiple components into one. This means not only integrating two functions – such as a manifold and a heat exchanger – but also physically combining the parts, resulting in a single, highly optimised component. Apart from the obvious advantage of not having to resort to two different suppliers, this also eliminates the need to assemble the parts, further reducing the chance of fluid leakage and allowing customers to save on assembling times and costs.

Strength and corrosion resistance: Materials and cooling channels

The PBF-LB machines operated by Aidro are able to create components from highly corrosion-resistant materials, including stainless steel, Inconel, aluminium and titanium. The choice of materials is extremely important, as every hydraulics system is vulnerable to both corrosive liquids as well as high pressures. For this reason, materials need to meet certain standards of

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Fig. 6 Detail of an oil-water heat exchanger designed with complex internal gyroid features and additively manufactured in AlSi10Mg aluminium alloy (Courtesy Aidro)

strength, durability, and corrosion resistance. This is especially important for applications that are either subjected to exceptional strain, for example tractors and other agricultural machinery that have to bear the continuous stress of uneven ground, bumps and holes, or applications that are in contact with a marine – and, therefore, highly corrosive – environment.

As components must to be strong enough to tolerate the heat of the engines as well as the salinity of the sea, the marine sector requires hydraulic components that are both as light as possible and that can guarantee durability and corrosion resistance. One particularly striking example is that of high-performance competition jet skis. In this case, there was a need for high heat and corrosion resistance for exhaust manifolds that, being designed for racing, are subject to intense heat, but are also in contact with seawater at all times. "Thanks to the design and integration of cooling channels exactly where they were needed," Tirelli explains, "we were able to create an exhaust manifold able to resist these challenges. The cooling channels, combined as they are with the manifold, would simply be impossible to achieve with conventional manufacturing methods."

"A conventional manifold redesigned for AM can achieve a weight reduction of 30–40%, and in some cases this can extend to a very impressive 80–90%. The fact that components can be much lighter and more compact is very attractive for the aeronautics and aerospace sectors."

Lightness and compactness

A major benefit of AM for many sectors is the possibility to produce objects with a reduced weight and size. Tirelli explained, "A conventional manifold redesigned for AM can achieve a weight reduction of 30–40%, and in some cases this can extend to a very impressive 80–90%. The fact that components can be much lighter and more compact is very attractive for aeronautics and aerospace, sectors that are always in search of ways to reduce the size and weight of their components. Similarly, agricultural and other heavy machinery have to rise up to increasingly strict requirements of space, weight, and energy consumption."

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Case Study: Validating and applying AM technology for agricultural machinery applications

Three years ago, Aidro Hydraulics began collaborating with CNH Industrial, an Italian-American multinational corporation whose brands include New Holland Agriculture, Iveco and Steyr Tractor, to develop additively manufactured hydraulic manifolds for agricultural machinery. The idea was to validate the technology and take forward the benefits of design optimisation, weight reduction and a more sustainable environmental impact.

The project was showcased in July with a joint presentation by Valeria Tirelli and Nicholas Zanasi, CNH Industrial Lead Engineer, at Inn4Mech 'Off-Highway Machine R-evolution', a conference organised by Trentino Sviluppo S.P.A.

The first step was to validate the technology for agricultural machinery applications. Aidro additively manufactured the manifold in AlSi10Mg on an EOS M290, with the shape and geometries remaining the same as in the conventional part. Using AM for this design was very challenging, as the size of the manifold reached the edges of the EOS M290's build area.

After support removal and CNC machining, the manifold was tested using endurance impulse pressure tests on CNH Industrial's test bench. The positive results confirmed the validity and reliability of AM for agricultural machinery applications.

In a second step, Aidro redesigned the manifold using a DfAM approach, adding material only where it was needed. Thanks to the design optimisation achieved, the following advantages were observed:

- A weight reduction of 35% compared to the conventional manufactured manifold, a key issue for the electrification of mobile machinery
- The integration of two components into a single part, resulting in a reduction of time and costs for part assembly and a shorter supply chain
- Increased smoothness of the internal channels and reduction in pressure drops, meaning the agricultural machinery consumes less energy
- A more sustainable and environmentally friendly hydraulic solution

To validate the 'sustainable impact' of Additive Manufacturing, Aidro performed a Life Cycle Assessment (LCA), calculating a carbon footprint reduction of more than 60% for the the design-optimised AM hydraulic manifold, compared to the conventionally manufactured hydraulic manifold. This analysis was performed at cradle-to-gate level.

As demonstrated through numerous case studies, the compactness of additively manufactured components allows them to fit into smaller spaces and adapt to the hydraulics system where they are installed. A single AM component, while being smaller, can also improve the overall performance of the system thanks to its optimised design. This means that other components can also be smaller, and, therefore, consume less, without taking anything away from overall performance. On top of that, a lighter component means a lighter machine, therefore, less energy needed for movement. As Tirelli pointed out, in a sector where electrification is becoming the dominant trend, saving on energy is an ever more crucial and urgent concern.

Sustainability

Additive Manufacturing is more sustainable and less wasteful than conventional production processes. Firstly, it is more sustainable as a manufacturing process because it is based on the principle of using only as much material as is needed for the component, as opposed to subtractive technologies that start from a block of metal and proceed by removing all the excess material. Secondly, PBF-LB machines have 400-watt lasers – "basically, as much as my hairdryer!" Tirelli joked. Finally, the new designs made possible with AM, by optimising the function of the object, also introduce a series of more sustainable solutions, from the prevention of leakage to the reduction of energy wastage.

Nowadays, Tirelli explained, it is ever more important to adapt to a global market that is evolving in the direction of greener solutions. This is why technologies such as AM can only gain increasing interest and visibility, especially for those sectors that need to adopt more sustainable processes, such as energy/oil & gas. "It is important for every manufacturer, in every sector – and, in particular, for the sectors that produce a lot of CO_2 – to pay

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Fig. 7 Small AMES valves for hydraulic systems. AMES are CETOP directional control valves, here additively manufactured in 316L stainless steel and designed to work at 350 bar. These AM valves underwent high-pressure testing up to 1,400 bar (Courtesy Aidro)

attention to their carbon footprint," said Tirelli. "Whereas we once focused on the CO_2 emissions of power plants, today many customers are interested in the CO_2 emitted to produce an object. In this context, Additive Manufacturing, being in itself a sustainable technology, has an advantage over traditional manufacturing processes. But, of course," she clarified, "it is also up to the individual companies. We, as Aidro, realise the importance of reducing our carbon footprint, and keep taking steps in this direction."

Among the initiatives taken to foster and enforce a greener manufacturing process, Tirelli mentions one of their most recent projects, presented at the international conference Off-Highway R-Evolution 2021 (see inset box). The project, developed in collaboration with CNH Industrial, involved applying Life Cycle Assessment (LCA) to compare the amount of CO_2 emitted by traditional production with that emitted by additive techniques throughout every stage of the manufacturing process, 'cradle to gate': from raw materials (comparing the ingot with atomised metallic powder), to methods (comparing casting and AM) and post-processing. "The results, calculated in Global Warming Potential, were more than impressive," Tirelli stated. "In comparison to casting, the workflow of an additively manufactured object amounted to a reduction of carbon emissions of over 60%."

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Spare parts and digital inventory

A related, much-discussed subject regarding AM and sustainability is the issue of spare parts. Possibly the main reason why a sector such as oil & gas approached the technology in the first place is the fact that AM processes are much quicker than conventional ones. Malfunctions that can cause a power plant to stop production are a big problem in this industry, as they may end up costing millions – but when it comes to replacing the defective part, AM has a very quick response time,

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Fig. 8 An accessible aeronautic system that allows pilots who have only one hand to fly safely and easily. The AM flight control parts shown, manufactured by Aidro, are used in the Servofly system (www.servofly.it/en/) (Courtesy Aidro)

"Many large corporations are putting into action long-term programmes of digitalisation, and we are cooperating with them to investigate which of their spare parts can effectively be digitalised. In fact, this is the biggest obstacle: the identification and selection of which spare parts can be produced by AM..."

and, of course, the sooner the part is replaced, the faster the plant can get back to producing power. As a result, the need to store ready-to-use spare parts in warehouses is greatly diminished.

The accumulation of very large numbers of spare parts to be kept in stock, however, is still currently one of the major problems of the industry, due to the fact that most of these components are never used and end up becoming obsolete. One way to tackle this problem is by adopting a 'digital inventory', which refers to the digitalisation of design files for ready-to-use spare parts. "Many large corporations are putting into action long-term programmes of digitalisation, and we are cooperating with them to investigate which of their spare parts can effectively be digitalised," stated Tirelli. "In fact, this is the biggest obstacle: the identification and selection of which spare parts can be produced by AM, and then the validation of those parts, especially if they are critical components, as parts that can legitimately replace the ones currently used."

It is also worth mentioning a project in progress at Italian start-up f3nice srl, based in Milan, of which Aidro is a collaborator and supporter. If the digitisation of spare parts were to be normalised, the question remains: What to do with the millions of obsolete parts abandoned in warehouses? f3nice's response is to recycle the old metal components, turning them back into stainless steel, aluminium and titanium powder by atomisation. The metal powder thus obtained is then reused to make new products. Tirelli explained: "We liked the idea from the beginning, and this is why, after the due tests and trials, we now offer, alongside the other materials, green recycled stainless steel. And the best thing is that customers seemed to immediately pick up on the idea and even consider it, most of the times, an added value."

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Overcoming fears, insecurities and scepticism

Tirelli explained that when first approaching Aidro, companies have, of course, already heard of Additive Manufacturing. They are curious, intrigued by the technology's potential, but are naturally also hesitant about its reliability and applicability. For this reason, Aidro has developed an 'introduction to AM course', directed, for the most part, at designers and engineers, and aimed at answering every question on the technology.

This process of familiarisation includes an overview of the current status of AM, as well as technical data and test results. It is important to speak the same language, Tirelli emphasised: a technical language. "Still, telling the benefits of Additive Manufacturing is not enough. When someone, and specifically a technician, holds the AM part in their hand, that's when they can really see, with their own eyes, what the technology is, how different the design is, and what are the actual potentialities."

Aidro understands this scepticism all too well. "The usual fears and insecurities are the same we had at the beginning," says Tirelli. "Does it *resist*? Will it break? We understand that for an engineer who has been used to designing components in the same way for a long time, the change of mentality can be really difficult. We have been there. This is why we are the right people to accompany them in this journey."

After the first questions are answered, it is necessary to maintain ongoing communication throughout the Additive Manufacturing process chain, from designing to post-processing, in order to make sure that the part is manufactured according to the needs of the application. Companies that approach Aidro either need to redesign a part made with conventional processes that does not fulfil specific requirements, or they know which benefits of AM they want to take advantage of, but do not know how to achieve their goals.

Fig. 9 A test bench for hydraulics components at Aidro (Courtesy Aidro)

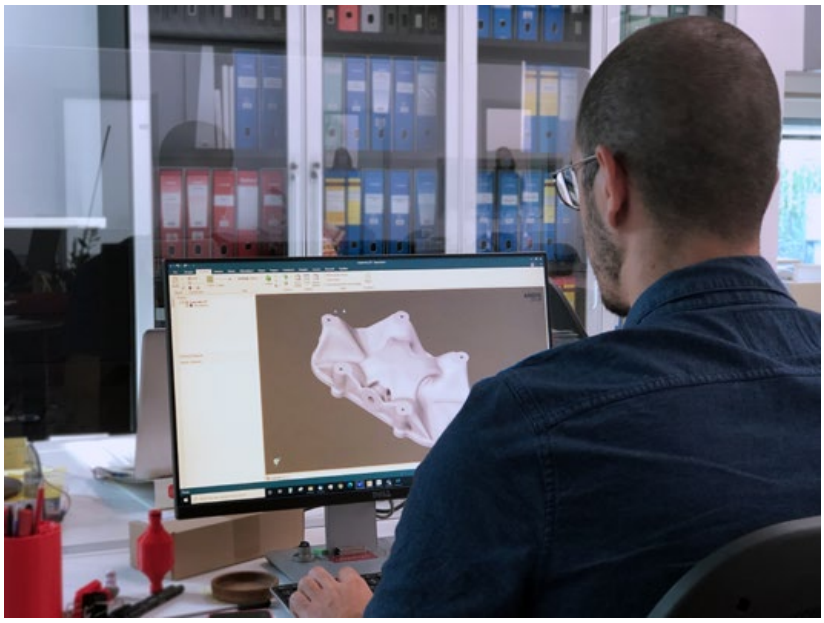

Fig. 10 AM application development at Aidro (Courtesy Aidro)

In the latter case, the object must be designed from scratch, using established practices of designing for AM, but keeping in mind the final application at all times. "It is all about understanding what the exact requirements of the application are, in order to identify the right design for each individual component," explained Tirelli. "Keeping the dialogue open with the client, together with the possibility to run fluid dynamics simulations to continuously test the level of efficiency of the components, ensures a final design that is as optimised as possible for its specific function."

To achieve this optimisation, taking full advantage of AM's 'freedom to design', it is important to take the entire workflow into account. In post-processing in particular, conventional operations such as machining come into play to generate final surfaces, usually for those joints and extremities of the additively manufactured parts that have to connect to other components within the hydraulics system. "Additive Manufacturing

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Fig. 11 Celebrations at Aidro for the announcement of its acquisition by Desktop Metal (Courtesy Aidro)

has to be integrated with traditional methodologies," Tirelli clarified, "which means that it is not supposed to replace established production processes, but to stand in beside them, and satisfy those requirements that otherwise could not be met."

A catalyst for growth: the acquisition by Desktop Metal

In early September 2021, Aidro was acquired by Desktop Metal, one of the most high-profile companies in AM and, amongst others, a provider of metal Binder Jetting technologies. The acquisition was announced with an air of huge excitement for both parties, motivated by the prospect of combining Aidro's expertise of the AM production of hydraulics components with Desktop Metal's technical resources and metal Binder Jetting solutions.

Although the acquisition appeared to happen rather suddenly, Tirelli remarked that growth has been on the cards for Aidro, and that the acquisition was not entirely unexpected. "We were not actively seeking to join with bigger groups", Tirelli said, "but the substantial changes in quality management and technology development that we have undergone in the past few years has prepared us for such an opportunity and laid the foundation for growth. It is what we've been building up to."

When Aidro started exploring metal AM technologies, PBF-LB was, among the AM processes available at the time, the most advanced and reliable, and, most importantly, the most suited for the needs of hydraulics. The technology was chosen for its mechanical properties and the many benefits it brought to a range of important hydraulic applications. Aidro has all intentions of continuing to utilise PBF-LB technology for those products that have the specific requirements that are best solved by this well-proven process. When it comes to the high-volume production of customised products, however, Tirelli believes that current medium-sized PBF-LB machines still have limitations. "This is why we always kept looking around. For the type and volume of products that we make, laser technology is perfect for special, niche applications. Binder Jetting will be the technology that allows us to achieve mass production of our innovative AM solutions."

Tirelli states that Desktop Metal approached Aidro in part because of the increased visibility of the company as a promoter of AM, and that it is Aidro's advocacy of the technology, as well as tangible examples of successful applications in industry, that Desktop Metal recognised as the greatest asset of this modest-sized Italian company. "What we bring to the table is a concrete, realistic image of what AM can do. From the conventional production of hydraulic components to introducing AM and now to a further expansion of AM

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processes, we can see that the technology will become more and more the core business of our company. This is why I believe that, despite our small size, we can become a point of reference for the hydraulics industry."

Aidro's objective is now to start exploring the new technologies provided by Desktop Metal. "As we did with laser, we have to prove the effectiveness of the technology. Of course, we now come from a position of far stronger experience. Compared to five years ago, when we had to learn from scratch, today we have much more understanding with regards to design, tests to be run, post-processing etc. We are ready to take the machines home, start immediately to make products, and try to realise all the ideas that we have. We now have the chance to make these ideas a reality."

Tirelli recognises that there is still a lot of work to do to get Binder Jetting 'up to speed'. Compared to PBF-LB, Binder Jetting has a long way to go in terms of market penetration, the validation of the technology, and the many complexities surrounding standards and qualification. However, Binder Jetting has the potential to replace conventional manufacturing by enabling the high-volume production of customisable products in shorter time frames. Tirelli commented, "The importance of having an alternative technology to casting is especially evident in a post-pandemic world where foundries are experiencing difficulties in supplying raw materials and components, with a consequent dragging-out of delivery times. Thanks to Binder Jetting, we hope to overcome the drawbacks of long delivery times by producing in-house, without having to rely on external suppliers."

The Aidro team is now waiting for the first Binder Jetting machines to arrive, and is eager to run the first tests and get down to business. "It will be necessary, at first, to establish a space for mutual learning", said Tirelli. "The next step is to investigate the technology, and we intend to do so not only by taking full advantage of Desktop Metal's resources, but also of our connections with the Politecnico Milano, other research centres, and, of course, other AM promoters in the Italy or the US. AM has from its inception always fostered a strong sense of community when it comes to advancing and validating the technology, and we know we will receive the support we need."

Fig. 12 Alberto Tacconelli, General Manager, Aidro srl; Valeria Tirelli, co-CEO and President, Aidro srl; Ric Fulop, CEO, Desktop Metal; Tommasso Tirelli, co-CEO VP Business Development, Aidro srl (Courtesy Aidro)

> *"The importance of having an alternative technology to casting is especially evident in a post-pandemic world where foundries are experiencing difficulties in supplying raw materials and components, with a consequent dragging-out of delivery times."*

Aidro's experience with laser technology has taught it how crucial it is for the overall success of the new technology to be able to provide exact data. The process of acceptance, Tirelli remarked, will be the same. "Whether it is Binder Jetting or laser, the first thing our clients want to know are mechanical properties and test results." They are therefore committed to walking the same steps that confirmed PBF-LB as a safe, repeatable manufacturing approach.

Tirelli stresses that she believes Desktop Metal highly values the team at Aidro, as well as its clients, and she is keen to ensure that there is uninterrupted continuity of customer relationships. "The acquisition will not in any way disrupt Aidro's present activity, but rather open the doors to exceptional opportunities for

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Fig. 13 Aidro collaborated with watch designer Riccardo Tiboni to create the 'Octopus', the first watch to be produced by Additive Manufacturing by Materiaggiunta Watches. It was premiered at the Watches of Italy event, September 25–26, in Tortona (Courtesy Aidro)

cooperation. The idea is of a collaboration that allows us to bring together our strengths for mutual benefit. They provide technical support and equipment, while we contribute our knowledge of the hydraulics sector, which is considered a very important sector for its far-reaching applications, as well as our knowledge of design for additive. The next months will see a growth both on a technical level and of Aidro's engineering team – because in the end, what really makes the difference is people."

With this in mind, the company enters the vast, fast-growing family of Desktop Metal, in a spirit of reciprocal exchange and togetherness. "The feeling is to be in a family", says Tirelli, "where people are recognised for their value. I can see the definite will to work together for a common good. Desktop Metal has been given a lot of trust from the market, and after due consideration, we decided it was worthy of our trust as well."

Current and future challenges

According to Tirelli, there are two major obstacles to the wider adoption of Additive Manufacturing in the hydraulics sector: productivity and mentality. As far as productivity goes, at the moment, there are only a few small AM components ready to enter serial production – one example being 'cursors': small valve parts that only reach up to 5 cm in length. In the case of bigger parts, the technology is not quite there yet. "Some technologies, such as Binder Jetting, show much promise for increasing productivity," added Tirelli. "And, of course, machine manufacturers are constantly at work to produce increasingly bigger, more efficient machines."

Mentality may be the hardest obstacle to overcome. Tirelli states that, in this case, to be able to validate the technology as an established manufacturing process, it is fundamental to communicate its potential both to the engineers and management of manufacturing companies.

"Mentality may be the hardest obstacle to overcome. Tirelli states that, in this case, to be able to validate the technology as an established manufacturing process, it is fundamental to communicate its potential both to the engineers and management of manufacturing companies."

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"In our experience, if there isn't pressure from the top and from the bottom, at some point the process will come to a halt. There needs to be communication between the two levels, and open-mindedness at all levels. At that point, I believe, AM will succeed in becoming a technology acknowledged and widespread in every sector."

"In this particular moment," she continued, "every sector of mechanics is suffering from a lack of raw materials and components. Due to the pandemic, and the higher cost and limited availability of raw material, delivery times drag on for weeks – sometimes months. This is the perfect moment for Additive Manufacturing to flourish. The market needs quicker reaction times: this is the moment to make AM a fully integrated productive technology."

For this reason, Aidro's team plans to keep growing and promoting the technology as forcefully as they can. Tirelli concluded, "A few years ago, we were crazy enough to invest in the technology. Now that we have relationships with leading players in the industry, we are ready to take the next step and become one of the focal points of Additive Manufacturing in our sector."

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Autumn 2020

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- Additive Manufacturing of hardmetals: An evaluation of potential processes for tool production
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I want to break free: The journey towards reducing or eliminating support structures

Support structures have been there for us since the beginning of AM, anchoring us to a firm foundation and taking the heat when things get intense. But they also bring with them baggage that is now holding us back, blocking channels and taking up valuable time and materials. Is it time to break free? In this article, Jennifer Coyne and John Barnes, of The Barnes Global Advisors, explore our journey so far with support structures, their advantages and disadvantages, and consider the opportunities and impact of the shift towards 'support free' strategies. Through three case studies, cost and productivity of conventional and 'support free' production are compared.

As we contemplate recent developments that minimise the need for support structures in Powder Bed Fusion (PBF) Additive Manufacturing, Queen's 1984 hit song 'I want to break free' inevitably plays in our heads. In the AM world, nothing elicits a strong reaction like the mere mention of supports and support structures. It's with mixed emotions that process engineers will design them in to hold the build together until completion; but, at the same time, they know that some geometries cannot be built without supports. How do they break free?

In our minds, there is an AM pub where regular arguments break out about the best kinds of supports: pins, curtains, on and on. The group commiserates as they share tragic support removal stories of hands being punctured with tools from the 19th century. The materials engineers sit on one side of the bar and cast condescending looks at their mechanical engineering colleagues, because, after all, the supports aren't just about mechanics: they affect the microstructure. Regular arguments break out. Supports hold the part in place! No, supports control solidification! In the shadows of the AM pub, programme managers sit with crossed arms muttering about the need for a business case. Everyone wants the option to break free of supports.

In the regular world, supports, supporters and support networks are all good things. You support a colleague having a bad day – perhaps after having hurt themselves removing a block support or lost a build because the support separated and caused a recoater jam. In the AM world, supports limit what can be made, because they take time to build, consume material, and cost more money to remove and dispose of, so there is a real expense

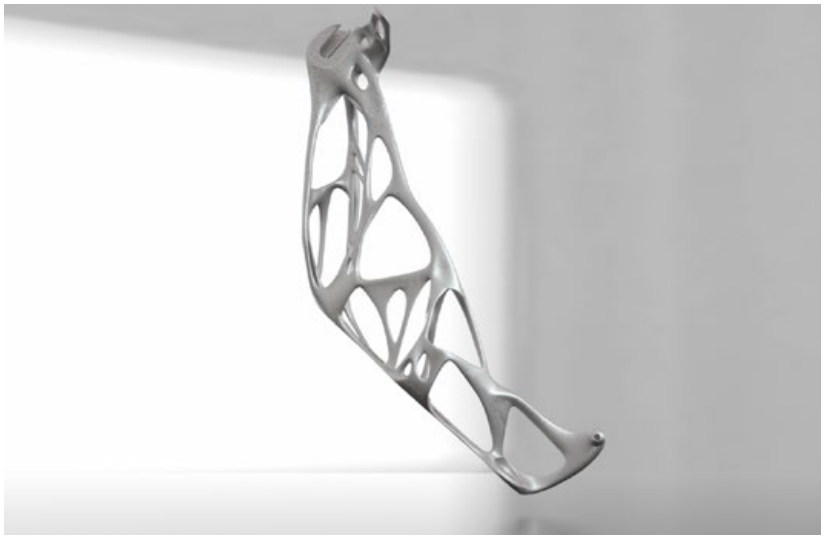

Fig. 1 The ability to reduce support structures has become a hot topic in Laser Beam Powder Bed Fusion (Courtesy SLM Solutions)

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associated with them. They also limit which geometries can be made, and while Design for AM (DfAM) can help reduce or eliminate the need for supports by re-examining the product requirements and consolidating parts, for some parts, where Modify for AM (MfAM) may be the only approach, the need for supports limits what geometries can be additively manufactured. And that's an issue. Rather than improving performance by modifying the design, we are likely reducing it.

As of 2021, there are several approaches to solving these problems. System architecture has been introduced to allow further design flexibility via the ability to additively manufacture lower angles and/or eliminate external supports altogether. Software approaches exist that help mitigate the need for support through simulation and optimised orientation. Do these systems then have costs associated with them? The software approaches cost money and take time. Is 'support free'... wait for it... free? In this article, the team has taken our data-driven approach to elucidate the benefits of these different approaches against the two situations: 1) economics – the cost to make and remove supports – and 2) design – the design freedom enabled when supports are not needed.

What is support free AM?

The history of 'support free' is quite interesting. Originally, support free was used to describe the ability to reduce the need for supports through topology optimisation, or simply a mathematical calculation to minimise the inherent mechanical need for a support. More recently, it is being used to describe the ability to reduce or eliminate supports through the use of geometry-specific machine parameter optimisation. Multiple machine vendors now offer a support free capability.

Support free AM is a subset of *a priori* [1] or 'intelligent feed forward' [2, 3] control. Feed forward involves the control of machine parameters associated with various scan patterns or geometries with the goal of minimising defects. One of the earliest reported implementations of feed forward was in 2016 [4], and one of the earliest reported uses of support free was in 2017 [5]. Commercially, one early concept was implemented by the company Realizer, called RDESIGNER. Today feed forward and support free are being implemented and actively promoted by a number of Laser Beam Powder Bed Fusion (PBF-LB) machine producers.

Reasons for supports

There is obviously a reason to use supports, so we went back and researched the origins as well as all the benefits supports offer. Supports have been in use since the earliest days of stereolithography. This earliest AM technology exemplified the initial purposes of supports:

1. Keeping the part in place
As AM builds layer by layer, it is vital that the position of the part being built is known, so that each layer is aligned with the one below it. If not, the part will contain stitch lines where the layers are misaligned and the part surface is notched; or, if the thickness of the feature is smaller than the misalignment, the part is discontinuous. The best way to maintain proper alignment is by affixing the part to the machine bed. Supports initially serve this role by anchoring the part to the machine bed. In the case of larger and more complex parts, especially in processes with solidification shrinkage such as Powder Bed Fusion, supports may be used higher in the build to better fixture those locations.

2. Countering recoil pressure, gravity or consolidation forces
The other initial role is in supporting downskins, which are portions of the part that do not have solid material below them. Up to a certain angle off vertical, surface tension is sufficient to overcome the effects of the laser such as recoil pressure on the powder, gravity, and surface tension. After that, however, some form of physical support is necessary. The angle and the distance are a complex function of liquid viscosity and surface tension. In the case of PBF, the properties of the powder below the melt puddle and the solidification of the puddle are also factors.

An early example of reducing or eliminating supports was achieved in the Arcam Electron Beam PBF (PBF-EB) process, developed by what was Arcam AB and is now GE Additive Arcam EBM. In this case, the electron beam is used to lightly sinter the powder bed to improve its mechanical properties to better hold the part in place and to support downskins. The development of the variants of PBF has resulted in additional reasons for supports, such as:

3. Achieving steady state
The heat extraction and stiffness of the solid build plate below the first layers differs significantly from the powder bed that is encountered for most of the part. This can be accommodated by adjusting the height and density of the initial supports below the part to allow for the first layers to see a thermal and mechanical environment more akin to that of the upper layers.

4. Consistent microstructure
Beds of powder are quite good thermal insulators, which means that parts having different thicknesses will have a variation in how the heat is extracted from the different regions, resulting in inconsistent microstructure which will then yield variation in material properties. Differences in cooling rate will result in variable shrinkage, residual stresses, dimensions, and microstructure throughout the part. Supports can be added to specific regions to improve heat extraction to better homogenise the thermal history of the part.

5. Electric current dissipation
Unique to electron beam PBF processes, the supports are used to close the electric loop by providing a conduction path to the ground plane of the machine.

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The need for supports, however, impacts the design, build, post-processing, and, potentially, the service usage of AM parts.

Consequences of supports

As we have noted some of the positive things supports do for us, let's now discuss the negative consequences. Noted previously, supports have an overall impact on both economics and part design. Assessing the economic impact on the process is essential, and is useful to part design as well, so we'll discuss the financial impact of supports first.

ECONOMIC IMPACT

1. Build time & powder consumption
In a typical part, the build process can represent ~40% of the overall cost, whereas post-processing is ~50%, and the balance is the material cost. Using supports affects all three categories. Supports typically take the form of wasted material; they enable the process, but, unless they are somehow incorporated into the design to fulfil multiple functions such as honeycomb type supports that also serve as cooling channels, they are ultimately removed and discarded. These supports add build time and consume material that increase the total cost of the part, and the MfAM and DfAM skills required to design them out are certainly above average.

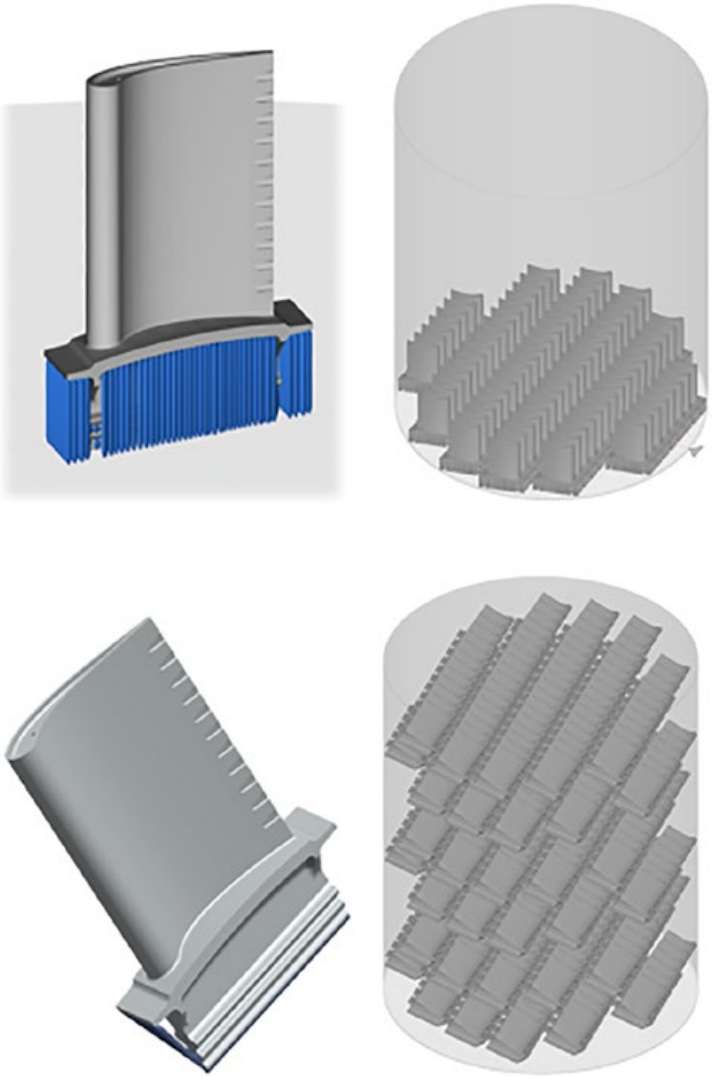

Fig. 2 A simulation of two builds showing when (top) supports are required and (bottom) how support free capability enables 'stacking' of parts. The productivity, specifically the output, of the machine on the right is much higher than the output of the machine on the left

2. Post-build processing
Supports not only add time during the build process – they also are a significant driver of post-processing time. Supports can make the de-powdering process more complex, especially in the case of lattice or honeycomb structured supports that trap powder. They also add time to part handling as most supports need to be removed from the final build by machining or using hand tools (snap-off supports). They can even create hazards such as sharp edges. All of these post-processing concerns ultimately increase cost by requiring non-value added labour.

3. Unproductive use of the AM machine
Fitted with our economist's green visor and calculator, using supports can limit use of all the available production space, therefore limiting the productivity of the machine. Supports hinder the full use of the build volume, making stacking, floating or nesting of parts in the vertical direction difficult, if not impossible. Inefficient part orientations are another possible impact of supports. The requirement for a supported surface to build on also drives inefficiencies in how the build volume is used.

Closely associated with #3, we see that eliminating and minimising the need for supports attached to the base plate allows for higher productivity; more specifically, it increases the AM machine's output. Electron Beam PBF and Binder Jetting technologies have always enjoyed the option to 'stack' or 'float' parts into the vertical volume of the bed. Fig. 2 shows an example of a generic turbine blade where eighty parts can be accommodated in a single layer using the traditional supports-required approach – but, when stacking is an option, the same machine can make upwards of 450 parts in a single build!

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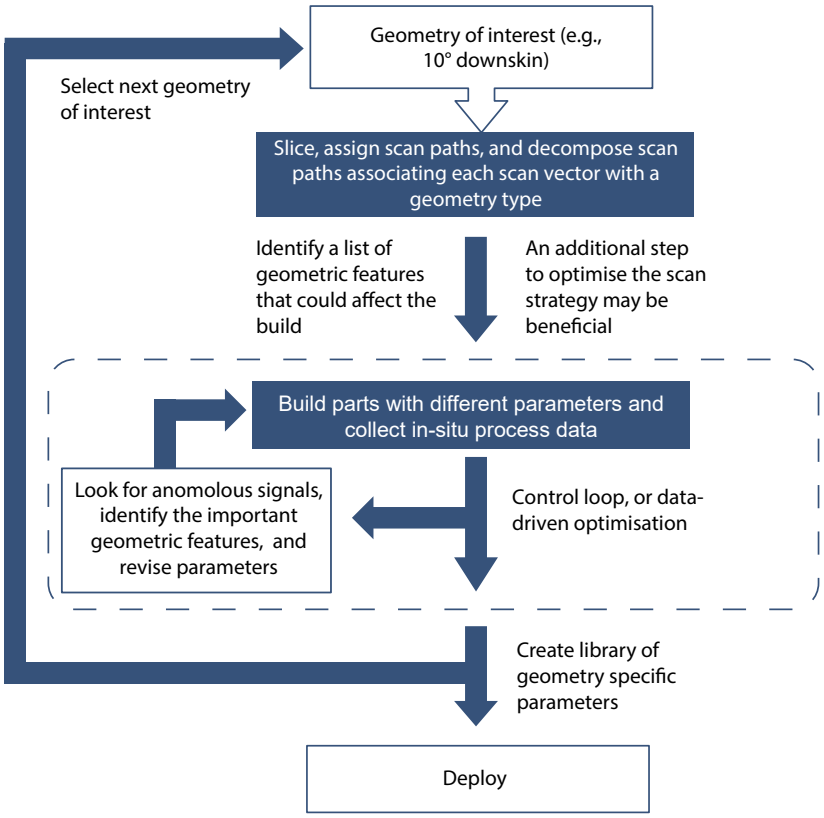

Fig. 3 Workflow for development of machine parameters from the perspective of the machine manufacturer

DESIGN IMPACT

Now that we have addressed the financial implications of supports, we will now consider their impact on part design.

1. Complexity

One selling point of AM is 'design freedom', but, after reviewing a list of design rules such as no diameters larger than X, or strict avoidance of overhang angles > Y, a design engineer may argue that AM can be quite restrictive. These design rules are specific to the process and create rules of thumb for best incorporating supports to the design to support features that may otherwise cause a build failure. They also force the design engineer to really understand the requirements of the part, such as, "do those fluid passages really need to be round?" (re: DfAM).

For the most part, this forced requirements review is a great exercise to reimagine the problem and unlock new potential or performance. Other times, when a spare part is required and any change in geometry means a system-level revalidation of performance, these restrictions can create design hurdles (re: MfAM). In either case, the time consumed chasing answers hinders the business case.

2. Surface finish

After support removal, supported surfaces may require post-process finishing to remove sharp edges and rough surfaces. Of course, some of these supported downskin surfaces may have required surface finishing regardless. When supports are removed from internal surfaces, it may affect requirements, like fluid performance, in an unpredictable way. Emerging process technologies using chemical, electro and/or abrasive methods are being used to remove supports (especially those in hard to reach internal locations) and treat surfaces at the same time.

Methods for minimising or eliminating supports

It's clear that the need for supports complicates things; this is probably why the topic of supports is among the first listed in the cons list for adopting AM. If the industry is to move forward to larger production volumes, manual processes need to be either automated or eliminated. As with most problems, there is more than one solution. We will now look at some of the support reduction methods enabling the reduction or elimination of supports.

Feed forward – controlling power and speed

As mentioned earlier, support free Additive Manufacturing is a subset of *a priori* or 'intelligent feed forward' control. Feed forward involves the control of machine parameters associated with various scan patterns or geometries with the goal of minimising defects. Today,

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commercial implementation of feed forward involves parameter development by the machine manufacturer and implementation and optional tuning of the parameters by the machine owner. While these implementations are mostly proprietary, our view of how the development of process parameters might proceed is illustrated in Fig. 3.

Initially, the manufacturer identifies geometries of interest which might include inclined downward facing surfaces, thin walls, unsupported overhangs, or internal channels. The geometries are then labelled with features that characterise the geometry. Test parts that exhibit these geometries are then designed and sliced. Scan paths are generated and then decomposed into scan vectors that are associated with the features. For example, each scan vector is interrogated to see if it is over powder or solid material.

Then, initial parameters are assigned to the individual vectors based on the geometry. There are numerous features that could be used to describe the relation of the vector to the geometry. The premise is that the applied power should depend on the local thermal boundary conditions. For example, is the current scan vector over powder (poor thermal conductor) or solid (better thermal conductor)?

Vectors that are not close to boundaries are assigned bulk parameters. Vectors that are close to boundaries are given diminished parameters depending on how close they are to the boundaries. Laser power or speed are the most likely parameters to be adjusted based on the geometry. In past implementations, power has typically been selected for PBF-LB because it can be changed very quickly. For PBF-EB, speed is varied [4].

The scan vectors and associated parameters are then loaded in the machine, and test parts are built. During the build, in-situ process monitors are used to record a signal that is related to the melt pool (e.g., a photodiode signal).

"The less apparent, software-driven part of this approach is in the control of the scanning parameters. By integrating geometry, a thermal/process model and process monitoring, the Velo3D approach reduces thermal stresses and distortions that can drive the need for supports."

After the build, the part geometries are observed and the best selected. The associated process monitoring signals are reviewed for anomalies (scan vectors that are too hot or too cold), and the parameters for the scan vectors that exhibit anomalies are corrected to reduce the deviation. In the optimisation process, the list of geometric features is reviewed to identify the most important features and optimisation is restricted to those features. The build is repeated with the revised scan vectors until the parameters are optimised. Then, the next geometry is selected, and the process is repeated until all geometries have been completed and parameter sets have been optimised.

In-situ monitoring

In the case of Velo3D, a holistic hardware and software approach is taken to reduce or eliminate the need for supports. The most apparent of these is the use of a contactless recoating system. This feature eliminates one need for supports, which is to secure the part in the Z-direction to prevent the recoater from catching on any protuberances positive to the surface of the bed. The less apparent, software-driven part of this approach is in the control of the scanning parameters. By integrating geometry, a thermal/process model and process monitoring, the Velo3D approach reduces thermal stresses and distortions that can drive the need for supports.

Vector technology for thermal management

In all approaches, building without supports is an evolution in the understanding of a PBF-LB machine; a key focus is thermal management of the melt pool. SLM Solutions' Free Float approach is an example of this evolution, which started with development of process parameters for thin features and evolved into a solution for support free AM.

In this case, SLM Solutions created a bolt-on software product, compatible with newer machines, that allows users to select from three different profiles depending on the part quality and support elimination desired. After traditional build prep is complete, the slice file is loaded into Free Float and profiles are applied to the slice file.

The approach uses a vector technology to create a steady melt pool. By applying different profiles, the part has the time it needs to cool down instead of melting additional metal powder for supports. The goal is to achieve an equal build time compared to a standard build with conventional supporting, and generate savings in reduced post-processing and powder usage. The fact that the product is retrofittable to the company's 2018+ machines shows that the secret is in the scan strategy. The breakthrough here is knowing how to control the laser power versus the geometry and packaging this power for the typical AM user in an easy control interface.

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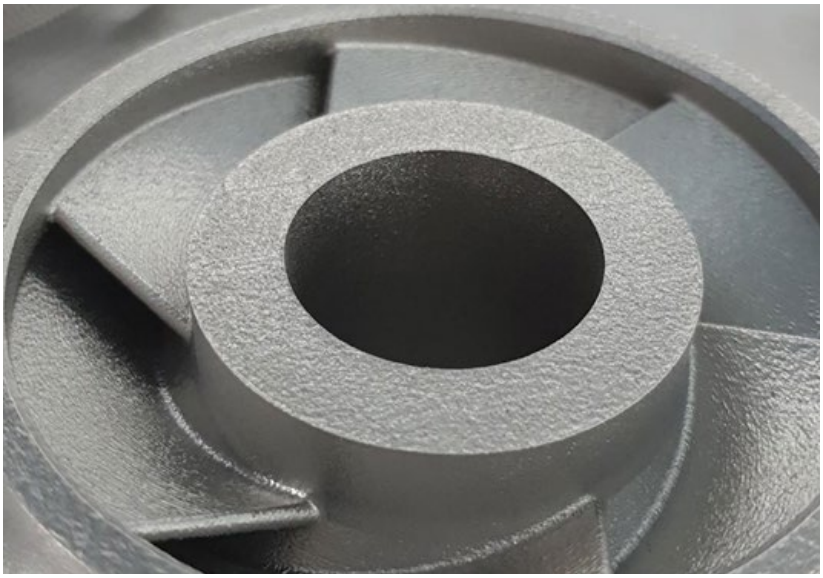

Fig. 4 Detail of the impeller geometry

Better defined segments
An emerging approach, demonstrated by Dyndrite, further discretises the geometry and defines scan segments based on where they sit in the build volume. Imagine each layer of the 3D model having tiny segments with defined fields such as downskin, upskin, normal vectors, etc. The fields can be assigned a priority order (e.g., if a segment has both a downskin and normal vector field in it, downskins are identified as more critical and take precedence).

The tool gives the user the ability to define the important fields (based on geometry rules), query them, and combine or prioritise them, all before assigning the toolpath or parameters. The software itself doesn't eliminate the need for supports; rather, it is a tool that allows the user to define, query, and order different sections of the geometry to treat them differently. A software engine like this could bring support free to all, even those OEMs or users without a huge software development team.

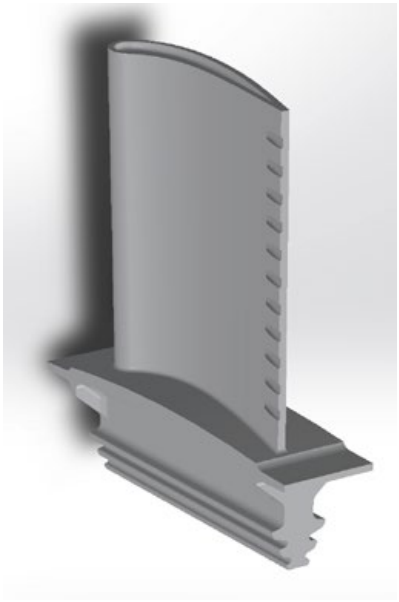

Fig. 5 A representative image of the turbine blade

Considerations when minimising or eliminating supports

As these support elimination approaches mature, some may wonder how to eliminate supports on their existing machines. Some methods to minimise, or even eliminate, supports include careful part design, build orientation and layout enhancement, build time adjustment, parameter optimisation, in-situ process monitoring, and machine type consideration.

Part design
It always comes back to design. Reducing or eliminating supports can be achieved by following design rules (MfAM and DfAM) such as avoiding angles greater than X, hole diameters greater than Y, etc. Clever design approaches incorporate supports into the function of the part, such as structures that simultaneously support features and act as fluid passages.

Build volume use restrictions
Restrictions include the inability to stack parts and inefficient or limited part orientation options. When the design is fixed, modifying part orientation and build layout can be an effective way to eliminate or reduce supports. For example, part orientation can be adjusted to minimise unsupported angles.

Build time
Slowing down the scan speed can be an effective way to reduce the amount of heat in the part and the subsequent need for supports in some sections. This creates a trade-off between the extra time you put into the process (and path planning) compared to the time saved by reducing post-processing time of removing supports and treating surfaces as required.

New and different parameters
Adjusting machine parameters like laser power or scan strategies and speeds is another way to reduce the need for supports. These machines can have hundreds of adjustable parameters, so this method requires a very experienced user. The parameter sets that enable support free are often developed and progressed by machine OEMs. As long as the machine has the same architecture (gas flow setup, laser power, optics, etc.), the parameter sets should be transferrable between machines with the same make/model; however, using the transferred parameter sets would still require requalification of existing fixed process qualified parts.

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Automated support removal

Another factor in the support equation is automated support removal. Several chemical, electrochemical, and mechanical-chemical post-processing technologies have been introduced that can not only smooth the surface of a part but can also remove supports [5]. One of these, called Hirtisation, is a two-stage process. While the second stage is used to smooth the final surface, it can be preceded by removing the supports, either before or after build plate removal. Depending on the geometry and final part surface finish requirements, it may be better to use a standard supported design and remove the supports as a post-processing operation.

Assessing the impact of support elimination

Now to the fun part! Our data-driven approach starts with several exemplar parts and two support scenarios. The parts are an impeller and a turbine blade, shown in Figs. 4 and 5, and a turbocharger, shown in Figs. 6 and 7. We first examined a scenario with standard supports, using a twin-laser 250 x 250 mm class PBF-LB machine. We then compared the Velo3D and the SLM Solutions options for minimising supports. We invited others to contribute, but they declined.

We analysed the entire part cost including feedstock, build, full post-processing (build plate and support removal, Hot Isostatic Pressing (HIP), heat treatment, surface smoothing, machining), and inspection (dimensional, NDT, and lot acceptance testing). Hirtisation is used as a semi-automated process for support removal and surface smoothing. The most economical batch sizes were used for HIP and heat treatment. Typical Organisation for Economic Co-operation and Development labour rates and a service bureau cost structure were used. Note that the same Quality Assurance (QA) cost is used for all three scenarios, although it can be imagined that the QA cost will be higher for a part with more supports

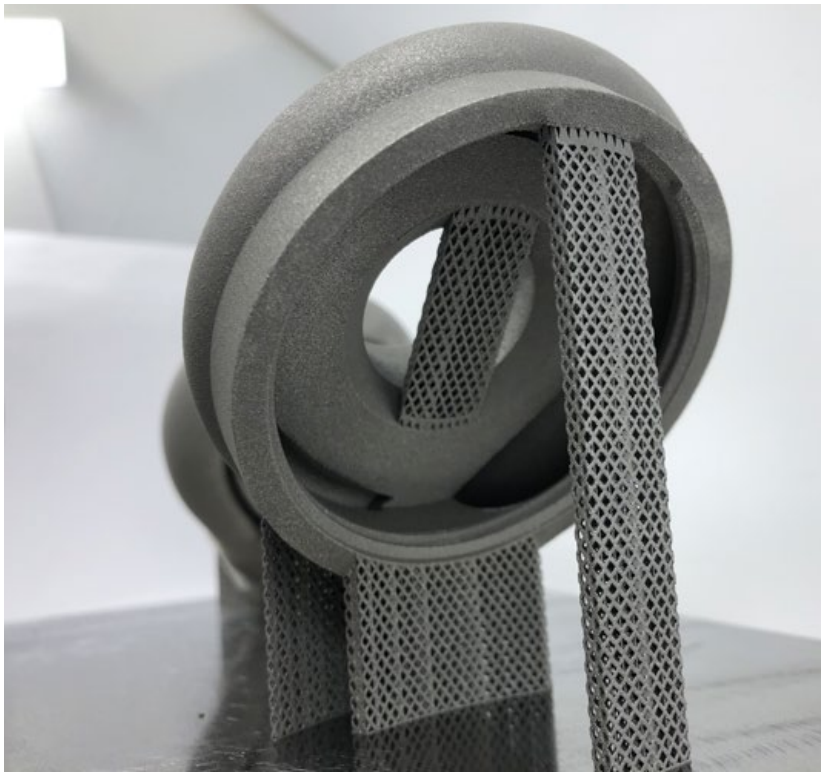

Fig. 6 The turbocharger with standard supports

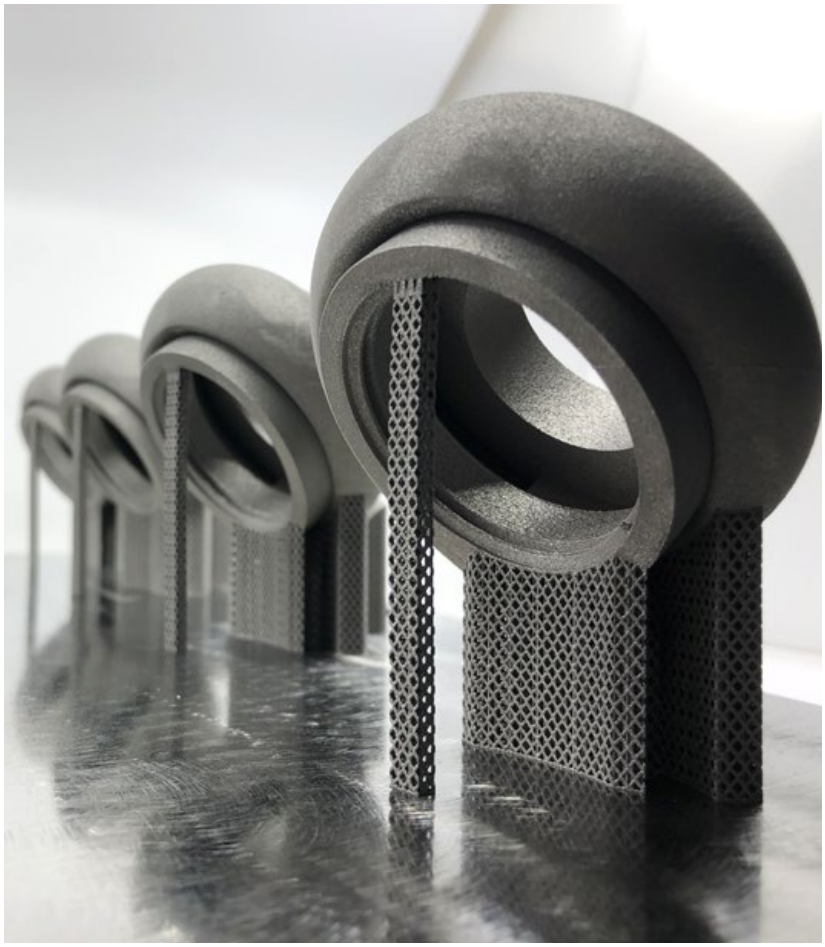

Fig. 7 The turbocharger with minimal supports

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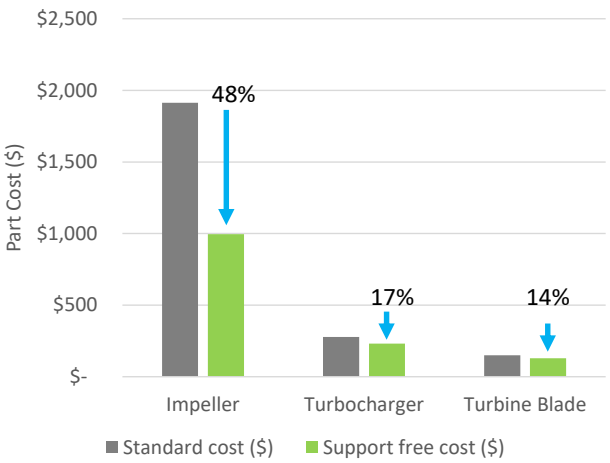

Fig. 8 Final part cost comparison of standard supports (250 mm build) and minimal supports for three different parts via Velo3D and SLM Solutions

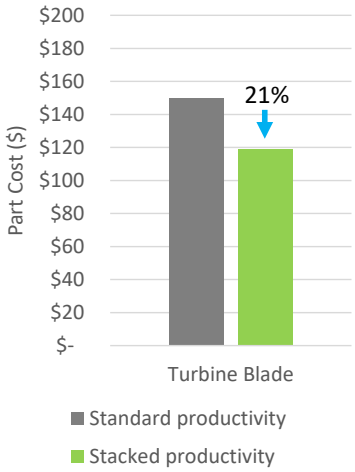

Fig. 9 Comparison of standard support 250 mm bed with optimised minimum support and stacking

"In all three cases, the reduction or elimination of supports reduced the cost of the finished part, with the cost benefit being highly dependent on part geometry. Just as important, however, is that the reduction or elimination of supports, especially for internal channels, provides greater design freedom and reductions in the number of inspection steps."

to verify complete and correct removal.

Fig. 8 shows the final part cost comparing a standard, twin-laser system with standard support concepts to the newer Velo3D and SLM Solutions minimal support scenarios.

For those interested in the details, the equipment analysed for the impeller and turbine blade employed the Velo3D Sapphire. The bed size in the Sapphire is 718 cm^2, only slightly higher than a 250 mm class machine (625 cm^2). The turbocharger employed the SLM Solutions' SLM®500 Quad 700 W. The SLM®500 has a 1400 cm^2 bed size compared to the standard 625 cm^2.

As an additional exercise, we then evaluated the impact of squeezing more productivity – i.e., output – from the turbine blade example. The minimised use of supports enabled more blades to be produced by conserving space for blades in a given layer, and also allowed use of the vertical height of the build volume. Fig. 9 shows the total change in part cost reduction from the standard support 250 mm class system with minimised supports and stacking.

In all three cases, the reduction or elimination of supports reduced the cost of the finished part, with the cost benefit being highly dependent on part geometry. Just as important, however, is that the reduction or elimination of supports, especially for internal channels, provides greater design freedom and reductions in the number of inspection steps. In the case where the elimination of supports allows for tighter part packing (i.e., the turbine blade) or where minimal surface smoothing is required, the elimination of supports will provide further cost benefit.

Conclusions

Back in the AM pub, what have we learned? Two things are now obvious to us. That minimising supports via these many methods is good for opening the design space and enabling previously difficult, cost prohibitive or just impossible geometries to be built, and that the journey we are on is enormously positive.

While the impeller has impressive part cost benefits, the turbine blade and turbocharger are moving in the right direction, though not as significantly. However, we know the technology will only get better.

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A likely third lesson we can take away from this work is that, in concert with improved software, finishing methods catering to layer-wise powder builds will improve the productivity of AM, which will open the application space and appease the programme managers looking for that elusive business case.

You'll note that we fell well short of saying 'it depends' – which, of course, it does. The results of this work clearly indicate that geometry, part size and orientation effects play a big role. We are quite excited about these advancements, because clever people will always find a way to make the best use of new technology.

What it further illustrates is the complexity inherent in these advanced PBF AM machines. Materials science, optics, sensors, mechanics and an entire multidisciplinary team are at work every time a beam of energy hits the surface of a powder bed, requiring simultaneous optimisation, control and sensing to occur. If Queen correctly, if unintentionally, predicted that the AM industry would "want to break free" of its supports by 2021, perhaps it could also signal the end of the era of "another [part] bites the dust"?

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References

[1] S. Clijsters, T. Craeghs, J.P. Kruth, A priori process parameter adjustment for SLM process optimization, in: P.J. Bartolo, A.C.S. DeLemos, A.P.O. Tojeira, A.M.H. Pereira, A.J. Mateus, A.L.A. Mendes, C. DosSantos, D.M.F. Freitas, H.M. Bartolo, H.D. Almeida, I.M. DosReis, J.R. Dias, M.A.N. Domingos, N.M.F. Alves, R.F.B. Pereira, T.M.F. Patricio, T.M.D. Ferreira (Eds.) *Innovative Developments on Virtual and Physical Prototyping*, CRC Press-Taylor & Francis Group, Boca Raton, 2012, pp. 553-560.

[2] D.L. Bourell, M.C. Leu, D.W. Rosen, Roadmap for Additive Manufacturing Identifying the Future of Freeform Processing, The University of Texas at Austin, Austin TX, 2009.

[3] W. Frazier, Metal Additive Manufacturing: A Review, *J. Mater. Eng. Perform.*, 23 (2014) 1917-1928. https://doi.org/10.1007/s11665-014-0958-z

[4] J. Wright, Additive Manufacturing of Tungsten via Selective Laser Melting and Electron Beam Melting, University of Sheffield, 2019.

[5] Unsettled Topics on Surface Finishing of Metallic Powder Bed Fusion Parts in the Mobility Industry SAE EDGE Report 2021001 e-ISSN 2640-3540.

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Simufact Additive: Accelerating the metal Binder Jetting workflow with sintering simulation

The ability to 'design out' distortion during sintering is seen as key to enabling the faster commercialisation of metal Binder Jetting (BJT). The Simufact Additive software platform, now on the third release of its BJT sintering module, is able to accurately simulate the sintering process, predicting shrinkage, slumping and friction-related distortion, either with or without 'live' and 'ceramic' setters, resulting in a downloadable 'compensated' component geometry to be fed directly to the AM machine. In this article, Jeff Robertson explores through case studies how The ExOne Company has been using the software in its AM adoption and R&D centres to optimise customer parts for sintering.

While the manufacturing industry has been successfully sintering parts formed with bound metal particles for volume production through the Metal Injection Moulding (MIM) process since the 1980s, newcomers to sinter-based AM processes such as Binder Jetting now want a fast and easy digital manufacturing solution more in line with the Additive Manufacturing mindset. Both MIM and BJT parts are created with ultra-fine metal powders, usually in the 10–30 µm range, and binders, with BJT using far less binder than MIM. In MIM, this pre-blend of powder and binder is shot into a mould. In BJT, the binder is jetted onto a layer of loose powder, layer by layer, until the final shape is created. In both processes, the green parts created from the bound powder must then be debound and sintered at just below the melting point of the metal powder until the particles are successfully fused to the desired density.

In order for metal Binder Jetting to realise its full potential as a high-speed, low-cost metal AM process for complex designs, it is widely acknowledged that the sintering process must be effectively managed. At ExOne, BJT can now reliably deliver final parts with high densities of 97+% for a wide range of metals, as well as dimensional accuracy of 1–2.5% on the first build, with even better results of less than 1% after a design has been optimised for the process (primarily sintering). Despite the ability to build and sinter BJT parts consistently, the challenges associated with large amounts of shrinkage and distortion still remain. Until recently, however, MIM and BJT experts have relied solely on their experience and iterative trial-and-error processes to nail down a final design that could be transitioned to high-volume production. This often

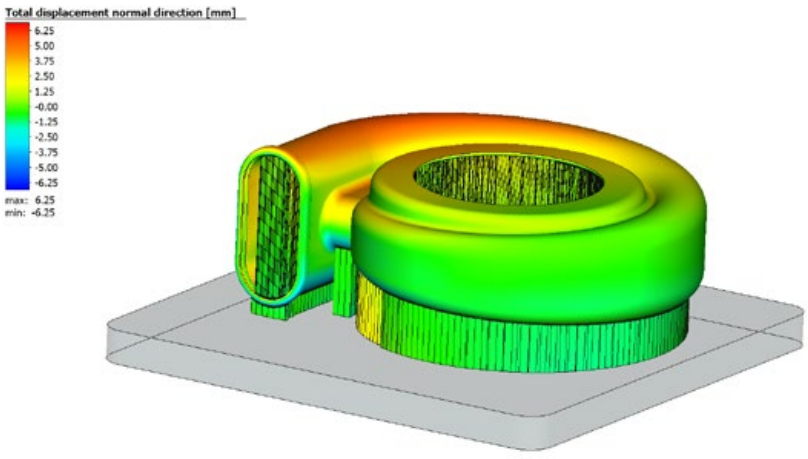

Fig. 1 Simufact Additive has been a class leading solution provider for metal Powder Bed Fusion (PBF) process simulation since its release in 2016. Here, predicted distortion of a turbo-pump housing built on a large format (400 mm) machine is shown

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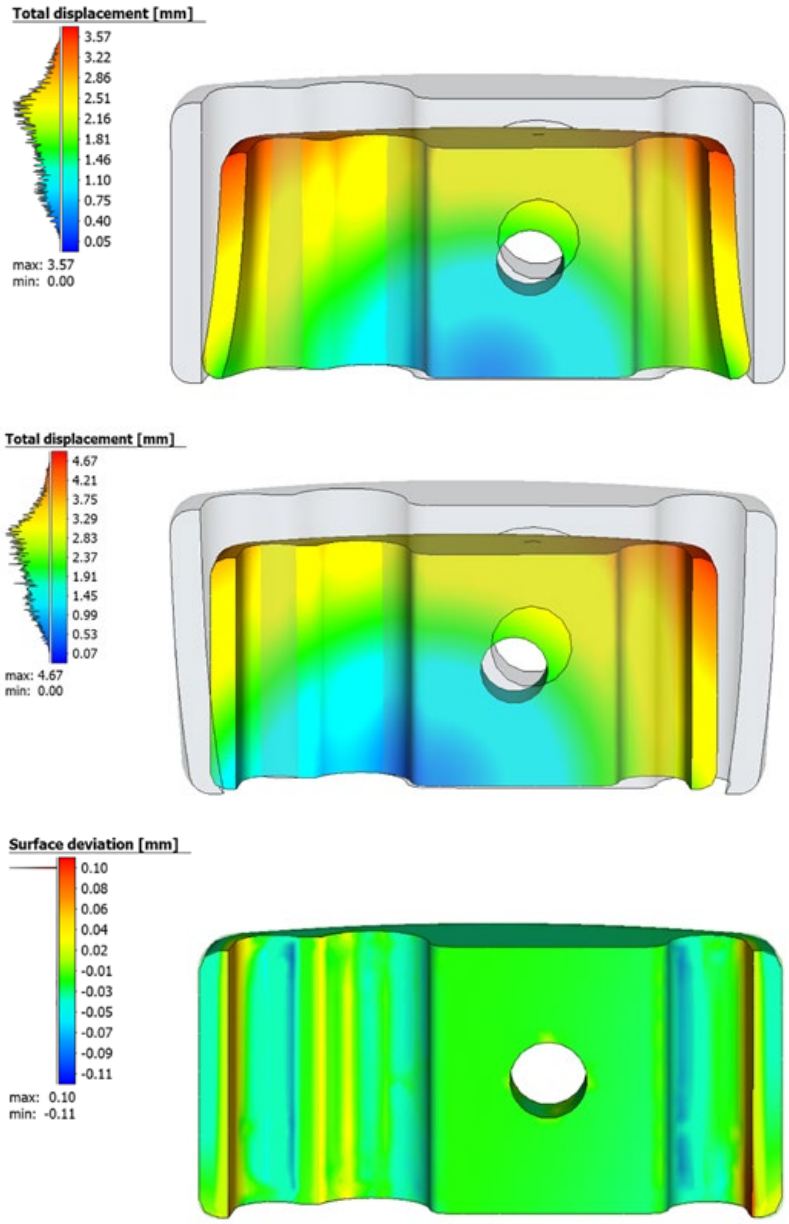

Fig. 2 Top: Distortion of nominal geometry, middle: Distortion of compensated geometry, bottom: Comparison between compensated and nominal

involves multiple iterations, as manufacturers work through distortion issues, such as slumping, with design changes and setters. At ExOne, it usually takes three or four iterations to dial in a complex part to its best Design for Additive Manufacturing (DfAM) accuracy.

With all the new excitement over BJT, and a strong desire across the industry to speed its adoption to serious serial production volumes, the market now demands a sintering simulation software that enables the DfAM process to be optimised for engineers who lack the extensive, somewhat tribal, knowledge of sintering phenomena which is held by the MIM industry. What's more, there's a belief that better simulation tools could reduce or eliminate the need for setters or other final finishing processes altogether, bringing increased efficiency to the BJT process and making it even more appealing for lower part volumes. With the successful implementation of effective simulation software to facilitate technological maturation, BJT may deliver on its long-awaited potential.

The Simufact approach to sintering simulation

Simufact Engineering, a division of Sweden's Hexagon AB, is a world-leading metal manufacturing process simulation software developer, which has been delivering best-in-class solutions for metal forming, welding, joining, and AM for more than twenty-five years. With this deep base of knowledge and experience, Simufact has a strong understanding of how to effectively model most metal manufacturing processes.

Simufact Additive has been a leading solution for metal Powder Bed Fusion (PBF) process simulation since its release in 2016. Following the success of the initial release, and at the request of some in the German automotive industry, Simufact set out to develop its own sintering simulation solution. The challenge of creating an entirely new modelling approach, one that had not been achieved despite previous attempts by the MIM industry, was not lost on the Simufact team. The challenge inherent in modelling the sintering behaviour of metal powders is that this involves much more complex multi-physics than have previously been included in Simufact's process simulation models.

Four years later, in 2020, Simufact added its metal binder jet sintering module to the same Additive user interface. Simufact Additive's BJT sintering module utilises a phenomenological, macro-scale finite element analysis approach to model the thermo-visco-plastic material behaviour of bound metal powders during sintering. Using the macroscopic method, Simufact does not model the individual powder particles or pores, but applies a continuum modelling approach to predict the net strains and distortion in a powder aggregate. "Dominant mechanisms during sintering are diffusion and viscous behaviour of the powder material

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which must be captured in the constitutive relations to effectively simulate the process," explains Dr Kiranmayi Abburi Venkata, Senior R&D Manager at Simufact Engineering. The included multi-physics incorporates the following phenomena:

Diffusion
Reduction and elimination of pores between the powder particles. This is the dominant behaviour that drives shrinkage.

Gravity
Slumping due to the effect of gravity when the metal becomes more viscous as it approaches melting temperature.

Friction with baseplate and/or setter
Drag due to friction between baseplate and part or setter can inhibit movement of the part and contribute to total deformation, as well as part failure.

Creep
The tendency of a solid material to deform permanently or in an inelastic manner under the influence of external loads, such as gravity, and friction at elevated temperatures.

Grain growth
Rate of diffusion changes as a function of grain size. As grains grow during sintering, the rate of shrinkage decreases.

Using Simufact Additive sintering simulation

Using the software – which is currently optimised for 316L, with other materials coming soon – requires about 5–10 minutes of setup. User inputs required include:

- Geometry of the green part
- Setter design and type details (live or ceramic), as required
- Sintering cycle details, such as ramp rates, temperatures and hold times
- Initial relative density
- Friction coefficient
- Relevant material properties such as viscosity, surface energy or shrinkage rate, grain size (if not included in the library)

The user then generates the finite element mesh using the built-in meshing capability, with a single-click 'Generate Mesh' feature that does not require any prior FEA experience. One may also add a reference geometry as the desired final output for comparison at this point. Simufact is even able to compare the simulation with imported scan data directly in the GUI.

After starting the simulation run, the first simulation results are readily available to review, enabling the user to observe the simulation results as the calculation progresses. Metal binder jet sintering simulation runs do not require any advanced hardware, typically running on an engineering laptop. Simulation runs for parts with average size and complexity usually finish in 5–30 minutes, with complex geometries taking longer, generally not longer than a day, to run.

The functionality in highest demand from industry is the ability to perform distortion compensation (Fig. 2). The ability to output a pre-deformed shape that, when additively manufactured and sintered, will result in a nominal geometry, has the potential to change the way the industry designs parts for Binder Jetting.

Simufact Additive enables the user to define the final component geometry they are trying to achieve, and the required maximum surface deviation. From here, the software takes over and automatically performs multiple iterations of compensation, getting closer to the desired outcome with each step (Fig. 3). Out of this automated iterative compensation routine, the resulting geometry will have a non-uniform compensation vector across the geometry surface; applying more or less compensation at various regions on the part. While this capability was originally developed to support a PBF-LB compensation workflow, it is even more critical due to the highly non-linear deformations

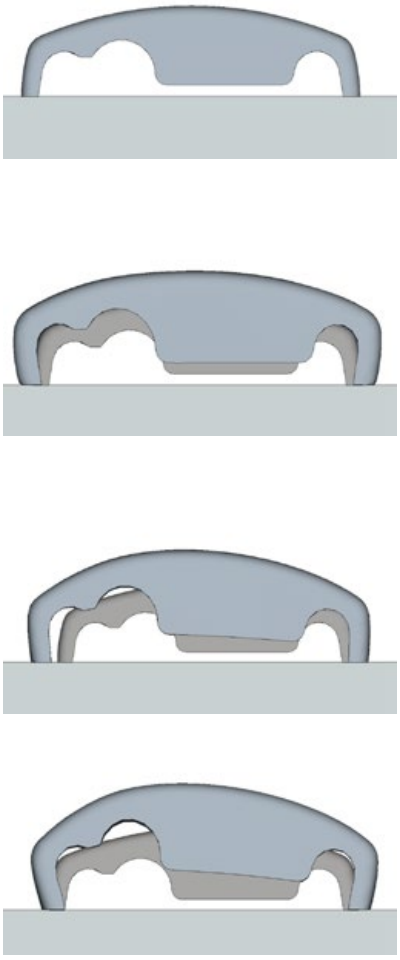

Fig. 3 Top to bottom: nominal geometry, first, fourth, sixth (final) compensation

inherent to the BJT sintering process. It should be noted, though, that compensation is not a silver bullet, and not all deformations can be effectively compensated. It is required that the design first yield a stable, controlled deformation without excessive non-linear behaviour.

Simulation to enable BJT DfAM

The process of DfAM in BJT is not that different from other AM processes; only the 'rules' are different. Process simulation software can be an effective DfAM tool that enables one to evaluate the effects of the manufacturing process given the combination of inputs, including:

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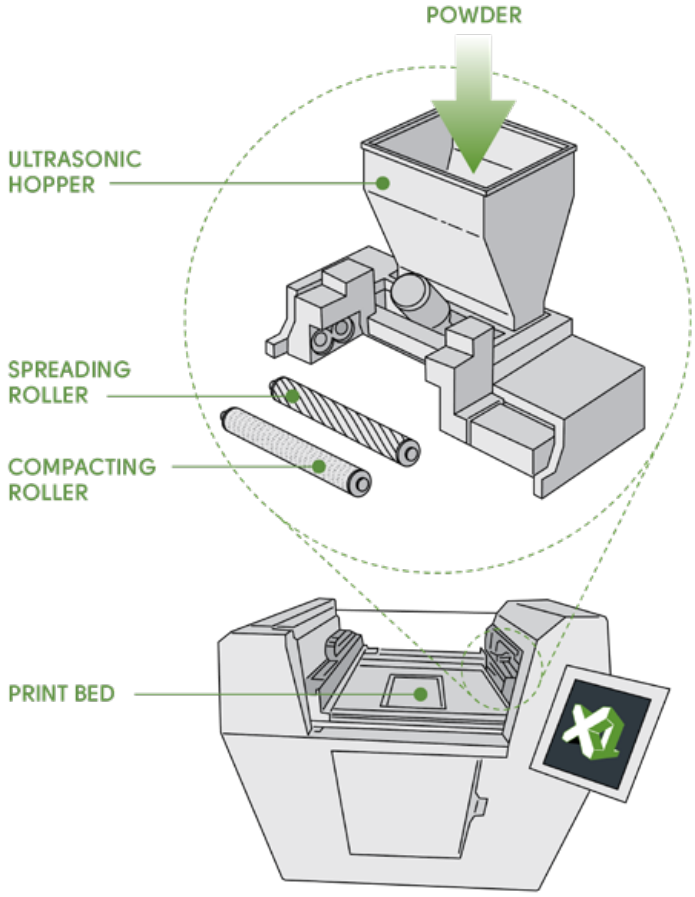

Fig. 4 ExOne's Triple Advanced Compaction Technology (ACT)

- Component geometry
- Sintering orientation
- Support/setter strategy
- Process parameters
- Material parameters

Changes to geometry may impact the desired orientation and support requirement. Changes to the orientation will likely also require changes to required supports (setters). All of these inputs will have an effect on the resultant part post sintering. It follows that the engineer must design the component geometry with the sintering orientation and support/setter strategy in mind; in an ideal case, the component would be dimensionally stable and totally self-supporting. However, this is generally not the case in practice. More often than not, a part that is not idealised for BJT is handed to the AM engineer responsible to build and sinter it effectively. In some cases, changes to the component design are available, in some cases, not.

Simulation software informs the designer of what will happen during manufacturing and enables them to quickly and efficiently evaluate in an effort to optimise the component design, orientation, and support/setter strategy. In this way, design engineers who do not have extensive experience and tribal knowledge of sintering behaviour may be able to evaluate various design trade-offs quickly and without the intervention of the more seasoned manufacturing engineers. When DfAM is done well, the engineer is able to find the optimal balance between part performance, dimensional stability, risk of build failure, post-processing effort, and cost. The iterative process of going from preliminary design to successful build and sinter can be reduced by several [design > print > sinter > inspection] loops.

The question is frequently posed (normally in the context of PBF-LB): Would you trade a bit of mass, stiffness, or whatever other performance metric is relevant for a part that will be guaranteed to build successfully, within dimensional tolerances, with no support removal required? The answer is: Maybe, but the compelling question illustrates what the design engineer may go through when generating new part designs. Process simulation gives engineers the opportunity to efficiently evaluate these design trade-offs with relatively low risk.

Another approach to determine the optimal design is through automated evaluation of many design variants. Simufact is able to be driven entirely by automated scripts. This capability enables the engineer to come up with potentially limitless design candidates for parametric/sensitivity investigation, queue them all up and run them overnight. Through the use of advanced automated result post-processing techniques, engineers can quickly review a large number of results and select the best design candidates for closer review.

Regarding accuracy and material characterisation

During development and validation work with industry partners, Simufact was able to achieve 95+% correlation (+/- 5% dimensional deviation) between simulation prediction and scan-based measurement. This level of accuracy of course requires special attention to material characterisation for a given 'recipe'. Much like in PBF-LB, a recipe consists of many contributing factors including powder, binder, build parameters, debinding, and sintering process parameters. Recent observations indicate that the software delivers 80–90% accuracy of out of the box with default 316L material properties, improving to 85–95% with limited calibration effort.

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One important consideration is that the software requires input of an initial relative density which is assumed to be uniform across the part. While the solver is capable of considering a non-uniform green part density, that information must be known and provided as an input to the simulation. However, the difficulty in obtaining such a density distribution experimentally hinders the utilisation of this data in simulation. Based on simulation sensitivity studies performed, a pronounced effect of non-uniform green density distribution on sintering behaviour is observed. Logically, improved uniformity of green part density will result in more uniform sintered density and a more predictable deformation during sintering. Therefore, it is essential to qualify the build stage such that the desired green density is achieved. ExOne's approach to reducing green part density variation lies with its patented Triple Advanced Compaction Technology (ACT), as shown in Fig. 4. Not all BJT AM machines can produce parts with the same level of consistency and uniformity in green part density.

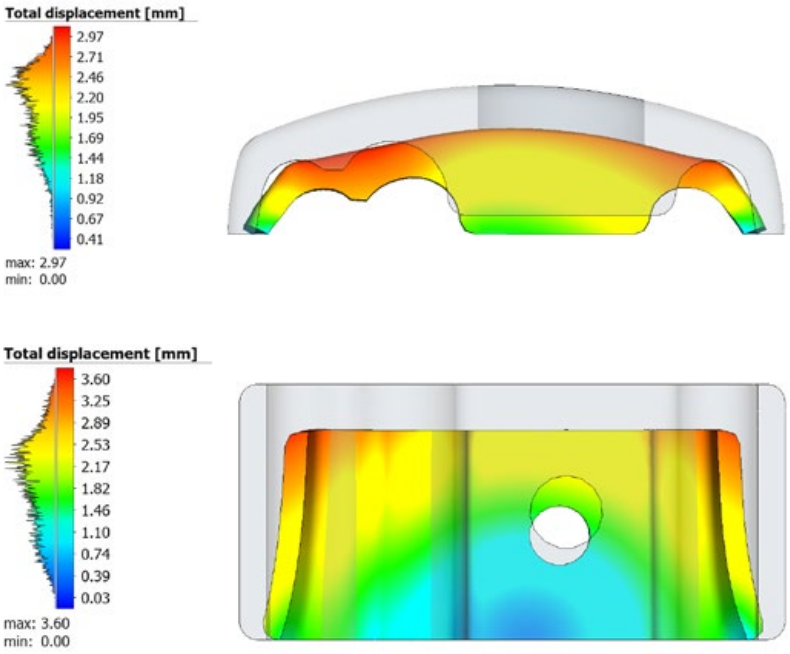

Fig. 5 Simulated deformation of nominal geometry in horizontal and vertical sintering orientations

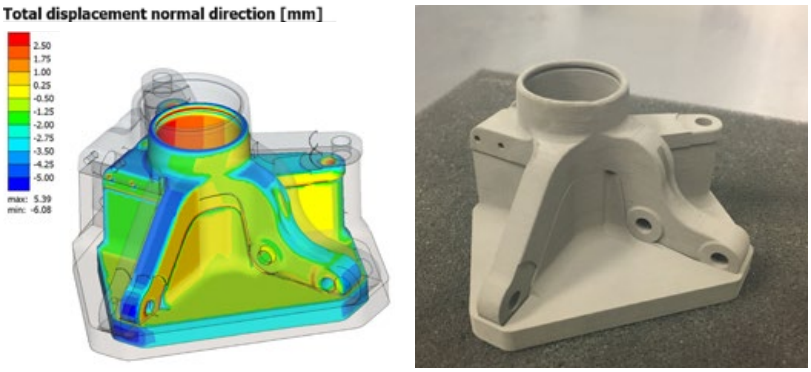

Fig. 6 Simulated deformation and actual sintered nominal steering knuckle geometry with live setter

Achieving success with ExOne

Over the course of 2021, ExOne has able to achieve success in working with Simufact Additive. ExOne has applied the software on multiple customer projects and validated its capability to support the BJT DfAM process. "Fundamentally, the software works," stated Kyle Myers, Director R&D at ExOne. "We've proven it out with real parts with real challenges. ExOne's goal was: does the software intuitively predict where parts would distort? And it does. As this area of digital sintering simulation is still very new, we're really looking forward to how far a reliable simulation software can take the binder jet market in improving part design for sintering. Already, recent updates have improved the Simufact software to a place of enhanced understanding and acceleration of design, and we expect the whole field of sintering simulation to continue advancing rapidly."

In the recent case of the Maxxwell Motors, the ExOne team wanted to evaluate feasibility for a radical new approach to build and support the copper windings during sintering. Simufact Additive enabled ExOne to determine that what seemed like a 'crazy' design would in fact work. Upon physically building and sintering the part, the results from physical and virtual tryout were more or less a match. In this case, ExOne was able to validate that the novel design was in fact feasible.

Two example applications are shared here to illustrate how the software has been applied at ExOne. The first example is a simple wire fastener that does not require a setter and was sintered in two orientations. Fig. 5 shows the simulation result when sintering the nominal geometry for both the horizontal and vertical orientations. The second example is a more complicated automotive-style steering knuckle that is built with a live setter, as shown in Fig. 6. In both cases, no special material characterisation was performed and all simulations were run with off-the-shelf 316L material

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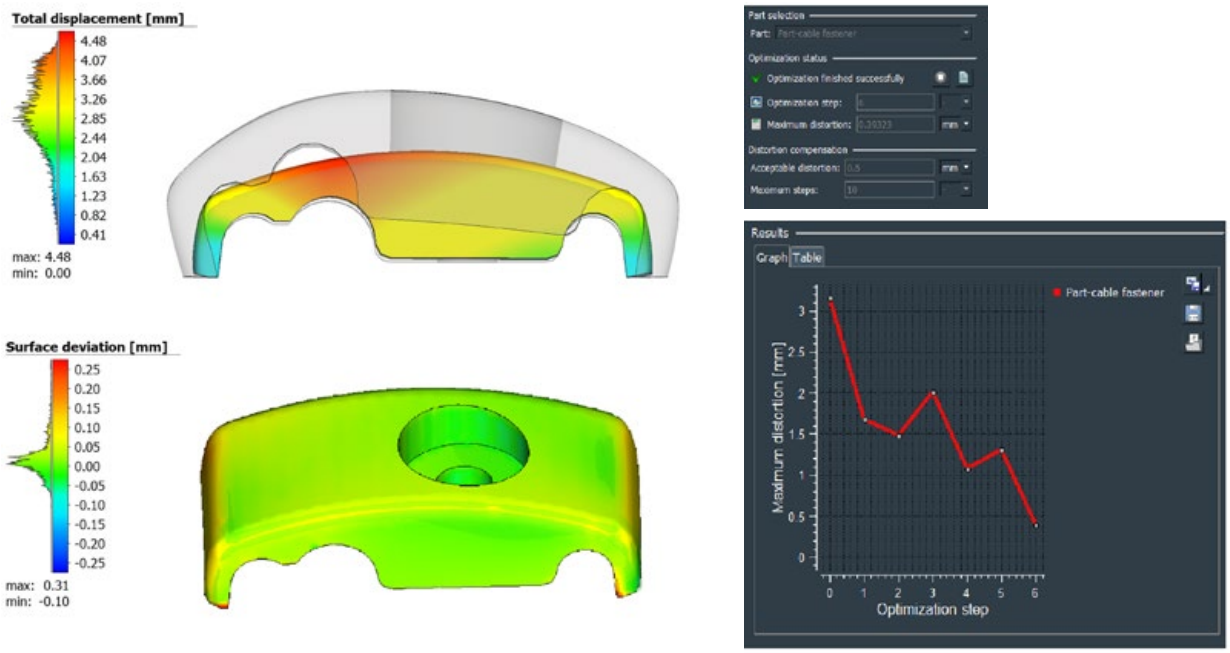

Fig. 7 Final compensated sintered geometry compared to compensated initial geometry, surface deviation, and compensation dialog box showing the max surface deviation of each iteration

properties that ship with Simufact Additive. All geometries were built in an ExOne Innovent machine with 316L powder and sintered in an Elnik 3045 furnace. The final sintered parts were then scanned using Hexagon's Absolute Scanner and surfaces compared with a best-fit alignment.

The two sintering orientations resulted in significantly different behaviours, as illustrated in Fig. 5. The horizontal orientation results in a bridge-type section where slumping due to gravity becomes the dominant driver of distortion. Friction also has a noticeable effect in this case, affecting how much the 'legs' will resist shrinkage laterally during sintering. The vertical orientation is more dominated by friction between the part and the baseplate. In this orientation, the resistance to shrinkage due to friction is very noticeable and results in a sintered geometry that is much narrower at the top than at the bottom. While the steering knuckle was a larger and much more complex geometry, it distorted more predictably due to the application of a live setter (support made from the same material as the part). A lack of unsupported or thin, free standing features meant that the shrinkage component was the dominant strain component affecting the sintering deformation.

Only the cable fastener was selected for compensation. The horizontal orientation required six simulation-based compensation iterations to achieve the desired tolerance of less than 0.5 mm, whereas the vertical orientation required only two iterations. A selection of compensation iteration geometries compared to nominal are highlighted in Fig. 3. The progression of the compensation routine and results from the successful (sixth) iterations are

Fig. 8 Compensated, sintered cable fastener in horizontal and vertical orientations

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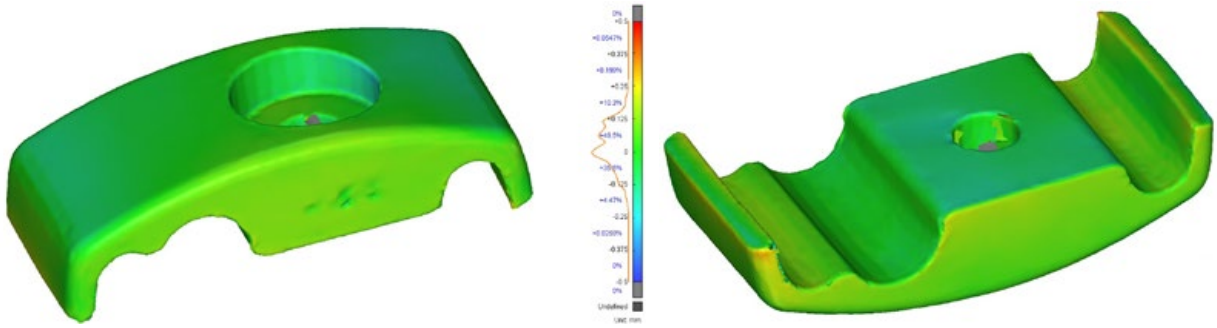

Fig. 9 Shape comparison between scan of compensated geometries post-sintering and nominal geometry for horizontal orientation

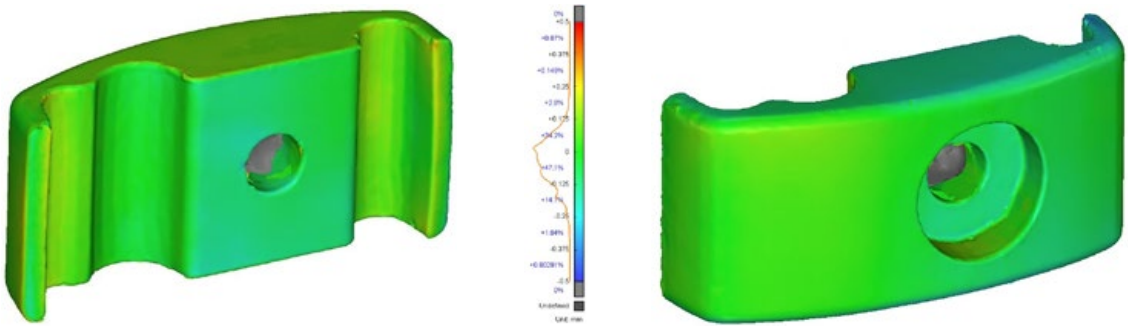

Fig. 10 Shape comparison between scan of compensated geometries post-sintering and nominal geometry for vertical orientation

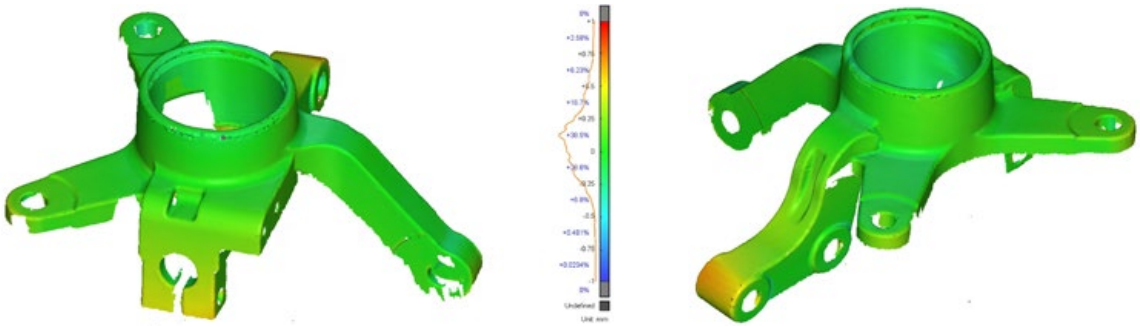

Fig. 11 Shape comparison between scan and simulation predicted final geometry

shown in Fig. 7. Each simulation run took about 7 minutes to complete on a 4 core laptop.

Fig. 8 shows the compensated, additively manufactured and sintered cable fastener for both orientations. It is visually apparent that the simulation software was able to effectively capture the relevant behaviours for both the horizontal and vertical orientations, and generate a compensated geometry that would distort into the desired shape.

Figs. 9 and 10 provide a shape comparison between the scan data of the compensated, post-sintering physical specimens and the target nominal geometry used to drive the compensation. 99+% of scan data points are within +/- 0.25 mm of the desired nominal shape for both the horizontal orientation and vertical orientation.

Scan based evaluation of the steering knuckle simulation results also showed a positive outcome and good agreement between the simulation based predicted final geometry and scan data of the as-sintered nominal geometry is observed (Fig. 11). While not entirely within the desired tolerance of +/- 0.5 mm, approximately 91% of the measured surface was within that range. An additional consideration is that the steering knuckle is larger, measuring 72 mm at the widest point compared to 30 mm for the cable fastener. Holding the same absolute tolerance

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inevitably is more challenging on larger components. The correlation level could likely be improved through additional calibration of the friction coefficient.

The Simufact roadmap for sintering simulation

While these are still the early days of simulation software for metal BJT AM, Simufact has a detailed roadmap for where it plans to take the solution in the future. It plans to achieve this through a mix of in-house development, partnerships with industry, and funded research projects. Future capabilities may include:

- More material data shipped with the software, starting with 17-4PH and 4130
- A generalised material characterisation to reduce the effort of calibration
- Anisotropy of the part resulting from build orientation
- Considerations for different sintering environments

Conclusion

Metal BJT AM has the potential to open the application of AM to a much wider range of industries. When compared to other metal AM technologies, BJT can produce parts faster, cheaper, and without the effects of residual stress and strain due to melting and solidification. One of the main hurdles to its widespread adoption, however, is the need to manage complex sintering behaviour.

Reliable simulation software can be a powerful BJT DfAM tool, enabling the designer to rapidly iterate the design and manufacturing strategy to determine the optimal balance of dimensional control, robustness, cost, and speed. Through this study, Simufact and ExOne have demonstrated that complex sintering behaviour can be effectively managed, lowering the hurdle towards industrialisation of metal BJT AM. Simulation software on its own does not make the BJT process work, but applying it effectively can increase industrialisation of the technology.

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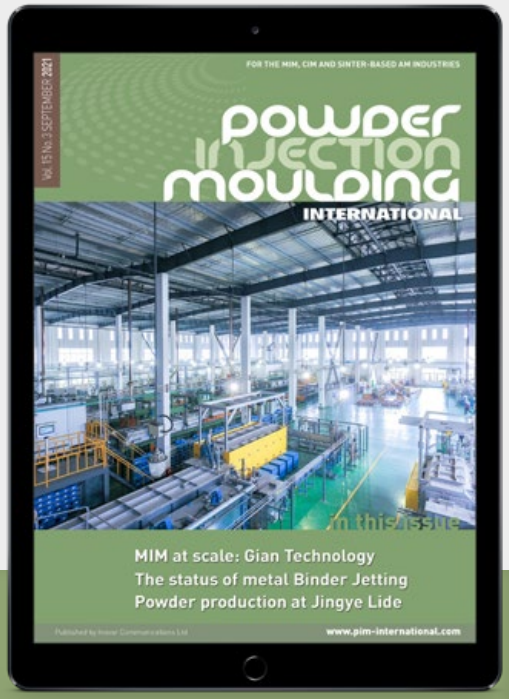
Binder Jetting insight...

In *PIM International*, September 2021

The evolving story of metal Binder Jetting: The pain and the promise.

Binder Jetting – at once the new kid on the block yet one of the industry's earliest processes – holds the promise of taking metal AM into the territory of true high-volume production. Yet progress towards this goal appears to be struggling, with machine sales lower than many hoped and two new 'big players' appearing to be holding back on full commercialisation.

In this report, Joseph Kowen considers the development of this industry to date, the obstacles facing its growth, and, of course, the recent announcement of two of Binder Jetting's biggest rivals coming together in the most unexpected acquisition.



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Metal powder characterisation for Additive Manufacturing: Beyond state-of-the-art standards

The control of powder feedstock characteristics is essential in metal Additive Manufacturing in order to guarantee the quality of built parts and reduce production costs. However, powder behaviour is influenced by a large number of particle properties, along with environmental conditions which can modify these properties. In the following article, Granutools' Dr Aurélien Neveu reviews some of the current standards applicable to powder feedstock characterisation, and highlights how to make such procedures more robust, repeatable and meaningful for end-users with regards to real AM powders and process conditions.

Much important work in defining standardised procedures for metal AM has been carried out over the last decade. In particular, recent technical specifications for powder feedstock characterisation have been published in ISO/ASTM 52907. The document provides technical recommendations on performing characterisation tests ranging from microscopic to macroscopic particle properties.

The current state of the art in standards relies on well-established methods allowing manufacturers to independently evaluate either the intrinsic properties of the particles (e.g., particle size distribution (PSD), morphology, chemical composition) or the macroscopic manifestation of these properties (e.g., flowability, packing dynamics). Despite the fact that the information gathered from these methods relies on the same underlying mechanisms, the results obtained are strongly dependent on the measurement configuration and conditions. Moreover, the large number of methods described in ISO/ASTM 52907 prevents the standard from providing comprehensive and universally applicable procedures to Additive Manufacturing end-users.

This situation highlights a need to identify the relevant parameters to be used in metal powder characterisation for Additive Manufacturing. More specifically, the link between powder properties and their relation to the powder's performance in the AM process is still lacking. Therefore, improvements to the current standards are required based on state-of-the-art characterisation methods and their recent outcomes. In the following article, we shed light on the importance of some key param-

Fig. 1 Granutools offers a range of instruments for powder testing and characterisation

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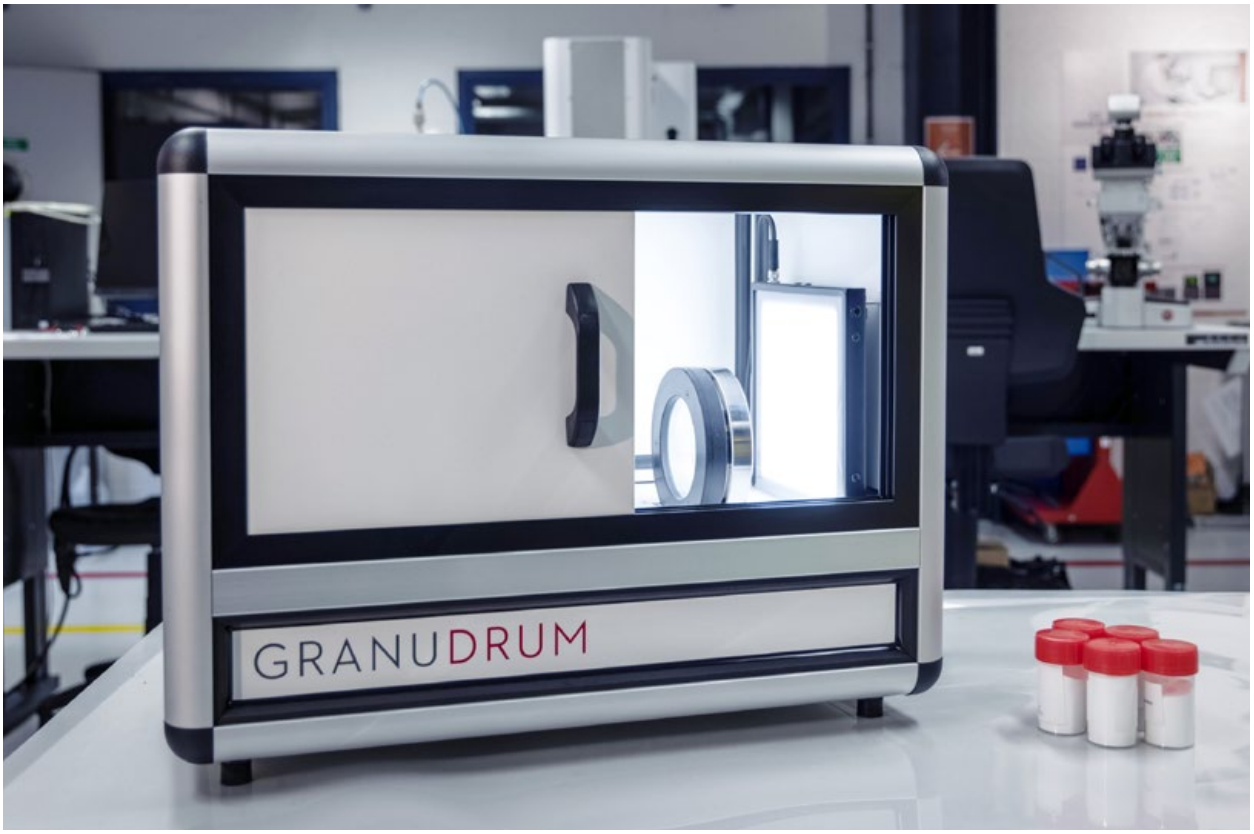

Fig. 2 The GranuDrum instrument evaluates powder characteristics, such as cohesiveness, based on rotating drum measurements

eters for AM powders and propose procedures to characterise these parameters in a clear, repeatable and robust way.

Importance of powder flowability

Powder flowability is defined in the ISO/ASTM 52907 as the "capability of a powder to displace powder particles with respect to each other, or relative to another surface, under the effect of one or more motive forces." By definition, flowability is then influenced by numerous properties. Regarding the particles themselves, PSD will drastically influence powder flowing behaviour, as the presence of fines tends to increase the global cohesiveness. Surface roughness and the morphology (e.g., sphericity, shape ratio, etc) will, in turn, play a key role in the interparticle friction forces, and impact flowability.

"By definition, flowability is then influenced by numerous properties. Regarding the particles themselves, PSD will drastically influence powder flowing behaviour, as the presence of fines tends to increase the global cohesiveness."

Regarding the properties of bulk powders, environmental conditions such as temperature and humidity will also affect flowability. Indeed, the relative humidity to which the powder is exposed during storage, handling, and processing modifies its moisture content; increasing humidity will lead to an increase in cohesive interactions between the particles due to the presence of capillary bridges. The extreme opposite scenario (very dry conditions) will eventually lead to a similar situation of increased cohesive forces, but, this time, due to the generation of electrostatic charges (not discussed in this article).

Numerous methods exist to evaluate the flowability of metal powders under different configurations. The funnel flow methods are generally a good first approach to assess powder flow properties. These methods involve determining the mass flow rate achieved when a certain amount of powder flows through an aperture. Among the most common methods are the Hall flow

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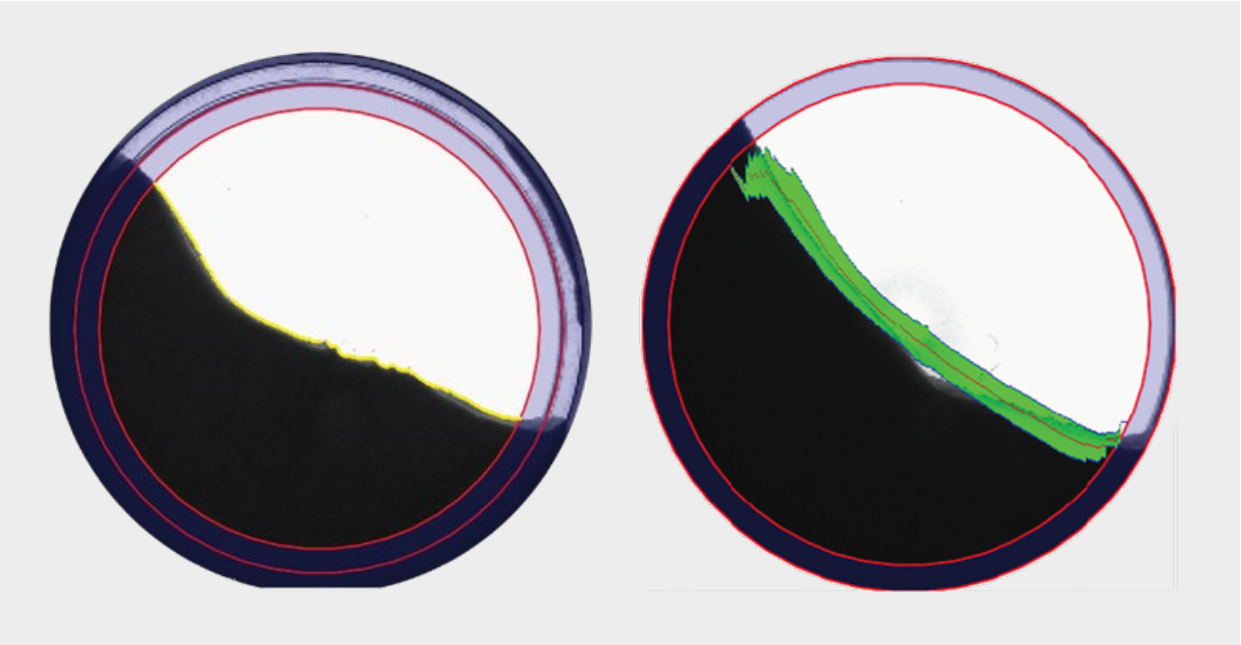

Fig. 3 The GranuDrum offers a customised image treatment algorithm to characterise cohesion

(ISO 4490 or ASTM B213) and the Carney flow (ASTM B964). However, the geometry of funnel flow methods limits the interpretations one can make with respect to real process conditions.

Going further in understanding of powder flow properties, tapped density analysis evaluates the ability of a powder to increase its bulk density when submitted to vertical taps (ISO 3953 or ASTM B527). Over the last decades, flow properties inside a rotating drum, such as the GranuDrum (Figs. 2, 3), are gaining more and more interest in metal AM powder characterisation, especially thanks to the information one can obtain on the rheological behaviour of the powder.

Going forward: spreadability assessment

Despite the methods described above, flowability is considered as a primary factor in the evaluation of the powder's ability to be conveyed through the different parts of the system (hopper, feeder, conveying pipes). The applicability of flowability to evaluate the global performance of AM powders regarding the quality of the built parts (absence of defects, mechanical strength) is rather limited. In Powder Bed Fusion (PBF), the requirements are based on the layer characteristics (i.e., spatial homogeneity, density, porosity), which depends mainly on powder spreading behaviour. Therefore, a question arises: is flowability a relevant property to assess spreadability?

The spreadability of a powder can be understood as its ability to produce spatially homogeneous layers during the recoating process. Deviations in layer smoothness and flatness will lead to defects in the parts. Such deviations have to be avoided. The spreadability terminology may also include the density homogeneity across the layer, as well as between successive layers, which is also an important factor to control the mechanical properties of built parts. The spreadability of a powder in a specific device is the result of interactions between the powder properties and the recoater configuration. It is commonly assumed that a powder with good flowability will exhibit good spreadability, justifying the choice of flowability as the

"In Powder Bed Fusion (PBF), the requirements are based on the layer characteristics (i.e., spatial homogeneity, density, porosity), which depends mainly on powder spreading behavior. Therefore, a question arises: is flowability a relevant property to assess spreadability?"

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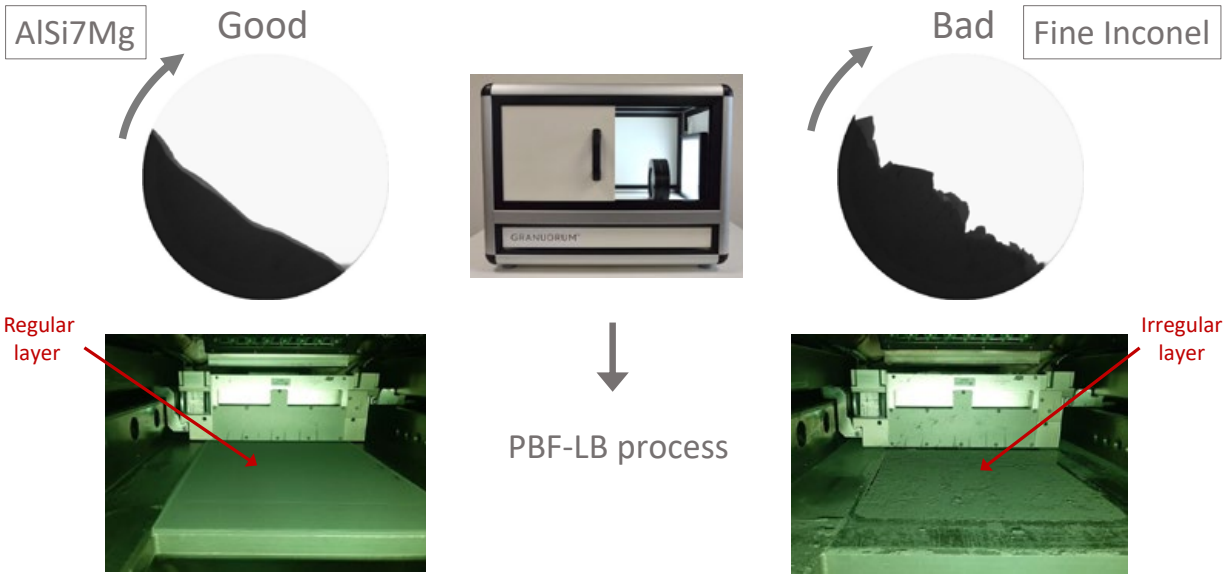

Fig. 4 General principle of how to relate GranuDrum measurements to powder performance inside a PBF-LB machine

main index to predict spreadability. However, it now becomes evident that flowability, as evaluated by the standard methods measured above, is not sufficient to explain the spreadability issues observed in production.

The recoating parameters – like recoater design (single blade, roller), recoater speed and layer – also influence the spreadability of the powder. Spreadability is thus a multi-parameter problem. It is dependent on powder properties, machine configuration, and a complex interplay between the two. Assessing all these parameters is very challenging, and is subject to ongoing research. Some attempts are being made to provide spreadability benchmark tests based on small-scale instrumented recoating devices. Despite being interesting for fundamental research purposes, the applicability of these tests for quality control in production facilities is uncertain. On the other hand, powder characterisation can be performed easily, without requiring complex methodology, and is therefore more suitable for this purpose.

Several questions also arise when it comes to the use of recycled AM powders. Powder recycling is a very common way in which manufacturers can reduce production costs. However, recycled powder properties are modified due to loss of fines and alteration of the chemical properties of the material. Standards should, thus, provide a methodology to characterise recycled AM powders properly and evaluate drifts in their properties during the recycling process.

Granutools as an actor in standardisation

Moving toward a better comprehension of the relationship between powder characteristics and their spreadability requires updated characterisation methods that provide deeper insights into powder properties. To this aim, Granutools has developed improved methods to overcome the limitations of existing methods and provide new deeper insights.

"...recycled powder properties are modified due to loss of fines and alteration of the chemical properties of the material. Standards should thus provide a methodology to characterise recycled AM powders properly and evaluate drifts in their properties."

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Rotating drum method

The GranuDrum provides a new measure to evaluate powder cohesiveness. The cohesive index was developed based on the observation that the temporal fluctuations of the powder/air interface of the powder flowing in a rotating drum are strongly linked to the strength of the cohesive interactions between the particles [1].

The global cohesiveness of a powder is the direct manifestation of these cohesive interactions, and is expected to be correlated to the spreadability of the powder. Recent studies have been performed in order to evaluate the suitability of the cohesive index as a predictive measure of powder spreadability. In particular, a direct correlation has been observed between the cohesive index evaluated with the GranuDrum and the spatial homogeneity of the recoated layers optically measured in a Laser Beam PBF (PBF-LB) AM machine (see Figs. 4 and 5) [2, 3].

Silo flow method

Funnel flows are very common for metal powder characterisation. However, this method suffers from a major drawback: if the powder does not flow through the unique aperture size, it cannot be investigated. A major improvement of the standard flow meters is proposed by the GranuFlow, which allows the investigation of different aperture sizes, giving access to a mass flow versus aperture size curve (Fig. 6). This opens up new possibilities to easily evaluate the flowability of powders that are unable to flow through standard Hall and Carney funnels.

If one aims to differentiate very small differences in flowability between different AM powders (e.g., recycling effects, or batch-to-batch differentiation), a more sensitive method can be used: the tapped density analysis.

Tapped density analysis

Tapped density is a very popular measurement for powder characterisation because of the simplicity and rapidity of the measurement. The ability of a

Fig. 5 Top; recoating of AlSi7Mg powder selected after GranuDrum measurements, bottom; PBF-LB in progress

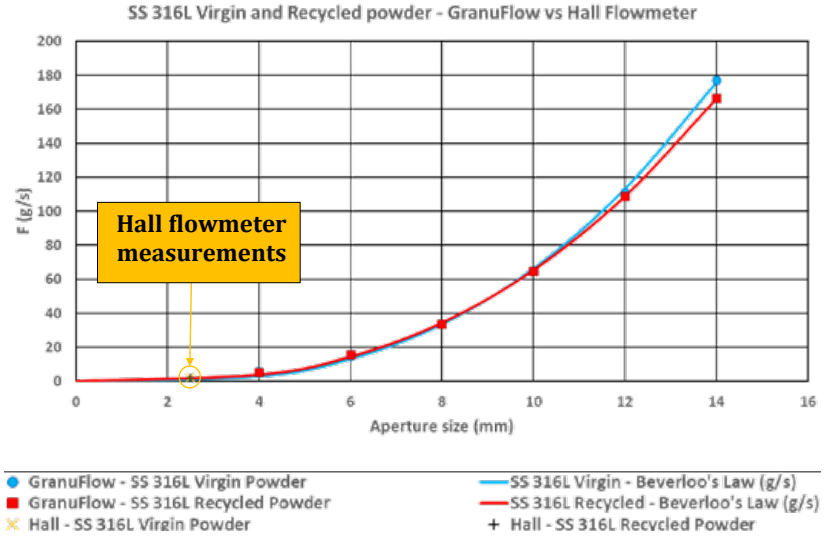

Fig. 6 Comparison between measurements from the GranuFlow and a Hall Flowmeter

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Fig. 7 The GranuPack is fully automated to measure the apparent, tapped density, the so-called Hausner ratio, Carr index and the complete packing curves at high resolution. It comes in two models: the Classic (for measurements at room temperature) and the High-Temperature (for measurements between room temperature and 200°C)

powder sample to pack under taps hints at its powder cohesiveness, which can be linked to its flowability. Powders can, thus, easily be classified for quality control and process optimisation. Apparent and tapped density measurement methodologies are well standardised (ISO 3953 or ASTM B527). However, although widely used, these procedures are based on old instrumental setups and procedures, resulting in a lack of accuracy and repeatability.

In addition, powder recycling and modification of the surface state (i.e., oxidated layer) can lead to small drifts in powder properties, which these methods are unable to track. More accurate and repeatable characterisation methods are thus required to develop and improve powder feedstock production, storage, and processing protocols.

With this in mind, an improved tapped density measurement device, the GranuPack (Fig. 7), has been developed by Granutools based on the more recent fundamental research results [4, 5, 6, 7].

A specifically designed initialisation protocol guarantees low operator dependency, while the automated powder volume measurement provides an accurate evaluation of the bulk density after each tap. Fig. 8 presents comparative results of the current ASTM B527 standard versus the GranuPack method. The improved reproducibility of the GranuPack method is clearly evidenced by the smaller error bars, obtained from three independent measurements.

Here again, Granutools aims to drastically improve the measurement reproducibility by removing any user dependency with an improved initialisation protocol and the ability to precisely measure the powder height with an inductive sensor, instead of the ASTM B527 naked-eye reading.

Besides these improvements, Granutools instruments go beyond the classical measurements. For instance, a GranuPack user has access to the so-called Hausner ratio and Carr index of AM powders, but also to the full packing curve, allowing them to investigate the dynamics of the packing. Such information is of primary importance to predict the layer density and homogeneity during recoating. Therefore, the GranuPack provides a modern and updated version of standardised tapped density procedures.

Conclusion

Despite the existence of numerous standard procedures for the characterisation of AM powders, there is a clear need to set more applicable, standardised tests with easily interpretable results for AM end-users, whether this be for quality control, R&D or production. Existing procedures suffer from several drawbacks, such as the variability of results due to measurement conditions (humidity, temperature), operator dependence,

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and a lack of correlation with real process parameters.

Some current standards are even unable to provide a proper differentiation of the actual AM powders. With this in mind, Granutools acts to propose improved test methods and innovative instruments to tackle aforementioned issues. With its strong expertise in the field of powders and granular materials, Granutools acts towards a clearer and better standardisation of AM powders.

Granutools brings to the market leading-edge instruments and innovative solutions in regards to the AM sector's needs and applications. The workflow presented in this paper (GranuFlow, GranuDrum, and GranuPack) allows end-users to characterise AM powders with improved test procedures (silo flow, tapped density, spreadability), and provide correlation with real AM processes.

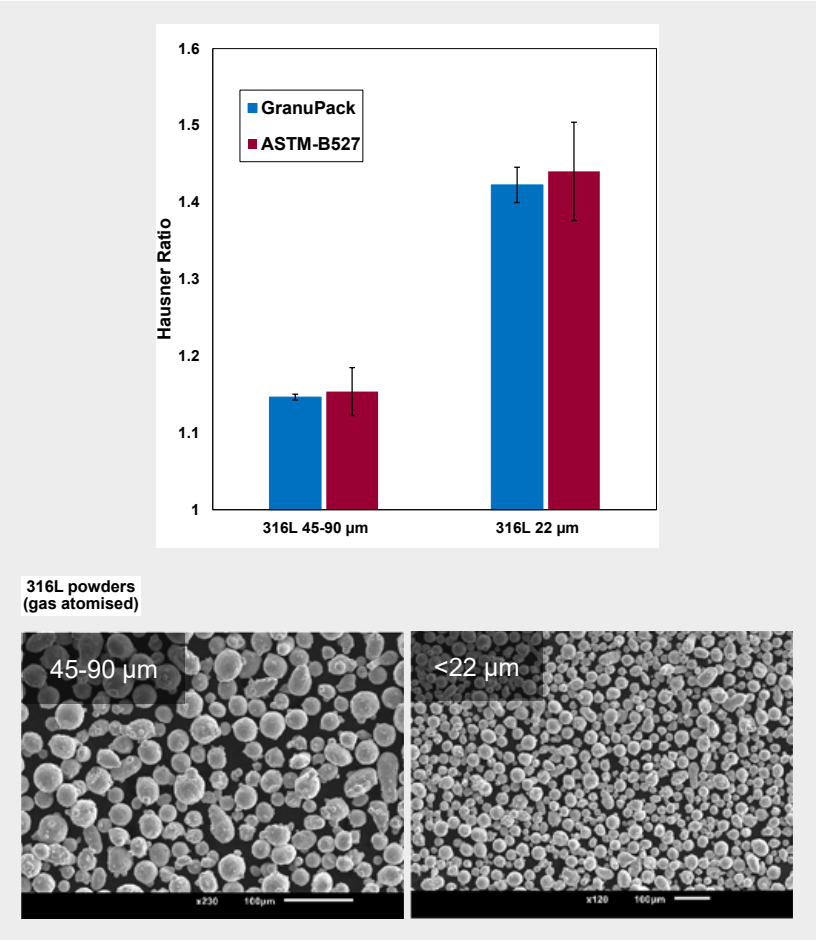

Fig. 8 Hausner ratio measured with the GranuPack Classic and the standardised ASTM B527 procedures on two metal AM powders. Error bars are standard deviations around the mean computed over three independent tests

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References

[1] Lumay G., Boschini F., Traina K., Bontempi S., Remy J.-C., Cloots R., Vandewalle N., Measuring the flowing properties of powders and grains, *Powder Technology 224* (2012) pp. 19–27

[2] Yablokova G., Speirs M., Van Humbeeck J., Kruth J.-P., Schrooten J., Cloots R., Boschini F., Lumay G., Luyten J., Rheological behavior of β-Ti and NiTi powders produced by atomization for SLM production of open porous orthopedic implants, *Powder Technology 283* (2015) pp. 199–209

[3] Neveu A., Francqui F., Lumay G., How to relate the spreadability of powder to the layer homogeneity in powder bed fusion Additive Manufacturing? A correlation between cohesion assessments and in situ printer measurements, ASTM International Conference on Additive Manufacturing (ASTM ICAM 2020), STP1637

[4] Lumay G. and Vandewalle N., Compaction of anisotropic granular materials: Experiments and simulations, *Physical Review E 70, 051314* (2004)

[5] Lumay G., Dorbolo S., Vandewalle N., Compaction dynamics of a magnetized powder, PHYSICAL REVIEW E 80, 041302 (2009)

[6] Fiscina J. E., Lumay G., Ludewig F., Vandewalle N., Compaction Dynamics of Wet Granular Assemblies, *PRL 105, 048001* (2010).

[7] Traina K., Cloots R., Bontempi S., Lumay G., Vandewalle N., Boschini F., Flow abilities of powders and granular materials evidenced from dynamical tap density measurement, *Powder Technology 235* (2013) pp. 842–852.

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A look at the future: What does the next decade hold for metal Additive Manufacturing?

Machine price and size, maintenance costs, production speed, safety, materials, metallurgy and quality – these are just some of the factors that will play a role in driving the development of metal AM over the next ten years. Concerns, such as repeatability, post-processing and ease of use, will determine whether the technology can fulfil the potential it promises. One thing is clear: many factors must improve before metal AM can become a true mainstream production technology. In this article, Olaf Diegel and Terry Wohlers, Wohlers Associates, draw on their expertise and experience to predict what the next decade may look like for metal Additive Manufacturing.

As metal Additive Manufacturing continues to grow in popularity, with an ever increasing range of industrial applications, what will it look like a decade from now? Several major drivers will shape the market, including machine price and size, maintenance costs, production speed, and safety. Materials, metallurgical properties, dimensional accuracy, surface quality, repeatability, post-processing requirements, and ease of use are also concerns. They must be addressed and improved upon if the technology is to develop into a large market.

Directed Energy Deposition and hybrid systems

One challenge for metal AM is the production of ready-to-use parts with tight engineering tolerances and good surface finish. Most additively manufactured parts with tight tolerances require some form of machining. Directed Energy Deposition (DED) machines with integrated multi-axis CNC capabilities, referred to by many as hybrid AM machines, offer a potential solution for certain types of parts (Fig. 1). These systems first additively manufacture several layers by DED before changing to a CNC cutting tool to remove material and machine finish surfaces where needed. DED then resumes, followed by additional machining. DED and machining alternate until the part is complete.

Hybrid DED and Powder Bed Fusion (PBF) can produce ready-to-use parts directly from the machine, although both require the removal of parts from the build plate. The surfaces where the parts are attached to the build plate may require additional machining and finishing following removal. The deposition speed of DED systems is good

Fig. 1 Hybrid AM showing material deposition (left) and milling (right) (Courtesy DMG Mori)

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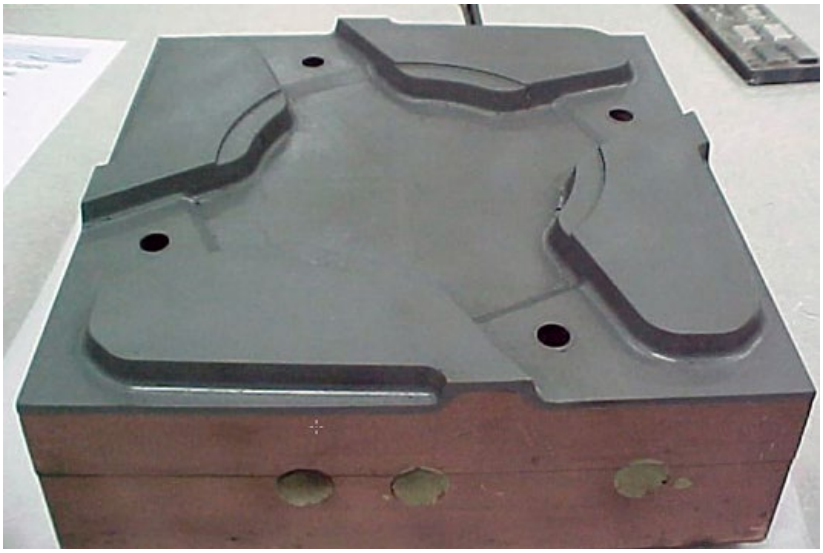

Fig. 2 A 3.18 mm H13 steel surface on a chromium copper block of 254 x 254 x 76 mm (Courtesy Additive Manufacturing Institute of Science and Technology, University of Louisville)

compared to PBF, but machining time must be taken into account. Also, small features, fine holes and channels, and lattice structures are often difficult or impossible to produce using DED.

Hybrid DED systems have been available for many years. Among the first was a hybrid machine produced by DMG Mori in 2013. These machines require significant decision-making and expert knowledge to produce good parts. The user typically decides when to switch from DED to cutting and then back to DED. Also, machining is usually carried out in 5-axes, requiring more programming knowledge compared to typical 3-axes of motion. Another challenge with hybrid DED systems is that the material is deposited at extremely high temperatures. Before machining, the material must cool. Heating and cooling cycles repeat many times when building a part, resulting in often unfamiliar metallurgical structures.

A benefit of DED is that it makes it possible to manufacture parts with functionally graded materials (Fig. 2). The POM Group, purchased by DM3D Technology in 2013, was among the first to deposit two or more metals when producing a part. The DED machine deposits powder into an energy beam through multiple tubes, each carrying a different powder. The machine can change from one metal to another, resulting in functionally graded material. This approach has potential, but it is mostly considered unproven and is not broadly understood or adopted. Part of the challenge is the possible incompatibility of the materials, preventing good metallurgical properties where they meet. While interesting, and even intriguing, we have little evidence from the past eight years to suggest that the market for AM functionally-graded parts will develop significantly in ten years from now. In some ways, it is a solution looking for a problem.

Over the coming decade, many of the challenges of hybrid DED will be overcome as users and producers invest in the technology's advancement. This may lead to it becoming a preferred process for medium and large AM parts. We can expect to see improved workflows and end-to-end solutions from established manufacturers. Companies have and will continue to retrofit existing CNC machines as opposed to developing hybrid DED from the ground up. As engineers improve their understanding of the technology, they will change their approach to design for certain types of metal parts.

Metal Powder Bed Fusion

Today, PBF is the most popular metal AM process, according to research conducted for *Wohlers Report 2021*. It remains a relatively slow process, and, in recent years, most machine manufacturers have worked to create faster systems, usually by adding more lasers (Fig. 3 shows a four-laser PBF machine from EOS in operation). Other than improving build speed, much of the work from machine manufacturers in recent years has focused on improving part quality, partly by building parts using thinner layers. However, this can result in slower build times. Adding a laser to a single-laser system can nearly double the production speed if the layer thickness does not change. Over the coming decade, expect the speed of PBF systems to be a significant focus.

"Adding a laser to a single-laser system can nearly double the production speed if the layer thickness does not change. Over the coming decade, expect the speed of PBF systems to be a significant focus."

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Other advancements will include intelligent software, better controls, and more consistent results. Currently, if three users set up the same part for metal PBF, without set protocols, they will likely get three different results. This is because the user must set several parameters while preparing the build. Among them are support/anchor design and locations, part orientation, and build parameters. In the future, software tools will suggest, and even automate, much of the setup. This will result in more consistency between users.

Hybrid PBF machines, such as the Lumex series from Matsuura, integrate PBF and CNC milling. After building several layers, a CNC cutting tool machines the surfaces before spreading the next layer of powder. We expect this hybrid process to develop further, possibly adding laser ablation for micromachining. Machined chips falling into the powder are currently a challenge for these types of systems.

In ten years, the cost to purchase and maintain a metal PBF machine is expected to decline. This will be driven by competition in the market, coupled with economy of scale. The same will be true with the price of metal powders. *Wohlers Report 2021* includes sixty-eight manufacturers of metal PBF systems and sixty third-party producers of metal powder, which illustrates the number of companies now competing.

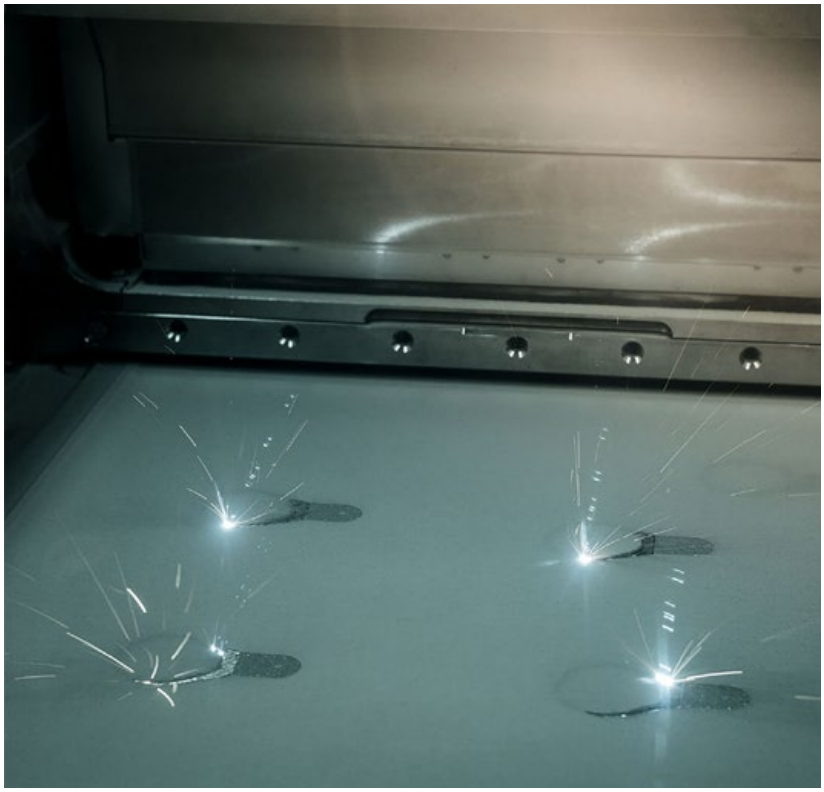

Fig. 3 A four-laser PBF machine in operation (Courtesy EOS)

"After HP and Desktop Metal entered the metal BJT segment, interest in the technology increased significantly. One of the attractive features of the process is its speed in producing 'green' parts, potentially making it an interesting process for series production."

Binder Jetting

Metal Binder Jetting (BJT) has been around for many years, with ExOne rolling out machines commercially in the early 2000s. Digital Metal followed years later by offering it as a service only, and then began to sell machines in 2016. Desktop Metal offered its Production and Shop metal BJT systems before acquiring ExOne in Q3 2021. GE Additive and HP are investing in the development of metal BJT systems.

After HP and Desktop Metal entered the metal BJT segment, interest in the technology increased significantly. One of the attractive features of the process is its speed in producing 'green' parts, potentially making it an interesting process for series production. The challenge is that BJT requires debinding and sintering in a furnace as a secondary process. Shrinkage of parts during sintering is typically in the range of 20%. This, coupled with other changes that occur in the furnace, can produce unexpected results. This inconsistency is less of a problem when parts are small, which is why metal BJT is not used as much for parts larger than about 50–75 mm in any direction.

Overall, metal BJT is not well understood today. When a problem occurs, it can be difficult to determine the exact cause. It could be the design, build process, build orientation, sintering, or something else. The high material cost, compared to conventional forms of manufacturing, is also a consideration for metal BJT.

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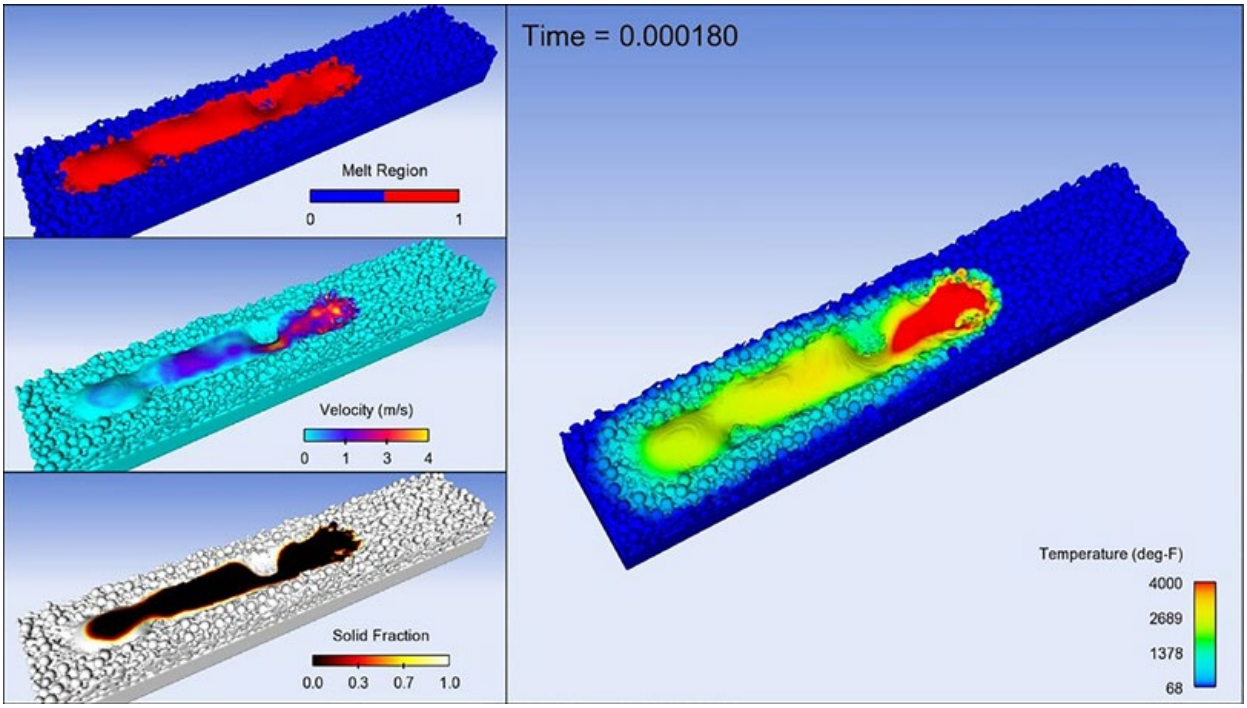

Fig. 4 Metal AM process monitoring and melt pool analysis (Courtesy Flow-3D)

In ten years, many of the current problems with metal BJT should be resolved, assuming companies continue to invest in it. Part of the solution will be an improved understanding of the process, coupled with simulation software. Other improvements will come from a wider range of available binders and materials. These advancements will make it more compelling for the automotive industry to adopt BJT for production volumes. This industry has been hesitant to use metal PBF due to its slow speed and relatively high production costs.

Other developments

Material Extrusion

Over the coming decade, we will see an increase in metal Material Extrusion (MEX) machines among educational and research organisations, as well as some hobbyists and engineers working from home. These machines cost less to purchase and maintain and are easier to use, although a sintering furnace is still required. We anticipate new metal filaments that melt at lower temperatures.

"Today, only a few alloys, such as Scalmalloy, have been developed specifically for metal AM. This field will experience significant developments in the coming decade. Watch for entirely new alloys that deliver better performance at lower cost..."

Custom alloys

Most metal AM alloys are conventional materials that are adapted for Additive Manufacturing. Today, only a few alloys, such as Scalmalloy, have been developed specifically for metal AM. This field will experience significant developments in the coming decade. Watch for entirely new alloys that deliver better performance at lower cost compared to materials for conventional manufacturing.

Integrated simulation and production software

We also expect to see substantial development in integrated simulation and production software over the next decade. This software will simulate the complete manufacturing process of an AM part, including the location of support material, residual stress, and the resulting metallurgical properties. Based on simulation results, combined with more advanced melt pool monitoring, machines will automatically adapt to produce better quality parts.

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Process monitoring
We expect more advanced in-situ process monitoring systems to become a standard for metal AM machines. The machines will automatically take corrective action when abnormalities are detected during the build process. These systems will be more fully integrated into the machine and design software.

Conclusion

Metal AM is still relatively new to most product development and manufacturing organisations. It has been available for twenty years, but, until recently, machine manufacturers only sold a few machines annually. Even today, few companies sell more than 100 machines per year, based on research for the *Wohlers Report*. Consequently, prices are still relatively high. This means that metal AM is not fully understood, processing speeds are low, and material and machine prices are high.

In ten years, expect the metal AM market to be quite different. Software, process monitoring, and end-to-end workflows will improve significantly. The aerospace, medical, energy and automotive sectors will likely buy and operate thousands of systems annually. Industry experience and knowledge will combine with better products and services. This will result in better quality parts at a lower cost, with new types of metal products and business models.

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Winter 2019

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Reducing residual stress with 500°C build chamber preheating for 'first time right' PBF-LB

According to Germany's Trumpf GmbH + Co. KG, preheating the substrate plate in Laser Beam Powder Bed Fusion (PBF-LB) to 500°C brings significant advantages in serial production: complex parts are more likely to be built successfully on the first try, design freedom increases, there is little residual stress and no cracks – and, for the first time, high-carbon alloy parts can be built reliably, without cracks, to a density comparable with their conventionally produced counterparts. Here, the company shares the results of tests demonstrating the advantages of 500°C preheating, and introduces the technology making it possible for manufacturers to integrate this step into their PBF workflow, and reap the benefits.

Laser Beam Powder Bed Fusion has become the most successful industrial AM process for metals over the last fifteen years. However, with the rapid success and gradual establishment in series production, the demands placed on the process by industrial companies are also increasing. In addition to the general desire for shorter production times, there is, in particular, a demand for higher part quality and more reliable initial production – even complex parts should succeed right from the start without any approximation tests.

These requirements can be met – by heating the substrate plate up to 500°C. Currently, preheating to 200°C is the industrial standard. This is a compromise between the advantage of inducing less residual stress by preheating on the one hand, and the disadvantages of a longer cooling time and possible problems with powder recycling on the other. In this article, we will demonstrate that this compromise is no longer necessary, and that a significantly higher preheating temperature is both reasonable and possible.

Trumpf has been able to show in tests that, by preheating to 500°C, higher quality titanium alloy parts (especially Ti64Al4V) can be achieved, by reducing residual stress. High-carbon-containing alloys such as H11 and H13 can also be processed using PBF-LB for the first time. This is of particular interest to the tool and die industry, which prefers H11 and H13, and can benefit significantly from PBF-LB due to its special production processes. The results of these tests will be discussed in this article (Fig. 1).

Further, we will discuss how to integrate the preheating technology into the manufacturing process such that the utilisation of the PBF-LB machine is maximised and – despite the high temperatures involved – any residual metal powder can be recycled without problems.

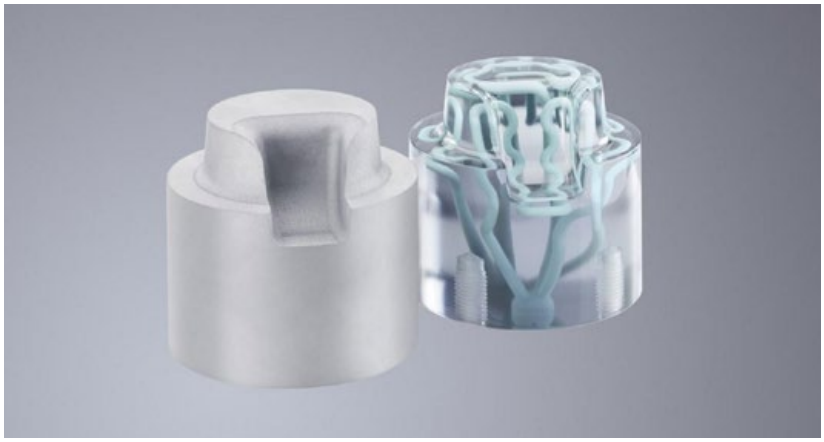

Fig. 1 Applications such as this inlet manifold from Laupp GmbH for the tool and die industry, with a rendering of internal cooling channels shown on the right, benefit from the ability to produce H11/H13 parts by PBF-LB

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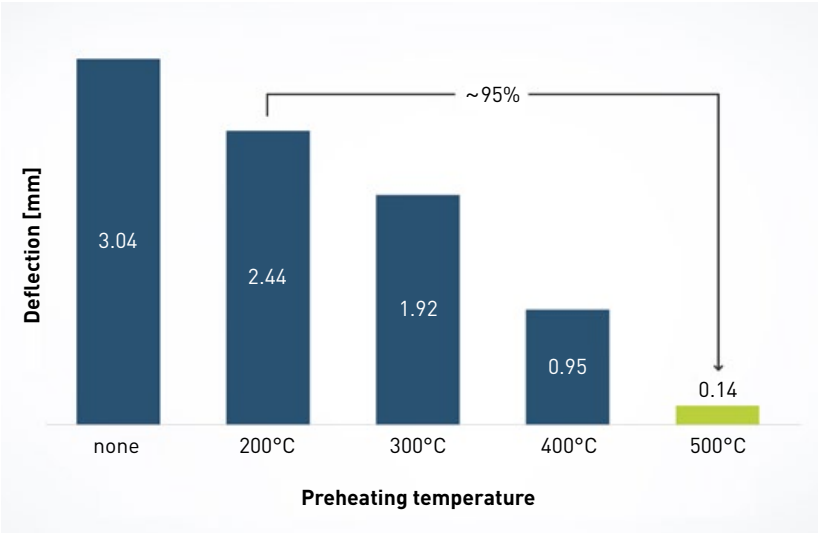

Fig. 2 500°C preheating reduces deflection by about 95% (measured at cantilever) compared to the industry-standard 200°C

Reducing residual stress in titanium alloys

Titanium alloys for Additive Manufacturing are in high demand in the aerospace, energy and medical industries. However, residual stresses and distortion frequently pose a problem in the PBF-LB of titanium alloys, especially when manufacturing large, high-volume components. In the case of volume cracks (i.e., typically at the edges or supports), large temperature differences occur, and, therefore, irregular heat dissipation. This induces thermal residual stress in the part: it can distort, delaminate during the PBF-LB process or afterwards (i.e., detach itself from the substrate plate by curving or lifting) and sometimes even exhibit cracks.

An effective antidote is to keep the top of the substrate plate at a temperature of 500°C throughout the building process. This is because the increased preheating temperature reduces the thermal gradients (i.e., the drops and increases in temperature) – for example, at the edges. Secondly, it lowers the yield strength. The combination of these two factors results in a reduction of residual stress during PBF-LB Additive Manufacturing.

Studies showed that 500°C preheating in PBF-LB reduces deflection by 95% compared to the current industry-standard 200°C preheating (Figs. 2–4). This reduced thermal stress increases geometric accuracy, having positive consequences both before the build process and afterward. In the design phase, many support structures and simulation steps that were previously needed to prevent deformation, delamination and cracking can be eliminated. This increases design freedom and, as a result, also reduces the amount of post-processing required, as fewer supports have to be removed.

The advantages of 500°C preheating apply to all part geometries. Although the heat distribution inside a part is variable depending on the part geometry, Trumpf was able to show in tests that high-temperature processing has the same positive effects in all cases.

Achieving reliable, crack-free high-carbon alloys

PBF-LB brings many advantages to the production of injection moulds or mould inserts for the injection moulding industry. Firstly, it is a highly economical process for such tasks, and secondly, it allows for the installation of complex, internal cooling channels which improve the cooling properties of the tools and moulds. But there is one problem: the industry prefers tooling made of carbon steels such as H11 (1.2343) or H13 (1.2344), because they are highly wear-resistant and polishable. However, if H11 or H13 is additively manufactured by PBF-LB with a

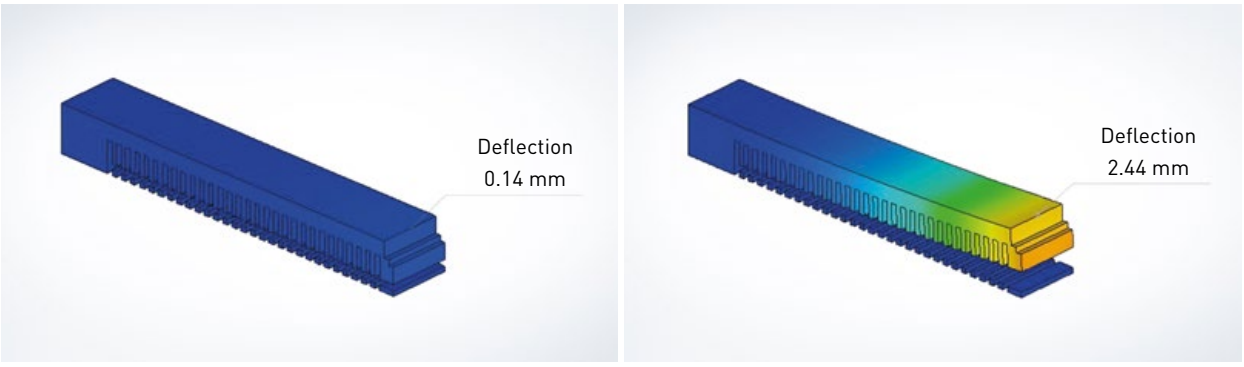

Fig. 3 Preheating the substrate plate to 500°C reduces deflection of the Ti64 cantilever by 95% (left) compared to 200°C (right)

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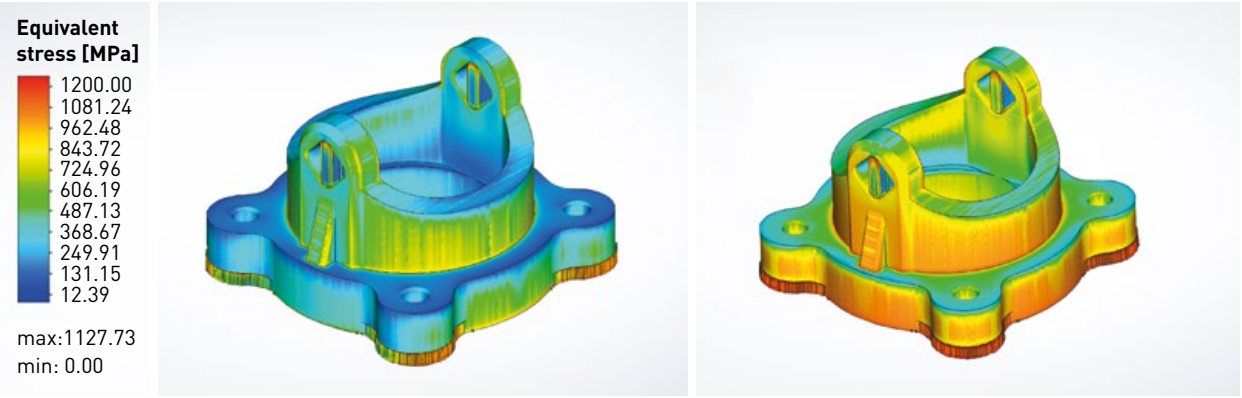

Fig. 4 If a gimbal bearing is additively manufactured with 500°C preheating, the residual stress in the Ti6Al4V component is significantly reduced (left). This opens up completely new possibilities in design, especially in the construction of large components. At 200°C, the internal stress is significantly higher (right); this leads to greater preparation, design reworking and part post-processing, as more simulations and support structures are needed

preheating of 200°C, which has been common up to now, hard and brittle martensite forms during the short cooling phase. As a result, cracks often form in the component. Many components made of H11 or H13 can therefore only be additively manufactured at great expense, making this unprofitable.

Preheating to 500°C removes this limitation. The higher base temperature slows down the cooling process, making it smoother and, thus, preventing the formation of undesirable martensite. Microscopic examinations showed that additively manufactured H11 components, created using PBF-LB after preheating to 500°C, have a density of up to 99.99% (Fig. 5). They also come close in strength and hardness close to conventionally produced H11 components. As a result, they are also highly polishable (Fig. 6).

High machine availability and powder recycling

Higher preheating means a longer cooling phase – up to twenty hours, depending on the component. This presents a potential drawback, as it could result in long machine downtimes. However, a suitable overall concept can prevent this drawback; Trumpf offers its proven exchangeable cylinder principle for the

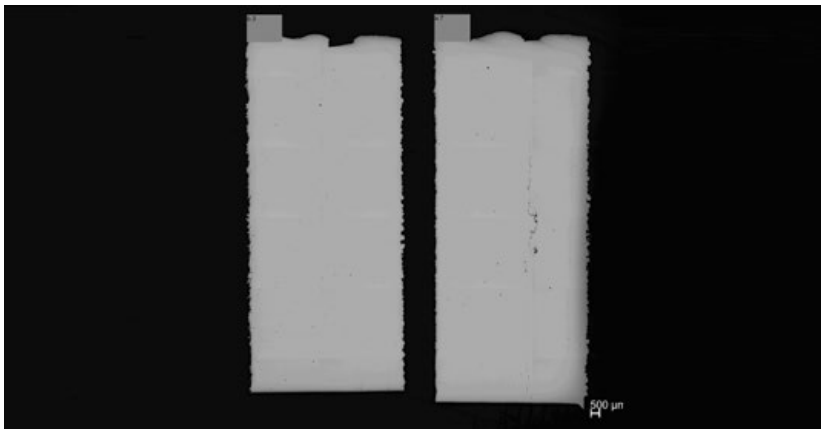

Fig. 5 Right: Cracking in H11 after 200°C preheating and PBF. Left: Crack-free H11 after preheating at 500°C and PBF-LB. In a downstream step, any remaining small defects can be corrected by annealing

Fig. 6 Highly polished mould core made from H11 by Additive Manufacturing after preheating to 500°C, from Reinhard Bretthauer GmbH. The component is crack-free and has a density of more than 99.9%. The polishability is correspondingly high – no difference can be detected compared to conventional production. Due to the integrated cooling channels, the stable production of plastic injection moulded parts is possible and the cycle time reduced

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TruPrint 5000, which is capable of preheating to 500°C.

Using Trumpf's exchangeable cylinder principle, the PBF-LB process takes place in an exchangeable build cylinder. Once the build is complete, the build cylinder is moved to a separate cooling station, allowing the PBF-LB machine to be reloaded immediately with a new build cylinder (and a full powder supply cylinder if required) and process the next build job.

Another possible disadvantage of 500°C preheating could be the poorer recyclability of the powder: since higher temperatures lead to stronger oxidation, this could reduce the recyclability of titanium alloy or H11 powders. Trumpf has also developed a counterstrategy for this, and has been able to demonstrate its effectiveness: Using the TruPrint 5000, the process chamber and the exchangeable cylinders are flooded with argon before production starts. This results in a system atmosphere with low residual moisture and a residual oxygen content at a very low level of a few ppm (parts per million). In compression tests with H11, chemical tests showed that even after several recycling cycles, the powder had the same oxygen content as new powder. Due to the low oxidation, the powder remained very free flowing, and particles did not adhere to each other. The powder could, therefore, be removed easily and without residue, for example from cooling channels.

In the case of the titanium alloy Ti6Al4V ELI, we were able to show that the required limit value for the oxygen content could be maintained even after several cycles. In practice, it will be possible to increase this value even further by repeatedly mixing in small amounts of new powder.

Conclusion

500°C preheating for PBF-LB processes increases the design freedom and component quality for titanium alloy parts. It also reduces further processing – making it possible to produce parts true to the motto 'first time right'. With preheating, tool steels containing carbon become reliably additively manufacturable for the very first time. Interchangeable build cylinders ensure high machine availability despite longer cooling times, and the recycling and flowability of powder are not significantly changed by high-temperature processing when the right atmosphere is used.

These results for tool steels and titanium alloys are just the beginning. Trumpf and our customers are already working on the next materials and parts that will benefit from preheating up to 500°C, or that can be processed this way for the first time. We are convinced that this will completely open up new markets.

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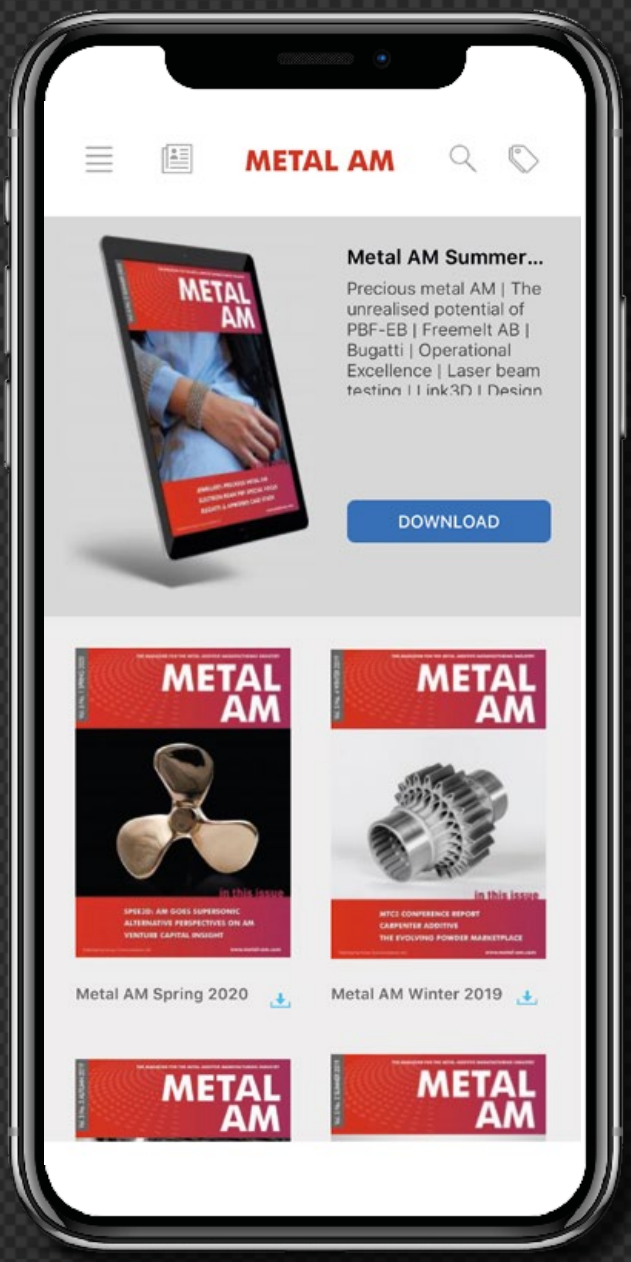

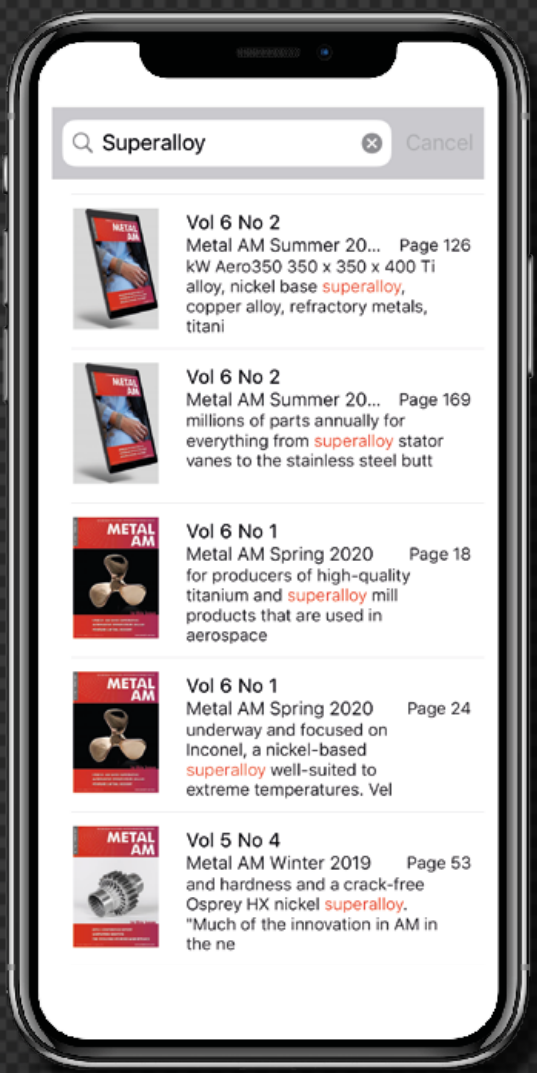

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Separating metal AM parts from the build plate – an underestimated challenge

Within the Additive Manufacturing workflow, it is easy to underestimate the challenge of removing parts from a build plate. As GF Machining Solutions' Dogan Basic explains, in Laser Beam Powder Bed Fusion (PBF-LB) the wrong choice of equipment can lead to higher costs, longer build times and even part breakages. In response to this challenge, the company developed a solution designed specifically for PBF-LB build plate removal: the AgieCharmilles CUT AM 500. Here, Basic introduces the features and benefits that the CUT AM 500 brings to the industry.

The Additive Manufacturing of metal parts is a complex process that requires specific expertise and high-performance solutions. Beyond just the build complexity, the majority of parts built with Laser Beam Powder Bed Fusion (PBF-LB) technology require critical post-processing steps, which have an impact on the geometry and quality of the final part and must be considered from the early stages of part design, and, therefore, can be restrictive. Among these critical steps is the separation of the parts from the build plate. This step may seem trivial, but in fact presents many challenges.

Should you have the opportunity to visit companies that use PBF-LB machines, you will discover that several techniques can be used for the separation process. Some of them may use so-called manual processes, typically for the smallest parts, such as dental implants, for which the support structures are easily breakable. As part size increases, other techniques are necessary and require the use of machining to remove the parts from the build plate. The most common processes used for this are bandsaw cutting and wire-cutting EDM.

The choice of technology used will depend on criteria such as the size of the part, its geometry, the build material, and the intended application, as well as the profile of the company, its sector of activity and even its geographical location. When looking at the bandsaw option, one can easily see the robustness of the process, the attractive price it offers and the cutting speed as key advantages. With regard to EDM, generally recognised advantages are the cut quality,

Fig. 1 The AgieCharmilles CUT AM 500, developed by GF Machining Solutions

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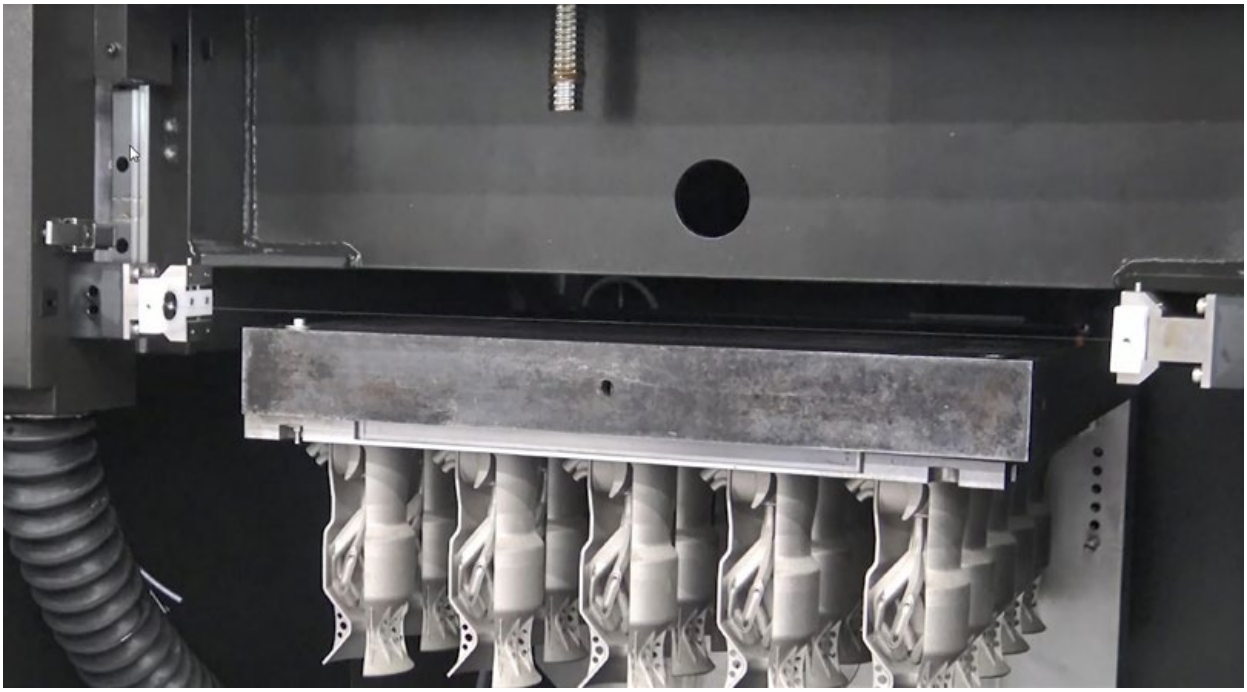

Fig. 2 The CUT AM 500 uses a horizontal rather than vertical cutting process

surface finish, and greater protection of the integrity of the cut, or accuracy, achievable with this technology, mostly due to the fact that it creates less cutting forces on the parts.

However, if you talk to users of one technology or another, you quickly understand that, currently, neither of them effectively overcome the unique challenges of the separation process. Indeed, when one looks more closely at the bandsaw, the economic advantages it appears to offer may turn out to be much smaller. This is because the width of the saw implies that a substantial number of additional layers must be produced during the AM process, which can dramatically increase build time and hence total production cost. Indeed, the use of the saw requires the building of at least 2 mm of additional stock material to be able to pass the saw between the part and the build plate. In addition, the saw cannot be used for all cuts, in order to obtain the required surface finish. The sawing forces on the parts are not negligible, and can cause damage and deformation, especially for thin-walled parts. The material used for the part can also create complications for a bandsaw; parts additively manufactured in Inconel and titanium present significant challenges for efficient sawing. However, some companies accept the limitations of the bandsaw, as they have not found an adequate alternative solution.

EDM technology offers some advantages over the bandsaw, particularly in that it uses a wire cutting diameter that is much thinner than the saw, allowing build costs to be reduced. Nevertheless, in terms of cutting speed, the results are much slower than those possible with the saw. In addition, standard EDM technology is not always suitable for cutting complex geometries or cutting through support structures, causing wire breaks. Cutting can quickly become difficult when this aspect comes into play! Finally, as standard EDM machines operate vertically (and so do bandsaws, for that matter), setup time can be very long, especially for large build plates, and it is difficult to preserve the integrity of the parts during cutting.

"The sawing forces on the parts are not negligible, and can cause damage and deformation, especially for thin-walled parts. The material used for the part can also create complications for a bandsaw; parts additively manufactured in Inconel and titanium present significant challenges..."

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The AgieCharmilles CUT AM 500

It is by observing these two technologies, and by identifying the problems faced by users of PBF-LB technology, that GF Machining Solutions has developed the AgieCharmilles CUT AM 500, a unique horizontal cutting machine suitable for use with all commercial PBF-LB machines. One benefit offered by this horizontal cutting machine includes a large work envelope of 500 x 500 x 490 mm which can easily accommodate not only large build plates, but also tall parts.

By using 0.20 mm diameter wire, enabling a small kerf (the width of material that is removed by the cutting process) users are able to minimise the extra material they need to add when building a part. This can result in substantial savings. Since there is no physical contact between the wire and the workpiece, there is no possibility of damage to the parts from the cutting action. In addition, the surface is both smooth and precisely oriented in line with the axis of the built part.

Some medical and aerospace applications prohibit contamination of the cut surface with copper or zinc, which is common with raw brass and traditionally coated EDM wires. The use of molybdenum wire in the CUT AM 500 eliminates this possibility.

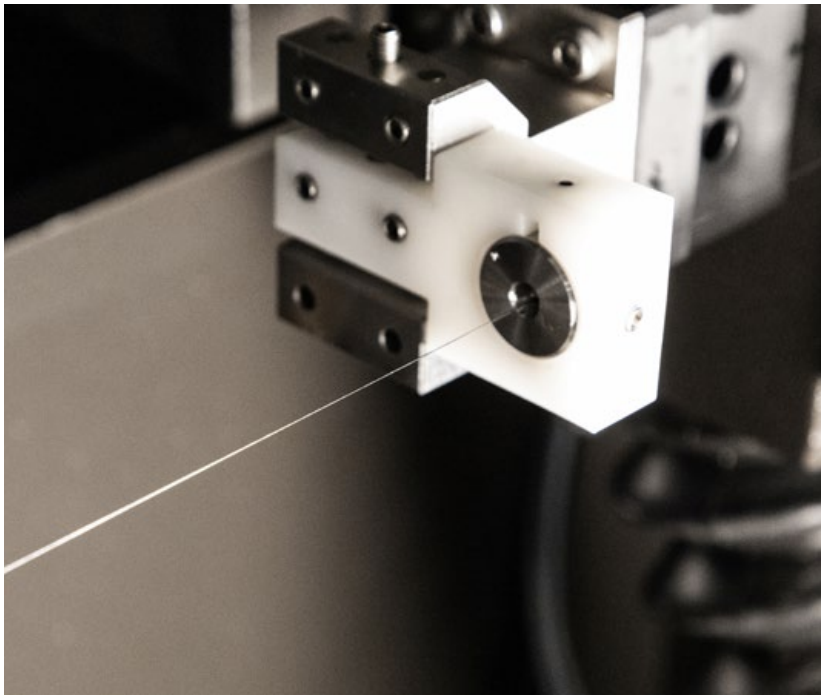

Fig. 3 Molybdenum wire used in the CUT AM 500

Finally, the CUT AM 500 offers significantly faster cutting speeds than conventional wire EDM. These high cutting speeds are accomplished by the combination of a number of advanced technologies: with a wire travel speed of 20 m per second, the wire actually drives the dielectric into the cut, even for multiple parts being cut simultaneously. This is a big advantage over other so-called

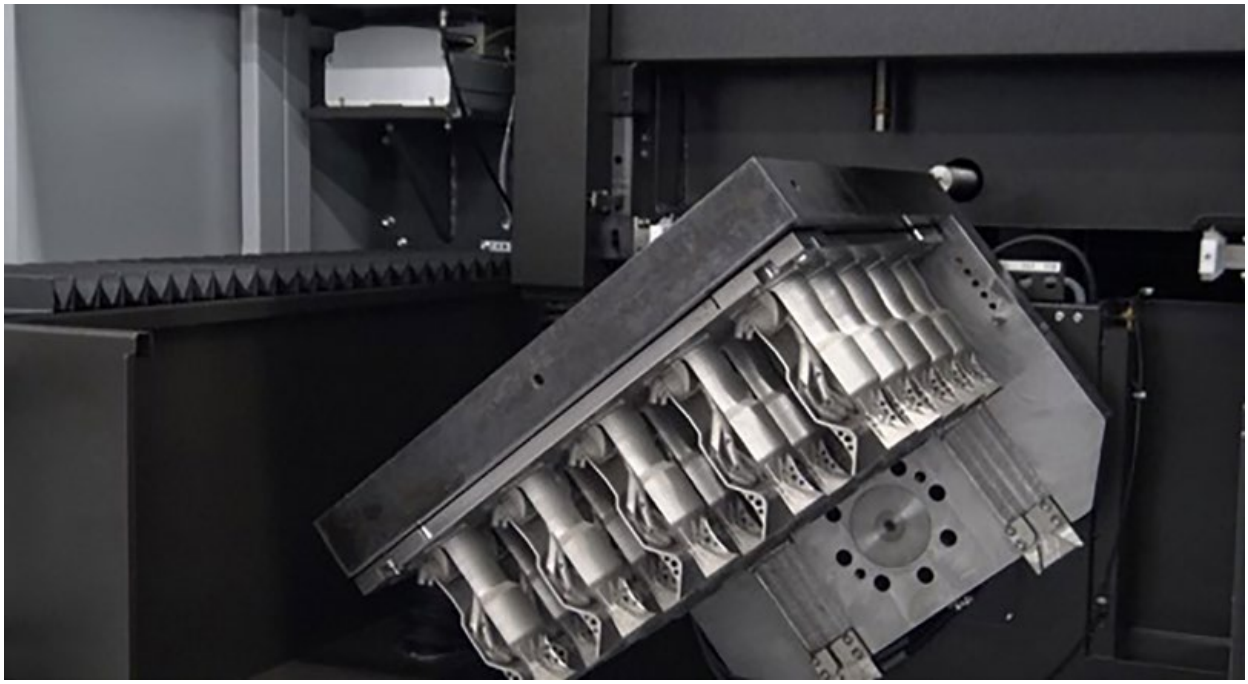

Fig. 4 Once loaded, the CUT AM 500 table inverts the build plate safely into the cutting position

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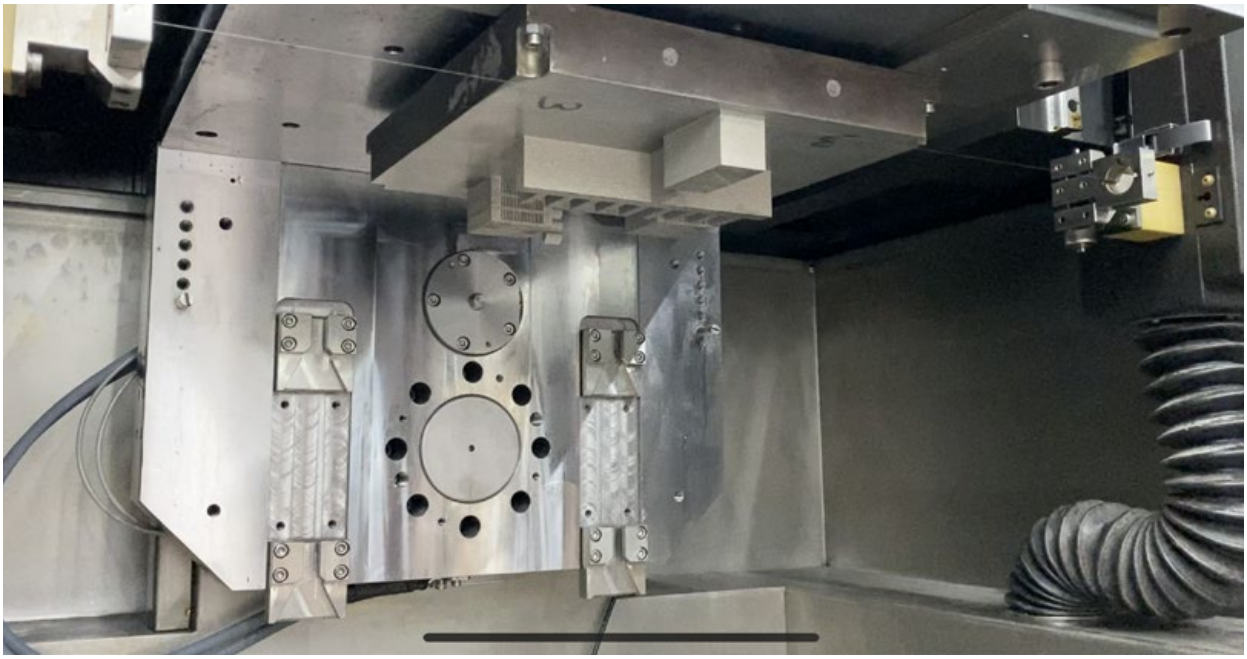

Fig. 5 A benchmark build plate inside the CUT AM 500

"Because the CUT AM 500 was designed to accept AM builds in their native horizontal position, the operator benefits from a safe and simplified solution when fixturing the builds to the table."

'fast-wire' EDM technologies. At these speeds, on a traditional wire EDM, a 5000 m spool normally does not last long; however, the CUT AM 500 reuses the thread by winding it onto another spool before reversing direction to wind the thread onto the original spool. This round-trip reuse of the wire between two spools allows a minimum use of consumables.

In addition, GF Machining Solutions has developed a dedicated water-based dielectric AC CUT AM 500 Concentrate to maximise erosion performance and minimise costs. A unique generator utilises a combined EDM / ECM cutting action that leads to improved cutting speeds. This power supply uses bipolar pulse technology, which virtually eliminates chemical attack on titanium and other susceptible materials.

Simplifying setup, operation and reducing costs

The combination of the horizontal wire, reverse part separation technology and the collecting basket ensures clean cut and undamaged parts. Because the CUT AM 500 was designed to accept AM builds in their native horizontal position, the operator benefits from a safe and simplified solution when fixturing the builds to the table. Once loaded, the table will invert the parts safely into position. Then, with a few simple inputs to the user-friendly HMI control panel, separation jobs are easily programmed. From the design stages of the machine development, the concept of minimising the operating costs was critical.

Benchmark testing

In order to test the performance of the CUT AM 500 compared to other traditional technologies, we recently performed a benchmark test, and the results are presented in the following points. The idea was to additively manufacture parts of different, complex geometries, in three different materials. As you can see in Fig. 5, we decided to attempt parts in three groups with the following, challenging features:

Group A
Two parts, bulk section, no supports:

- Front large cutting
- Multiple cuts

Group B
Two parts, 1 mm thick support section of two types:

- Wall
- Cone

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Group C
One part:

- Powder filled cavity

After cutting was complete, the results of these tests showed, with the CUT AM 500, we were able to achieve:

- A setup time of less than two minutes
- No wire breakage
- A low, surface-only level of oxidation on titanium parts
- A cutting rate that is 3–4 x faster than that achieved with standard EDM
- A total leadtime – including the build process – that is 3–4 x faster than that achieved with a bandsaw
- A total cost of ownership 3 x cheaper than that achieved with standard EDM
- A total cost of ownership* 6 x cheaper than that achieved with a bandsaw

Conclusion

The CUT AM 500 was developed based on our identification of needs observed among users of AM machines for a more effective, efficient build plate removal technology. Today, after receiving feedback from customers in all markets and industries, we can be confident that we have provided a solution that improves their daily manufacturing operations.

Author

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Spring 2021

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- Why do we need Women in 3D Printing? The what, the who, and the why of the blog that became a movement
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		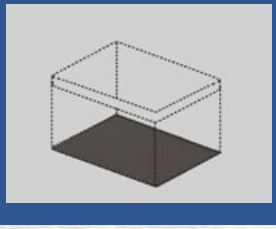

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How X-ray Computed Tomography is helping an AM service bureau to improve predictive-model based qualification

As metal Additive Manufacturing continues to grow as a technology for the production of critical end-use parts for the most demanding of applications, X-ray Computed Tomography (CT) remains an unrivalled non-destructive testing tool. In this article, Yxlon's Nathan Serafino and Dirk Steiner report on how Materials Resources LLC, an additive metals research and manufacturing company, defence contractor, and 'fast factory', is going a step further, using the technology to improve predictive-model based qualification processes as well as to calibrate in-process monitoring.

Interest in Additive Manufacturing is building rapidly. The technology is appealing because high-value, low-quantity parts can be made quickly and cost-effectively without the need for tooling. It offers another benefit in the potential for weight reduction by producing complex designs not attainable with conventional manufacturing.

The challenge for manufacturers is knowing whether a cast or forged metal part will perform equally well – or better – if it is additively manufactured. This is particularly important to designers in the aerospace and defence industries, where a part failure may have catastrophic consequences. Additionally, as the automotive industry changes from internal combustion engine (ICE)-powered vehicles to electric vehicles (EVs), the need for lightweight AM parts is rapidly increasing.

Materials Resources LLC (MRL), an additive metals research and manufacturing company and defence contractor in Dayton, Ohio, USA, answers this question for its customers using testing, computer modelling, artificial intelligence, and optimised AM machines. In addition to its consulting work, MRL describes itself as a 'fast factory', offering customers rapid, low-volume AM production and prototyping in-house.

MRL continually improves its understanding of materials and Additive Manufacturing processes, with the goal of providing accurate, predictive-model based qualification. To predict the fatigue behaviour and strength of a material, MRL researchers needed to see inside additively manufactured sample parts. They needed a Computed Tomography (CT) system – and didn't have one.

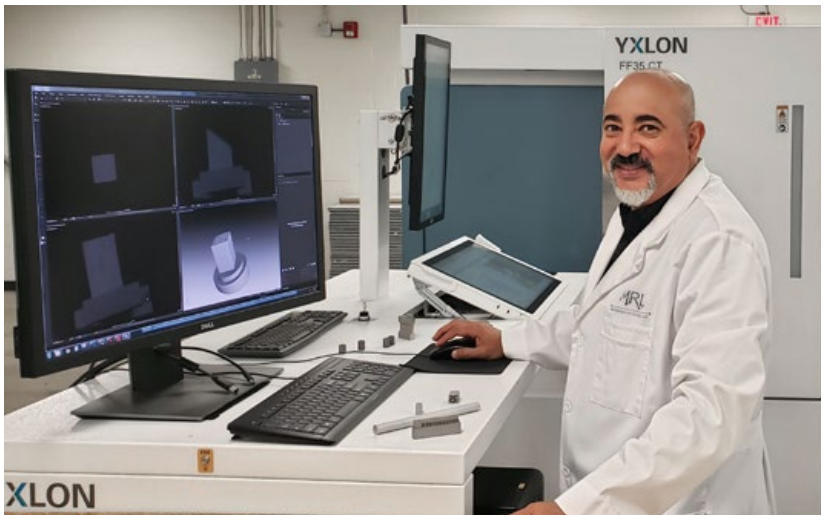

Fig. 1 Ayman Salem, PhD, founder of MRL, shown with the company's Yxlon FF35 CT high-resolution CT system, used for non-destructive testing of additively manufactured materials

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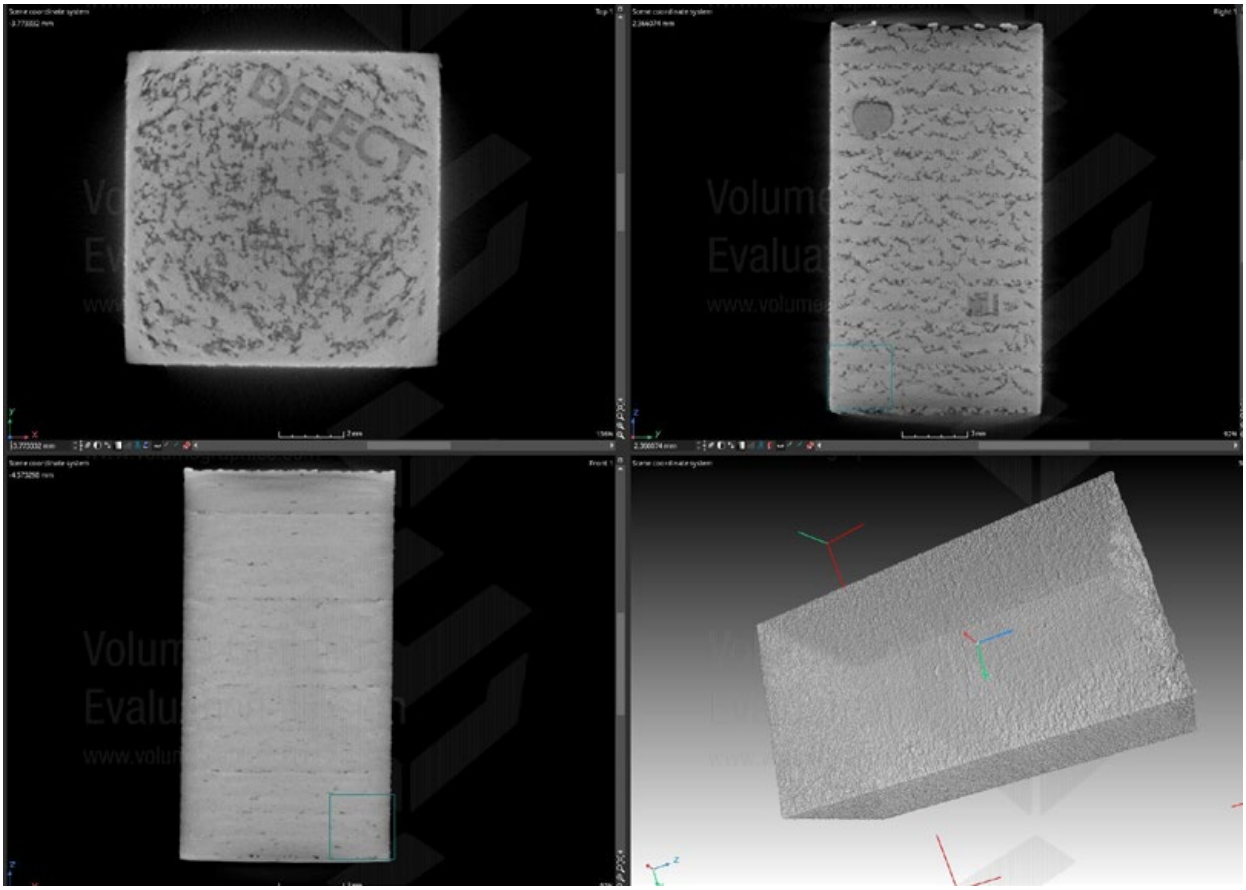

Fig. 2 Screenshot of the scanned data from optimised process parameters built to generate data on lack of fusion defects which is used to establish process maps in 17-4 PH steel

> *"A CT scan produces a two-dimensional density map of a cross-sectional slice of an object's interior. A 3D volumetric model can be produced from these views, taken at many different viewing angles, which are then reconstructed using a computer."*

Originally used as an imaging tool for the healthcare industry, CT has also proven to be a powerful resource for industrial applications. X-ray and Computed Tomography are widely used tools for non-destructive testing (NDT). A CT scan produces a two-dimensional density map of a cross-sectional slice of an object's interior. A 3D volumetric model can be produced from these views, taken at many different viewing angles, which are then reconstructed using a computer. Many 2D slices can be combined by powerful software to produce a 3D image of practically any part, object, or product. This is critical for any application wherein a manufacturer wishes to see inside an object without destroying it.

Through a third party, MRL began sending additively manufactured fatigue samples – approximately 5 cm, made of aluminium, stainless steel, and cobalt alloys – to Yxlon, a leading manufacturer of NDT inspection systems. Yxlon offered inspection services at the company's North American lab in Hudson, Ohio, USA. The requirement was to be able to detect flaws as small as 10 µm, and multiple samples were to be scanned at once to reduce cost, without losing the needed resolution.

The application engineer at Yxlon received the parts, scanned them using an FF35 CT system, and provided CT datasets to MRL. The FF35 CT is a high-resolution Computed Tomography system designed to achieve extremely precise NDT inspection results for small-to-medium sized parts with a base area of up to approximately 51 cm x 79 cm. With regard to additively manufactured parts, the system detects structural irregularities (e.g., pores,

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cavities, and cracks) and geometrical deviations (e.g., insufficient wall thickness). The inspection system met the requirements for the project, as it featured dual micro and nano focus tubes.

MRL used the inspection data for two different tasks. First, the system was used to detect bonding issues, critical to determining quality without destroying the part. Second, the system measured porosity, data that MRL experts used to determine quality levels and the effect on mechanical properties.

By understanding the micro- and meso-scale characteristics of AM materials, MRL can predict the suitability of a part for an application. The company uses a strategy called Integrated Computational Materials Engineering (ICME), which integrates the latest advances in computational science, and the principles of materials science, for engineering solutions.

MRL created a cloud-based ICME framework (iCAAM 2.0) for producing the digital twin for an additively manufactured part. This digital twin approach allows designers to build high-quality parts with model-based qualification.

The data provided by the FF35 CT system was critical to building accurate models, because no other technology at MRL could peer inside thick parts and reveal tiny structures and flaws. Some of the typical flaws that come from the Laser Beam Powder Bed Fusion (PBF-LB) process can be detected easily by CT, including porosity, lack of fusion, keyholes (due to metal evaporation), excessive surface roughness and material discontinuities. The ability to see inside an object is critical because internal structures can be seen in their functioning position. The CT scan data makes it fast and easy to identify these issues early in the manufacturing process, reducing manufacturing time and increasing productivity. In addition, software programs for industrial CT scanning allow for measurements to be taken from the CT dataset volume rendering. These measurements

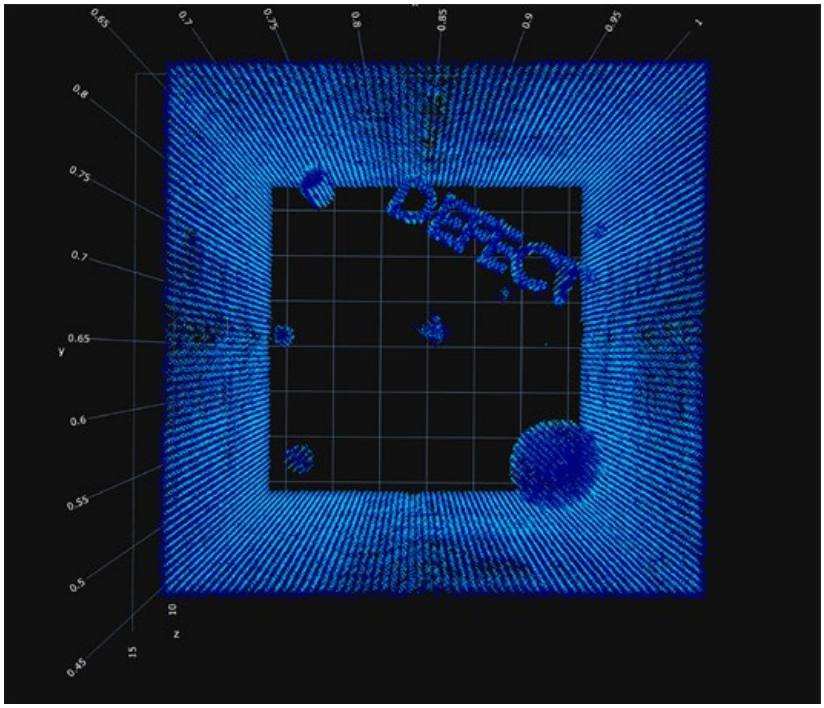

Fig. 3 3D visualisation of the lack of fusion defects, as captured by the melt pool monitor sensors and shown in 3D after MRL construction of the data

are useful for determining the clearances between assembled parts or other functional relevant dimensions (GD&T).

As the volume of samples increased, MRL took the decision to invest in a CT system from Yxlon, rather than continuing to sub-contract the inspection work. MRL now uses the FF35 CT system for defect measurement using 2D imaging and CT for defect prediction in high-strength aluminium, steel, titanium, and magnesium alloys. "Then we try to link that data to the microstructure of the material, the process parameters of the PBF-LB machines, and the expected properties of the manufactured part," stated Dr Salem.

The research that drives the predictive modelling depends on a huge amount of data collected by the Yxlon system. Salem said that for a titanium alloy, the modelling requires at least a 10 mm x 10 mm sample scanned at half a micron resolution. "Combined with sensor data and other inputs, many hundreds of millions of pieces of information are captured, stored, and put in our machine learning tools for analysis," he explained.

> *"Some of the typical flaws that come from the Laser Beam Powder Bed Fusion (PBF-LB) process can be detected easily by CT, including porosity, lack of fusion, keyholes (due to metal evaporation), excessive surface roughness and material discontinuities."*

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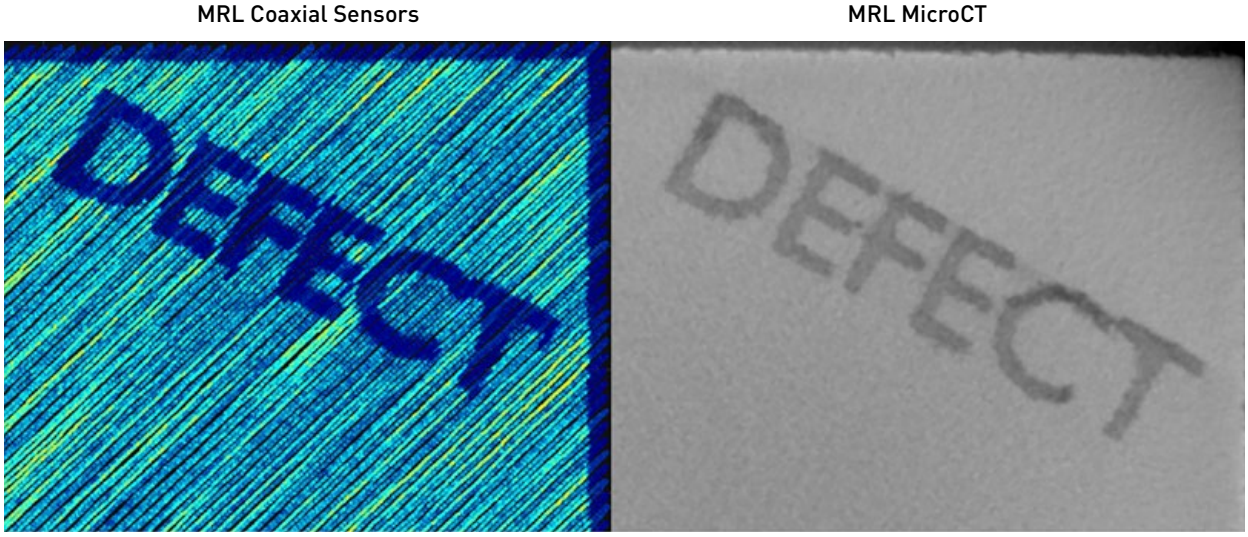

Fig. 4 Co-axial meltpool monitoring sensors stream the temperature of the melt pool. In the visualisation, blue indicates cold melt pools. An artefact of the word DEFECT is clearly visible in the sensor data (left) and is confirmed by the micro CT data (right)

"MRL also uses CT data to calibrate the AM machine's in-situ sensors. To validate the functionality of the sensors, MRL additively manufactured a cuboidal sample of 17-4PH stainless steel on a 3D Systems ProX® DMP 200 AM machine."

"Then we put those results into our predictive models."

MRL researchers also use the YXLON FF35 CT system to validate those predictive models in subsequent samples and to inspect quality during manufacturing. Dr Salem continued, "After we finish a part, the micro-CT system enables us to inspect the areas of high stress without breaking the part. This ensures that the part does not have anomalies that may negatively impact its performance."

Fig. 2 gives an example of the data used in the validation process. It shows a visualisation of planned lack of fusion defects as captured by melt pool monitor sensors and constructed into a 3D view. Spherical lack of fusion features as small as 50 µm were captured in various special locations in the sensor calibration cube. All of them were in excellent agreement with ground truth measurements made by the FF35 CT System.

MRL also uses CT data to calibrate the AM machine's in-situ sensors. To validate the functionality of the sensors, MRL additively manufactured a cuboidal sample of 17-4PH stainless steel on a 3D Systems ProX® DMP 200 AM machine. An artefact of the word 'DEFECT' was designed into the sample to represent a loss of fusion. Technicians used the FF35 CT system to scan the cube and validate whether the sensor measurements were correct. Fig. 3 shows two images side by side: an image from melt-pool monitoring sensors and a CT scan. The scan is a quantitative confirmation of the agreement between post-processing micro CT data and in-situ meltpool monitor measurements.

Dr Salem has stated that the company also plans to offer non-destructive testing as a service to manufacturers in the southwestern Ohio area. By providing state-of-the-art FF35 CT equipment, as well as onsite training and technical support, Yxlon is helping MRL move forward in its goals for problem solving in the AM industry.

Authors

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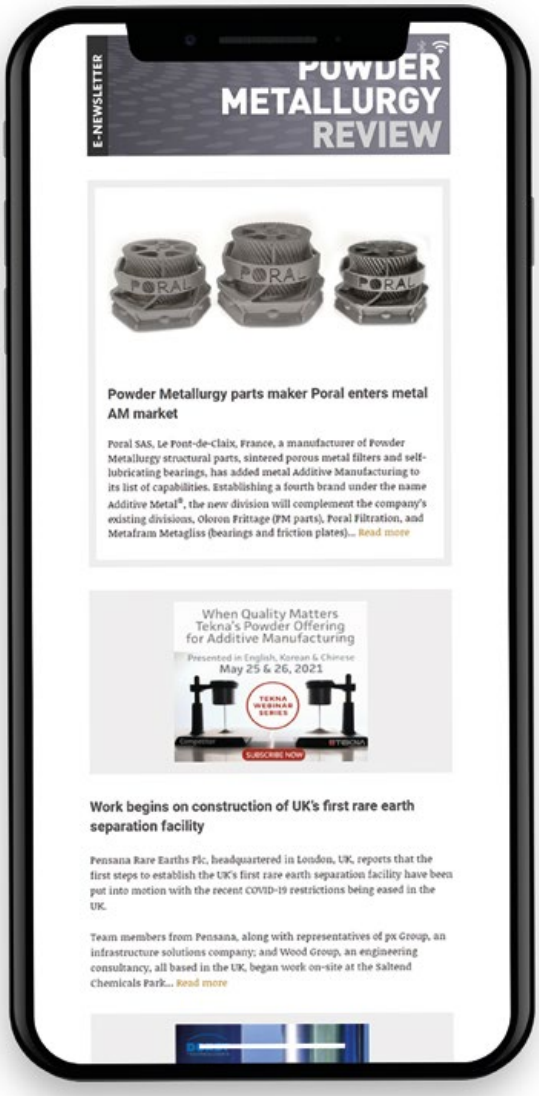

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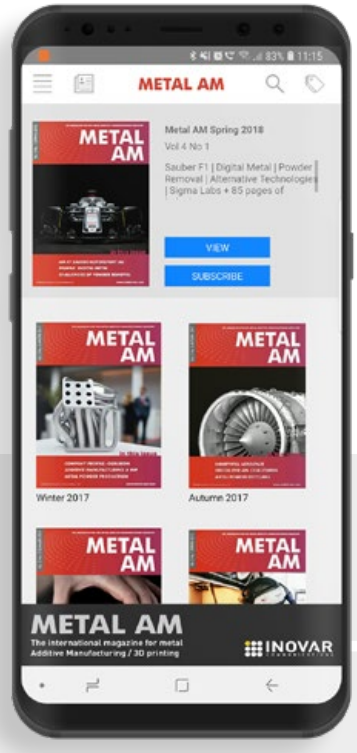

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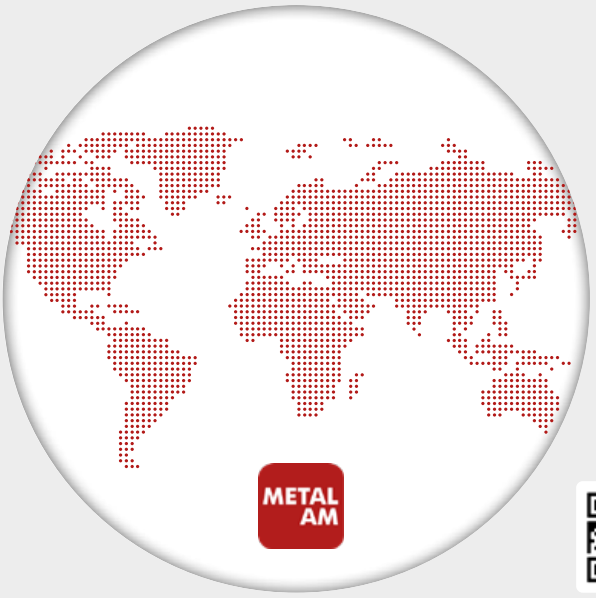

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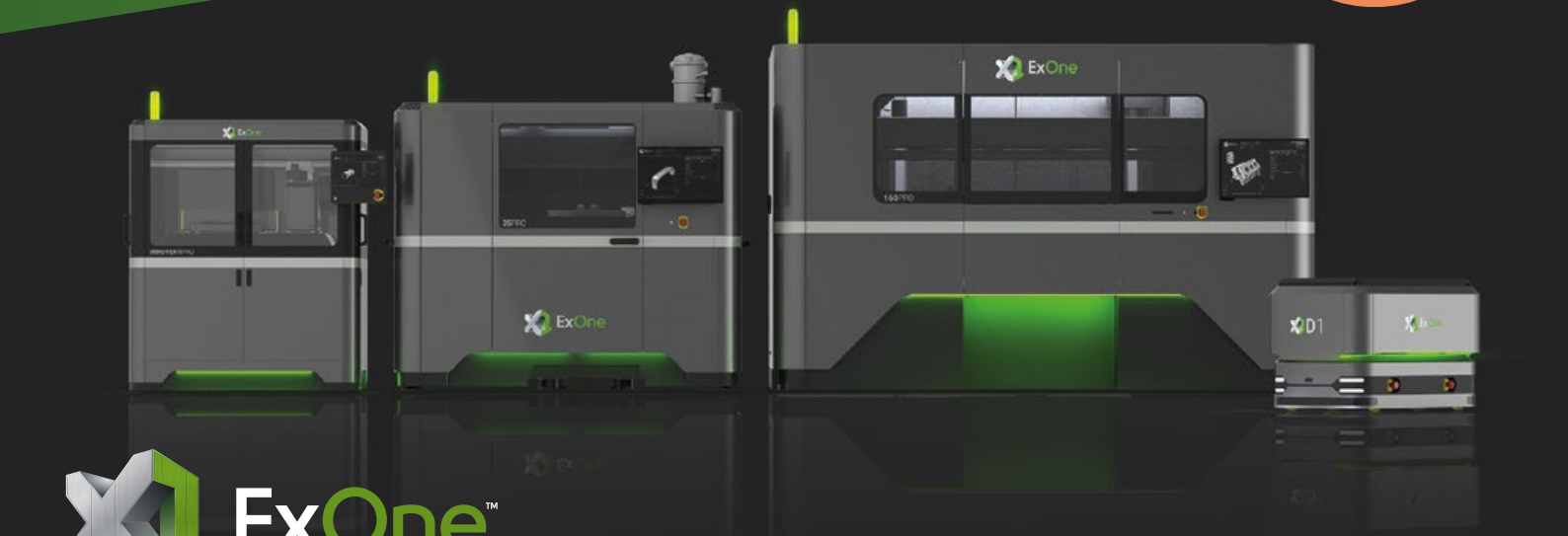

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