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POWDER METALLURGY REVIEW

INDUSTRY 4.0 AND POWDER COMPACTION

NEW TOOLING CHANGEOVER SYSTEM

DIFFERENCES IN PSD METHODS

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INOVAR COMMUNICATIONS

Gains to be made in powder compaction

With industry moving towards greater implementation of Industry 4.0 and the Internet of Things, it is clear that this digital revolution has the potential to benefit numerous stages of the Powder Metallurgy process.

Seeing the advantages of this first hand, powder press manufacturer Dorst Technologies has introduced IoT methodology within its own operations. Building on its experience, the company has developed smart software for use in presses, and in this issue reports how this is benefiting the powder compaction process (page 51).

In powder compaction there are also gains to be achieved through limiting the down-time incurred when changing tooling. In an attempt to reduce this time, Osterwalder reports on its development of a new cartridge based system for the handling and rapid installation of tooling (page 59).

Such innovations, geared towards optimisation of the compaction process, will ultimately reduce operating costs and improve part quality, opening the Powder Metallurgy process up to new applications and reaching new markets.

Paul Whittaker
Editor, *Powder Metallurgy Review*

Cover image
The laser measuring device feeds data back to the control system (Courtesy Dorst Technologies)

Spring 2020

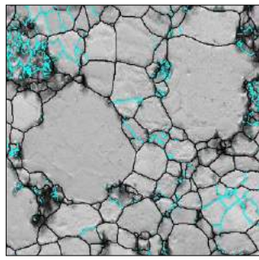
POWDER METALLURGY REVIEW

28

53

65

69



79

in this issue

regular features

industry news

To submit news for inclusion in *Powder Metallurgy Review* contact Paul Whittaker, paul@inovar-communications.com

Melrose reports challenging 2019 for GKN Powder Metallurgy

Melrose Industries PLC, UK, has announced its financial results for the year ended December 31, 2019, reporting that the group was comfortably ahead of the board's expectations for both profit and cash generation. Adjusted diluted earnings per share (EPS) were 14.3 pence, up 13% on last year, and adjusted free cash flow was £591 million, up 72% on an annualised like-for-like basis.

However, it was reported that in 2019 GKN Powder Metallurgy experienced its most challenging market conditions for some years, most notably in the automotive sector. Whilst the business largely outperformed the market in Europe, China and Brazil, in its largest market of North America the combination of a weaker domestic automotive market, the impact of industrial action at certain customers, such as the General Motors strike, and reduced exports to China proved challenging.

As a result, GKN Powder Metallurgy sales were down by 10% and its adjusted operating margins down to 10.5%. Although sales performance was impacted by macro events, the business was largely able to protect margins through investment and efficiency programmes that are said to be part of a wider renewed strategic plan for the business.

Further automation initiatives were reportedly deployed throughout the GKN Powder Metallurgy production footprint during 2019, supported by increased shop floor digitisation. The harnessing of additional activity data points has enabled more detailed and targeted mapping of future improvement initiatives in process efficiency, quality control and supply chain management, with a view to further bolstering GKN Powder Metallurgy's technological and operational leadership.

In the group's GKN Automotive division, sales were reported to have declined by 6% over the year, due to the global downturn in the automotive sector continuing into 2019. However, the business was able to improve its adjusted operating margins in the second half to just under 8%, and adjusted operating profit for the same period rose by 14% compared to 2018.

The GKN Aerospace division was reported to benefit from a strong sector, seeing sales grow by 7% in 2019, with adjusted operating margin rising to 10.6%. Continuing efficiency and productivity programmes also saw a return to profitability for the division's previously troubled North American sites.

www.melroseplc.net
www.gkn.com

Showa Denko announces $8.8 billion bid for Hitachi Chemical

Showa Denko K.K., a chemical engineering company headquartered in Tokyo, Japan, has agreed to pay more than double its own market value to purchase its larger rival Hitachi Chemical Co., Ltd. The move will reportedly scale up Showa Denko's lithium-ion battery and advanced materials businesses, maintaining pace with Chinese rivals.

The company states that it has offered ¥964 billion ($8.8 billion) for all shares of the chemicals unit of Hitachi Ltd., one of Japan's largest industrial conglomerates. The tender offer is expected to start around February at ¥4,630 a share.

The purchase would be Showa Denko's largest on record and would boost the company's revenue from lithium-ion automotive batteries and related materials - segments that are growing fast as carmakers compete to make more electric-powered vehicles.

"Chinese material manufacturers have developed a business that takes advantage of the economies of scale and Middle East material manufacturers have also been increasing cost competitiveness," Showa Denko said in the statement. The company reported that it needed a top market share and more scale to remain a major global manufacturer.

To pay for the purchase, Showa Denko explains that it is seeking a ¥295 billion loan from Mizuho Bank and will sell preference shares to the bank and to the Development Bank of Japan. Showa Denko's bid is among several major deals announced by Japanese companies as the year comes to a close.

www.sdk.co.jp
www.hitachi-chem.co.jp

Auto market sees weaker demand in 2019, faces impact of coronavirus

The international automotive markets faced a challenging year in 2019, with China, Japan, Korea and India all failing to match the sales and production levels of 2018. China reported its second year of declining vehicle sales and production, with 2019 showing a 9.2% reduction in car production to 21.360 million, even prior to the coronavirus (Covid-19)'s arrival in the country in January 2020.

Prior to the outbreak of the epidemic, original car output in China was forecast to decline by a further 10% in the first quarter of 2020 compared with the same period in 2019, but this has now been extended to the first half of 2020, with many car plants still inactive after a nationwide shutdown to control the spread of the virus. There have additionally been significant disruptions to the automotive supply chain. Analysts say that car sales could take many months to recover.

A similar picture is emerging in South Korea, which reported a 15% decline in vehicle production for 2019 to 3.957 million units, due to a slowdown of exports and domestic demand. Production declined by a further 27% to 251,575 units for January 2020, and further significant reductions are expected in the first half period.

Japan, Asia's second largest vehicle producer, saw car production holding up in 2019 with just a 0.2% decline to 9.215 million units. However, Japan's domestic vehicle sales dropped by 2.6% year-on-year and a 11.7% decline in sales to 360,103 units was reported for January 2020. Around 50% of Japan's car output is exported. The Indian car market failed to match the good results achieved in 2018, with a total of 3 million units sold – down 13% year-on-year.

In the USA, the light vehicle market (cars and light trucks) ended 2019 with just under 17 million units (-1.3%), which is the first time the US market has missed the 17 million mark since 2014. Passenger car sales fell by 11%, whilst the light truck market, which now accounts for 72% of the market as a whole, rose by 3%. In Canada, vehicle sales for 2019 declined by 3.6% to 1.914 million units.

In Europe, a total of 15.8 million passenger cars were sold in 2019, around 1% more than the previous year. However, the results varied in the large-volume European markets. Germany saw an increase of 5% in new car sales to a total of 3.6 million units, but recorded a drop of 9% in car production to 4.7 million units. France's car sales dropped by 2%, Italy saw no gains, Spain reported a drop of 5% and the UK a drop of 2%. The UK recorded a drop of 14.2% in car production in 2019 to 1.303 million units and production fell by a further 2.7% in January 2020 to 126,516 units – the lowest monthly total in nine years.

2020 looks set to be a difficult year for the global automotive industry and its suppliers because of market uncertainty caused by the coronavirus. The structural PM part sector supplies around 70% of its output to the automotive sector and any significant declines in demand will inevitably impact PM companies, particularly those in Asian markets.

Many global car companies have already reduced production in the first quarter of 2020 because of a lack of components from China, and whilst some Chinese car plants are said to be restarting operations after a nationwide shutdown, analysts state that any hits to the supply chain will take months to recover from.

The one bright spot in the global auto market is Brazil, which saw a 2.3% increase in vehicles produced in 2019 to 2.944 million units, of which 2.449 were passenger cars.

V&A Capital acquires SinterMet

V&A Capital, a private equity company based in New York City, USA, has acquired SinterMet LLC, Kittanning, Pennsylvania, USA. SinterMet specialises in the engineering and manufacturing of high-performance tungsten carbide, Powder Metallurgy tool steel and other advanced material rolls for use in steel rod and bar mills. The company serves customers worldwide.

"SinterMet is a great company with a long history of providing its customers with high-quality and highly-engineered products that are critical in their mill operations," stated Nicolò Vergani, Managing Partner of V&A. "We are extremely excited to support the company's growth by increasing its product offerings, entering new end markets and searching for complementary add-on acquisitions."

"V&A Capital has deep experience in the metals space and will leverage its expertise and network of operating executives to achieve its growth goals," Vergani added. "In addition, SinterMet fits closely with V&A's other portfolio investments, offering the opportunity for additional growth through operating synergies."

Paul Fleiner, CEO of SinterMet, commented, "V&A Capital was great to work with throughout the sale process. Their attention to detail, creative approach to issues, ability to move rapidly to close, expertise in metals manufacturing and portfolio of complementary businesses were key to selecting them as a partner as well as for the future success of SinterMet and its employees."

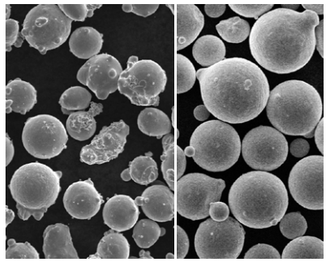
www.vandacapital.com
www.sintermet.com

ASL commissions new 400 kg gas atomiser specifically for AM and MIM powders

Atomising Systems Ltd. (ASL), Sheffield, UK, has expanded its capacity through the installation of a new 400 kg gas atomiser aimed specifically at the Additive Manufacturing (AM) and Metal Injection Moulding (MIM) powder markets.

An additional melter is now being installed for greater flexibility and capacity. The in-house-designed atomiser, equipped with ASL's proprietary anti-satellite and hot gas system, produces high yields of MIM and/or AM powders, enabling ASL to continue to serve its expanding AM and MIM customer base.

Paul Rose, Commercial Director, stated, "The addition of another atomiser, along with the associated sieving and classification equipment, means that we are able to keep pace with the growth of our existing client base and the requirements of new clients, especially in the AM and MIM sectors."



Powder from a conventional gas atomiser (left) vs powder from ASL's atomiser with anti-satellite system (right) (Courtesy Atomising Systems Ltd.)

Rose added, "In these sectors, the benefits of ASL's Anti-Satellite technology are clearly recognised through the excellent powder shape and flow properties."

www.atomising.co.uk

Abbott Furnace Company receives orders for two PM furnaces

Abbott Furnace Company, an industrial furnace manufacturer located in St. Mary's, Pennsylvania, USA, has received two orders for new Powder Metallurgy furnaces – a sintering furnace and soft magnetic alloy processing furnace.

The new sintering furnace has been ordered by a customer which specialises in manufacturing high volume, ferrous-based Powder Metallurgy components in the automotive, lawn and garden, agricultural, and industrial markets. The new furnace, reported to be the 36th furnace to be supplied to this company, is an electrically heated continuous belt furnace. Abbott Furnace will design, manufacture and install the furnace that is rated at 2150°F (1177°C) and includes Abbott's Varicool cooling system. It is scheduled for delivery in Q2 2020.

Abbott Furnace also received an order for an electrically heated continuous belt soft magnetic alloy processing furnace, from a customer in the Powder Metallurgy industry providing components to the metals and mining market. The furnace is scheduled to be shipped in Q2 2020 and has a maximum temperature of 1850°F (1010°C) in an air, nitrogen or steam atmosphere. It includes a delube chamber, oxidation chamber, water-jacketed cooling chamber and a thermostack thermal oxidiser.

Abbott Furnace has thirty-five years of experience in designing and producing high performing industrial continuous process furnaces and produces industrial sintering furnaces, annealing furnaces, tempering furnaces, brazing furnaces, heat treat furnaces, steam treat furnaces, industrial ovens, CAB furnaces, high-temperature furnaces and other speciality furnace products.

www.abbottfurnaceco.com

Ametek to sell Reading Alloys to Kymera International

Kymera International, a speciality materials company headquartered in Raleigh, North Carolina, USA, has entered into a definitive agreement with Ametek, Inc., Berwyn, Pennsylvania, USA, to acquire its Reading Alloys business. Founded in 1953, and acquired by Ametek in 2008, Reading Alloys designs, develops and produces master alloys, thermal barrier coatings and titanium powders. The business is a preferred supplier for producers of high-quality titanium and super alloy mill products that are used in aerospace and aircraft applications.

Kymera has been owned by affiliates of Palladium Equity Partners, LLC, New York, USA, a middle-market private equity firm with approximately $3 billion in assets under management, since 2018. "Reading Alloys is an outstanding company with highly skilled people and an excellent product and end market portfolio that we believe fits in perfectly with our existing business," stated Barton White, CEO of Kymera International. "For Kymera, we believe this is a transformative acquisition that will give our combined company strong technical and commercial resources to help fuel our growth in the aerospace, defence, medical and industrial markets."

Adam Shebitz, Managing Director of Palladium, stated, "The acquisition of Reading Alloys, Kymera's second to date, is right on strategy as the Kymera management team continues to build the company into a leading speciality materials producer. We are excited about this opportunity to enhance the Kymera platform with Reading's value-added products, growing end markets and its talented employees."

www.kymerainternational.com
www.readingalloys.com
www.ametek.com

BorgWarner to acquire automotive parts maker Delphi Technologies

BorgWarner Inc., headquartered in Auburn Hills, Michigan, USA, and Delphi Technologies PLC, headquartered in London, UK, have entered into a definitive transaction agreement, which will see BorgWarner acquire Delphi in an all-stock transaction valued at approximately $3.3 billion. The deal is said to give BorgWarner a unique, more comprehensive portfolio of industry-leading propulsion products and systems across combustion, hybrid and electric applications.

Delphi is developing next-generation vehicle propulsion systems (Courtesy Delphi Technologies)

According to BorgWarner, the acquisition will strengthen its power electronics products, capabilities and scale, enabling the company's evolution towards propulsion markets of the future. Following the close of the transaction, the combined company expects to be one of the leading propulsion companies globally, serving light and commercial vehicle manufacturers and aftermarket.

BorgWarner stated that under the terms of the agreement, which has been approved by the boards of directors of both companies, Delphi Technologies stockholders will receive a fixed exchange ratio of 0.4534 shares of BorgWarner common stock per Delphi Technologies share. Upon closing of the transaction, current BorgWarner stockholders are expected to own approximately 84% of the combined company, while current Delphi Technologies stockholders are expected to own approximately 16%. In the fiscal year 2019, BorgWarner and Delphi Technologies are reported to have generated an estimated $10.17 billion and $4.36 billion of net sales, respectively.

Following the close of the transaction, the combined company will be led by Frédéric Lissalde, BorgWarner's President and CEO, and Kevin Nowlan, BorgWarner's CFO, and will operate as BorgWarner. The transaction is expected to close in the second half of 2020.

"This exciting transaction represents the next step in BorgWarner's balanced propulsion strategy, strengthening our position in electrified propulsion as well as our combustion, commercial vehicle and aftermarket businesses," stated Frédéric Lissalde. "Delphi Technologies will bring proven leading power electronics technologies, talent and scale that will complement our hybrid and electric vehicle propulsion offerings. As a combined company, we look forward to delivering enhanced solutions to our customers while driving increased value for our stockholders."

Lissalde added, "We have a great deal of respect for Delphi Technologies' team around the world and look forward to welcoming them to BorgWarner. We are confident that together we will be able to move faster to address market trends toward electrification."

www.borgwarner.com
www.delphi.com

GTP receives $4.2 million funding to support US industrial base

Global Tungsten & Powders (GTP), Towanda, Pennsylvania, USA, has received funding for the further development and manufacturing of high-performance tungsten heavy alloys. The Industrial Base Analysis and Sustainment (IBAS) programme within the Department of Defense (DoD) provides funding to close gaps in defence manufacturing capabilities and create and sustain reliable sources that are critical to the DoD's focus on readiness and lethality.

GTP manufactures critical tungsten-based components such as tungsten heavy alloys, kinetic energy penetrators, rocket nozzles, as well as billets and forgings for the defence and aerospace industry. With funding of $4.2 million available through 2021, the Department of Defense is supporting the US industrial base by strengthening its domestic supply chain for critical defence components.

Hermann Walser, GTP's President & CEO, commented, "With this funding along with additional investment that GTP is making in support of the defence industry, GTP will be the only domestic manufacturer that is vertically integrated from powder through small to large calibre penetrators. We also appreciate the continued support of Congressman Fred Keller who is a strong advocate of GTP and the industrial base."

GTP's roots in the defence business date back to the early 1940s, when, as the Sylvania Electric Company, it produced proximity fuses for the Navy. Global Tungsten & Powders today employs 600 staff worldwide, with close to 500 based at its headquarters in Pennsylvania.

www.globaltungsten.com

EPMA to close UK headquarters and establish a new secretariat in France

The European Powder Metallurgy Association (EPMA) has announced that it will close its UK-based head office on April 30, 2020, and will establish a new secretariat team located in Chantilly, France.

The EPMA was founded in Brussels in 1989 and has had its secretariat based in Shrewsbury, UK, since 1990. A second office, originally established as a base for the EPMA's technical team, was opened in Chantilly, France, in 2018. According to the EPMA, the decision to move its head office was made in order to improve overall efficiency, as well as enabling a better platform for cost optimisation. As of May 1, the French office will become the main administrative base and home to a new secretariat team. The EPMA's registered headquarters will remain in Brussels. To ensure a level of continuity in the run-up to the EPMA's Euro PM2020 Congress & Exhibition, a number of key UK-based staff members will reportedly work from home, with employment extended until the event.

A new secretariat is currently being formed and further details will be published in due course.

www.epma.com

The EPMA promotes Powder Metallurgy at numerous events throughout the year (Courtesy EPMA)

Kennametal appoints Port as VP and COO of metal cutting

Kennametal Inc., Pittsburgh, Pennsylvania, USA, has appointed Ron Port, currently Vice President and President of the company's infrastructure segment, to Vice President and Chief Commercial Officer of the metal cutting business segments.

The company states that in this newly created position, Port is expected to drive business development strategies across the Industrial and Widia metal cutting segments.

Pete Dragich and Alexander Broetz will continue in their roles as Presidents of Industrial and Widia, respectively, and maintain responsibility for the corresponding financials of those segments. Franklin Cardenas will succeed Port as Vice President and President of the Infrastructure segment.

Port has nearly 25 years of experience across general management, strategy, sales and marketing, and corporate business development.

www.kennametal.com

ALD completes expansion of Hanau facility

ALD Vacuum Technologies GmbH, a division of AMG Advanced Metallurgical Group N.V., has completed the expansion of its headquarters in Hanau, Germany. The new building has added 5,000 m² of floor space, creating room for a hundred additional ALD employees.

Located in the Fraunhofer Science Park in the Hanau-Wolfgang district of Germany, the third construction phase comprised a 2,500 m² four-story office building with a further 2,500 m² hall. Reportedly identical to the large assembly hall from the first construction phase, the expansion offers sufficient hall volume and all necessary energy and media connections including the associated pits.

According to ALD, the administration of the globally active ALD Heat Treatment Services has also moved into its new offices at the expanded Hanau facility. It is expected that, in the new hall, various systems will be installed which will be used for the further technological development of processes and for the design of custom processes to meet customer requirements.

"The continuing good business development was accompanied by a parallel increase in the number of employees and led to increasing space requirements in 2018," stated Guido Löber, CEO of ALD Vacuum Technologies GmbH. "Recently, we have had to move closer together and even create temporary solutions in order to find a place for all our employees. We are therefore very pleased that we can now move into the new building."

Michael Protzmann, Technical Managing Director of ALD Vacuum Technologies GmbH, commented, "We feel very comfortable here in Hanau Wolfgang and can optimally organise our processes here and thus ensure our workforce a future-proof and modern location in a highly technical environment."

Protzmann added, "Here, our newly established 'Industry 4.0' department and our research and development departments for metallurgy and heat treatment will work on pioneering products such as Modultherm 3.0, which will increase the benefits for our customers."

www.ald-vt.com

Audi and Umicore begin to recycle cobalt and nickel from battery cells

Audi AG, Ingolstadt, Germany, and Umicore, a global materials technology and recycling group headquartered in Brussels, Belgium, report that they have successfully completed the test phase of their strategic research cooperation for battery recycling. According to the companies, the result of their research is that more than 90% of the cobalt and nickel used in high-voltage batteries for the Audi e-tron can now be recovered. Audi and Umicore report that they have now entered the next phase of their research cooperation strategy; a closed loop for cobalt and nickel with the recovered materials being used in new battery cells.

For this closed-loop pilot project, Umicore stated that it will receive cell modules from the Audi e-tron model, which will initially be taken from development vehicles. From those cells, the company will recover cobalt and nickel and process them into precursor and cathode materials. From these materials, new battery cells containing recycled cobalt and nickel can reportedly be produced. Since beginning the development of its first fully electric cars, Audi explained that it has worked on the recycling of the vehicle and aims to apply resources efficiently.

"A closed loop for battery raw materials is a big leap technologically. We save precious resources and reduce CO_2 emissions," stated Dr Bernd Martens, member of the Board of Management for Procurement and IT at Audi. "In this way, we come significantly closer to our goal of a sustainable supply chain and reach a milestone on the road to achieving an overall carbon-neutral balance by 2050. It is our aim to think of sustainability holistically. This includes dealing with the remaining 'end of life' as well as resource-saving development of our products."

Marc Grynberg, CEO of Umicore, commented, "Umicore is committed to enabling the transition to electrified mobility. Innovative technologies, responsible sourcing and closing the materials loop will lead the drive towards clean mobility. This project with Audi is at the forefront of the development of a sustainable value chain for electrified transport."

www.umicore.com
www.audi.com

Submitting news..

To submit news to *PM Review* please contact Paul Whittaker: paul@inovar-communications.com

Sumitomo Electric looks to expand cutting tool business with focus on aerospace industry

With materials used in airframes being hard to machine, Sumitomo Electric Industries has reported plans to use its Powder Metallurgy technology and ultra-high pressure technology to develop the next-generation cutting tools required in the aircraft industry. The statement came as the company announced it had recently joined its third aerospace-related consortium.

In December last year, the company's US-based subsidiary, Sumitomo Electric Carbide, Inc., headquartered in Illinois, USA, joined the Oregon Manufacturing Innovation Center Research and Development (OMIC R&D), an industry-academia-government cooperative consortium for aircraft R&D.

OMIC R&D was established in 2017 under the initiative of the Boeing Company, and includes six private enterprises in Oregon, USA, three universities in Oregon and the Oregon state government. Its objective is to promote collaboration among industries, academia and government, strengthening competitiveness in metalworking and developing those who will play key roles in the field of next-generation manufacturing.

Sumitomo previously joined the UK-based Advanced Manufacturing Research Center (AMRC) in 2017 and Germany's International Center for Turbomachinery Manufacturing (ICTM) in 2018.

In addition to joining the consortia, Sumitomo explains that it will implement a variety of strategies to drive full-scale expansion of its cutting tool business in the aircraft industry, such as technical support from its European Design and Engineering Centre and America Tool Engineering Center, quick response to the demands for non-standard special-purpose products through its local production bases and development of products in Japan.

Sumitomo manufactures a wide range of cutting tools (Courtesy Sumitomo Industries Ltd)

www.sumicarbide.com
www.global-sei.com

Sandvik acquires carbide tool maker Melin Tool Company

Walter, a division within Sandvik Machining Solutions, owned by Sandvik AB, Stockholm, Sweden, has acquired solid carbide tools manufacturer Melin Tool Company, headquartered in Cleveland, Ohio, USA. The acquisition is expected to strengthen Walter's round tool offering, especially for the aerospace industry and US channel partner market.

The Melin Tool Company generated revenues of $22 million with 100 employees in the twelve-month period ending September 2019. The transaction was closed on December 31, 2019, and the deal is neutral to Sandvik earnings per share from the start. The parties have agreed not to disclose the purchase price.

"By this acquisition, we will further strengthen our round tools offering which is in line with Sandvik Machining Solutions' growth strategy," commented Lars Bergström, President of Sandvik Machining Solutions.

Richard Harris, President of Walter, stated, "I am very pleased that we have reached an agreement to acquire Melin Tool Company as it increases our market presence, and has a strong innovation focus and high service level that is aligned with Walter's approach to doing business."

www.home.sandvik

www.melintool.com

Walter, a division within Sandvik Machining Solutions, has acquired Melin Tool Company, a manufacturer of solid carbide tools (Courtesy Melin Tool Company)

Gasbarre consolidates production of thermal processing systems at Pennsylvania facility

Gasbarre Products, Inc., DuBois, Pennsylvania, USA, announced at the end of 2019 that all Thermal Processing Systems will now be manufactured at its facility in St. Mary's, Pennsylvania. The company acquired the JL Becker brand of industrial furnace equipment in 2011 and, for the last eight years, has run parallel thermal equipment manufacturing facilities in Michigan and Pennsylvania.

Consolidating the manufacturing of its common product lines is expected to allow for the most efficient use of floor space, equipment and manufacturing processes. According to Alex Gasbarre, Gasbarre's Chief Executive Officer, "This move is not only beneficial to our current operations, but it will directly impact our customers. Our St. Mary's facility has a track record of on-time delivery, quality, safety and efficient processing. Those factors will drive competitive pricing with quick delivery."

Gasbarre will reportedly maintain a strong presence in the Detroit, Michigan area with a sales, engineering and service facility. Ben Gasbarre will also maintain his leadership role at the Plymouth, Michigan location. In future, Gasbarre stated that it has plans to establish a technical centre for process testing and demonstration purposes. Ben Gasbarre stated, "The move will allow us to better utilise our highly-skilled personnel to accelerate advancements to our products, technology and services."

The move will require some expansion of the St. Mary's facility and plans have begun for the addition of manufacturing space as well as office and conference room capacity.

www.gasbarre.com

Miba appoints Martin Liebl to its Management Board

Miba AG, Laakirchen, Austria, has appointed Martin Liebl to its Management Board, effective February 1, 2020. Liebl is the fifth member of Miba's Board, which also includes F Peter Mitterbauer, Wolfgang Litzlbauer, Markus Hofer and Harald Neubert. The appointment is said to be in preparation for the retirement of Neubert, who will stand down from the Miba Executive Board next year.

Liebl began his career at Audi in Germany and Hungary, before joining Miba in 2007 as Plant Manager of the company's facility in Vrable, Slovakia, until 2011. He then went on to join the management team of Miba Friction Group, the company's friction coating division with six production plants in Europe, USA and Asia. Since 2016, Liebl has been the Friction Group's General Manager.

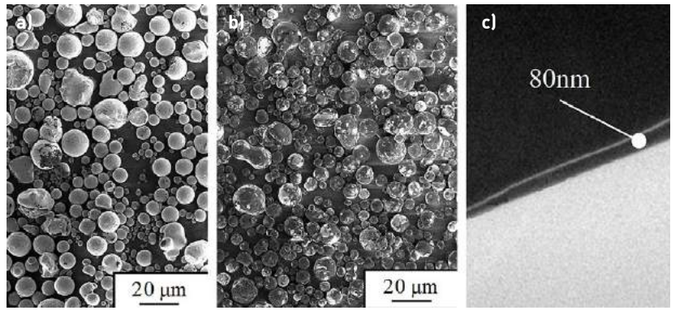
www.miba.com

Ricoh's new resin-coated powders and cross-linking ink to expand range of metals for Binder Jetting

Ricoh, based in Kanagawa, Japan, has developed a new resin-coated metal powder and cross-linking 'ink' for use in the Binder Jetting process. Said to increase the diversity of metals available for Binder Jetting and improve the quality of components, the new range is aimed at those adopting Binder Jetting as a manufacturing process.

The metal powders are coated with a uniform layer of binder resin around 100 nm in thickness, in a process developed from coating technology acquired through electrophotography. A cross-linking material in the ink is said to work with the resin to form the green part.

According to Ricoh, a key advantage of the new material is to remove the risk of dust explosions associated with fine powder particles and potentially explosive powders, such as aluminium and titanium. Fine powders tend to offer improved sinterability and can lead to higher achievable density and low surface roughness. However, fine powders can be more explosive than coarse powders.



SEM images of a) uncoated powder, b) coated powder, c) cross-section of coated powder of stainless steel 316L (Courtesy The Ricoh Company, Ltd.)

The new powders are coated with resin selected to improve both the minimum ignition energy and explosible concentration, important parameters in avoiding dust explosion. The resin-coating is said to prevent the propagation of fire between particles. This allows the use of fine powders and results in improved surface finish, reducing the need for additional post processing steps.

A further advantage of Ricoh's new process is the ability to control the permeability of the ink toward the powder bed. If permeation is less than expected, for example, it can cause increased porosity in the green part and, if the ink permeates too far, it affects the dimensional accuracy of the parts produced.

The control of ink permeability is a key factor for the achievement of the correct density and accuracy for a part. Using its new materials, Ricoh stated that it has achieved the adjustment of the contact angle between the ink and powder surface, and a level of control over permeability through a selected combination of surfactant and coating resin.

www.ricoh.com

Retech Systems finalises headquarters relocation

Retech Systems LLC, a wholly-owned subsidiary of Seco/Warwick, Swiebodzin, Poland, has finalised plans to relocate its headquarters from Ukiah, California, to Buffalo, New York, USA.

The company, a supplier of vacuum and cold hearth melting furnaces, which utilise electron beam, plasma and cold wall induction technologies to melt and cast titanium, nickel, alloys and rare earth metals for use by medical, defence and aerospace manufacturers, has now established its manufacturing and research and development in the new 4,552 m^2 facility to produce melting furnaces for global distribution. The company expects that the change of location could create approximately eighty new jobs over the next few years.

"Retech Systems is pleased to be moving to Buffalo," stated Earl Good, President and Managing Director of Retech Systems. "This decision was made not only to provide flawless regional and global support to our customers, but we also thought about the future. The engineering and technology schools in Western New York are important incubators to support the technologies that we are creating. While we are changing our location, the quality of our products will not be changing."

Sławomir Woźniak, CEO of Seco/Warwick, commented, "Among other reasons, we decided to relocate Retech headquarters to Buffalo due to the close proximity of other Seco/Warwick Group subsidiaries in nearby Meadville, Pennsylvania, USA. This decision will allow closer cooperation and improved operation management. The new location will also be a nice place to host customers and suppliers."

www.retechsystemsllc.com
www.secowarwick.com

Hyperion completes purchase of AFC Hartmetall

Hyperion Materials & Technologies Inc., Worthington, Ohio, USA, a developer of hard and super-hard materials, has completed the acquisition of AFC Hartmetall, headquartered in Mainleus, Germany, a cemented carbide tool blank manufacturer.

Hyperion stated that there will be little change as the companies begin the integration process, and AFC will maintain its own brand identity and continue operations at its Mainleus headquarters. AFC founder Arno Friedrichs has stepped down as CEO and joined the Hyperion Board of Directors, and Ralf Greifzu, who has led AFC's global sales for seven years, is now Vice President and General Manager of AFC.

"Bringing AFC into the Hyperion group creates an extensive product portfolio and expands our manufacturing capabilities, boosting our already robust offering and further positioning us as the first choice for toolmakers in need of high-precision, high-performance solutions for drilling and milling applications," stated Ron Voigt, CEO of Hyperion.

"AFC has an extremely talented workforce and a tremendous reputation for supporting customers. Together, we will work toward the shared goal of becoming the world's top independent supplier of cemented carbide tool blanks."

Ralf Greifzu, Vice President and General Manager of AFC, added, "We are looking forward to the benefits of collaboration across sales, product development and manufacturing. This partnership greatly expands our global footprint, creating the opportunity to introduce our industry-leading products to more markets while ensuring we can provide even better support to our existing clients."

www.hyperionmt.com
www.afcarbide.de

AFC Hartmetall's facility in Mainleus, Germany (Courtesy AFC Hartmetall)

Hannover Messe 2020 dates changed due to coronavirus

Hannover Messe 2020, one of Europe's leading trade fairs for industrial technology, originally set to run from April 20–24, 2020, has been postponed until July 13–17, due to coronavirus (Covid-19). Deutsche Messe AG, the event organiser, stated that the decision to postpone the Hannover Messe was made in close consultation with the Hannover Region Health Office, the event's exhibitor board and its partner associations, VDMA (Association of German Machine and Plant Manufacturers) and ZVEI (Central Association of the Electrical Engineering and Electronics Industry).

The Hannover Region Health Office is said to have strongly recommended that Deutsche Messe AG follow the advice of the Robert Koch Institute. This includes comprehensive measures to ensure health when organising major events, such as temperature measurement stations at all entrances, as well as the implementation of measures not to allow participants from risk areas and to refuse access to participants who have had contact with people from risk areas. To follow this advice would result in an extensive review of all trade fair participants – from exhibitors and visitors to service providers, stand builders and catering companies.

These measures could not be implemented by Deutsche Messe. In addition, their implementation would result in execution of the event being impaired to such an extent that its intended purpose could not be fulfilled for the exhibitors or the visitors, or could only be achieved with considerable restrictions, the organisers stated.

Therefore, as the health of the exhibitors, visitors, employees and the population is a top priority for Deutsche Messe, the decision has been made in coordination with the exhibitor advisory boards at Hannover Messe to postpone the event until July.

"With the appointment in July, we are offering our exhibitors the earliest possible time to present their innovations to a global audience and to initiate business," explained Dr Jochen Köckler, Chairman of the Board of Management of Deutsche Messe AG. "In view of the global economic challenges triggered by the coronavirus in the first half of the year, the new date offers considerable opportunities. This is how the world's most important industrial fair can provide important impulses for the global economy as early as July. Hannover Messe is and remains the figurehead of German industry. "

www.hannovermesse.de

Rapidia opens US facility, targets prototyping of PM components

Rapidia Inc, headquartered in Vancouver, British Columbia, Canada, has opened a new US facility in Innovation Park, just outside Chicago, Illinois, to showcase its Additive Manufacturing technology and serve its US customers. The Rapidia system uses a water-based metal paste AM process to produce parts in a range of materials, including stainless steel, Inconel, ceramics.

The Rapidia system builds parts using water-based metal paste technology (Courtesy Rapidia)

The two-stage office friendly system consists of a metal printer and a sintering furnace. The use of water, instead of a typical binding element, eliminates a solvent-based debinding step and is said to result in a fast, simple to use system that is environmentally friendly and completely solvent-free.

In addition to the growing Additive Manufacturing markets, the company sees the prototyping of Powder Metallurgy components as an ideal application for its technology. Using the Rapidia system, those in the PM industry can produce prototype metal components next day.

Rapidia also announced the appointment of Tim Ruffner as its new Head of North American Sales. Ruffner has a background in Additive Manufacturing, having previously worked for Desktop Metal, Concept Laser, Rize and Dynamism.

www.rapidia.com

Lynas to open rare earth minerals processing plant in Western Australia

Lynas Corporation Ltd, a rare earth mining company based in Mount Weld, Australia, has selected the city of Kalgoorlie, Western Australia, as the home for its new cracking and leaching plant for rare earth minerals processing, as reported in *Australian Mining*. The company states that this is the first step in transforming the historic mining town, known as the gold capital of Australia, into a critical minerals hub.

According to Lynas, Kalgoorlie was selected due to its close proximity to the company's mine in Mount Weld and Kalgoorlie's existing skilled workforce and history in the mining and processing industries. Mount Weld's rare earth concentrate is currently exported to Malaysia for processing at the company's plant in Kuantan, but the new cracking and leaching plant is believed to be a further step to advance the Australian government's critical minerals strategy.

The company explains that the Western Australian rare earth industry is still expanding, and in 2018/19, the state reportedly produced 29,000 tonnes of rare earth materials, directly increasing employment by 3%. The cracking and leaching plant project is expected to create around 500 construction jobs and 200 ongoing jobs in the city once approval processes are finalised.

Additionally to diversifying Kalgoorlie's production and employment options, Lynas states that it will be upskilling miners, chemists and engineers working with tertiary students at the site. It will also help the Western Australian Government achieve its objective for more downstream processing and allow the company to explore opportunities for next stage upstream solvent extraction processing in the state.

"Kalgoorlie is a terrific city and an ideal location for our new cracking and leaching plant," commented Amanda Lacaze, Chief Executive and Managing Director of Lynas Corporation. "Lynas was built from the ground up as an environmentally responsible rare earths producer and we will take the same approach for our facility in Kalgoorlie. The signing of this option is an important step for our project and we look forward to updating the market on its progress."

Mark McGowan, Western Australian Premier, stated, "I'm pleased Lynas will continue to work with Curtin University and the Western Australian School of Mines to enhance knowledge and technologies surrounding the processing of critical minerals in Australia. Kalgoorlie has a long and rich history in mining innovation, so there is no better place for Lynas Corporation to set up their processing operations."

www.lynascorp.com

Arcast begins year installing multiple gas atomisers in USA and Europe

Arcast Inc., Oxford, Maine, USA, has announced it shipped and installed several new gas atomisers in January 2020. The company, a producer of advanced melting and metal powder atomisation systems, has supplied atomisers to the Center for Manufacturing Research of Tennessee Tech, USA; CEIT, San Sebastián, Spain; South Dakota School of Mines and Technology, USA; and North Carolina State University, USA.

"The increase in metal powder research for Powder Metallurgy and AM applications is significant in the USA at the moment," stated Arcast. "We currently have seven inert gas atomisers being supplied within the USA. It is good to see the USA investing in this growing market. This is a big change from just a few years ago when most of the growth in this area was in Europe."

Tennessee Tech has received a VersaMelt multi-mode inert gas atomiser. Due to its wide range of melting and processing options, this atomiser is expected to give the research group the ability to cleanly melt and atomise a large number of diverse materials, including titanium, copper, iron, cobalt, hafnium, tantalum, tungsten and other metal alloys.

An Arc 200 arc melting furnace, with gas atomising option, has been installed at the South Dakota School of Mines and Technology's Materials and Metallurgical Engineering department. The system will enable the research team to work with industrial partners and government agencies to develop new materials and applications.

At North Carolina State University, the Center for Additive Manufacturing and Logistics (CAMAL) will use a VersaMelt gas atomiser for powder production to support its AM hub. The atomiser is expected to allow the centre team, led by Tim Horn, to produce the source material for its AM projects, eliminating long lead times for externally sourced powders.

Outside of the US, a large-scale inert gas atomiser has been shipped to Spain's Centro de Estudios e Investigaciones Técnicas de Gipuzkoa (CEIT), for installation at its new powder development centre in San Sebastián. CEIT's metal powder research includes the atomisation of metal powders for use in AM, magnetic materials and the automotive and aeronautic sectors; the development of Powder Metallurgy steels; the manufacture of hard and soft magnetic materials using PM routes; the design of metal powders specifically for AM, and more.

www.arcastinc.com

Bodycote agrees to buy Ellison Surface Technologies

Bodycote plc, headquartered in Macclesfield, Cheshire, UK, has agreed to acquire Ellison Surface Technologies, Inc., a leader in engineered surface coating solutions headquartered in Mason, Ohio, USA. The move is expected to create one of the world's largest providers of thermal spray and engineered coating surface technology services to the aerospace industry.

According to Bodycote, Ellison's business is highly complementary to Bodycote's existing surface technology business, being that it is primarily focused on the aerospace market. It is expected that the company will be integrated into Bodycote's surface technology and aerospace business, which has reportedly seen strong structural growth in recent years.

Ellison's business generated revenues of $50 million in 2018 and anticipated revenue for 2019 was $58 million. The company explains that its growth reflects the fact that Ellison has been successfully gaining share in the civil aviation business, which will also provide a solid foundation for further growth in future years. Ellison currently employs approximately 400 people across six sites located across the USA, Canada and Mexico.

Bodycote believes that by combining Ellison's thermal spray and engineered coating surface technology services with its own services and global infrastructure, it will enhance the combined organisation's ability to deliver industry-leading solutions that address aerospace customers' heat treatment and specialist thermal processing requirements. Completion of the transaction is contingent on various regulatory filings' processes; it is anticipated that the transaction will complete during the first quarter of 2020.

www.ellisonsurfacetech.com
www.bodycote.com

PM China 2020 announces new dates

The 13th International Exhibition for Powder Metallurgy, Cemented Carbides and Advanced Ceramics (PM China 2020), organised by Uniris Exhibition Shanghai Co., Ltd, has been moved to August 12–14, 2020, following the coronavirus (Covid-19) outbreak. Originally set to take place at the Shanghai World Expo & Convention Center, from March 24–26, 2020, PM China 2020 has over 500 Chinese and international organisations reported to be exhibiting at the event.

"We apologise for any inconveniences caused to you by the postponement and are sincerely grateful for your kind understanding and continual support. We look forward to seeing you August 12–14, 2020, at Shanghai World Expo & Convention Center."

http://en.pmexchina.com

ZF's new sintered metal brake pads offer increased durability and high sensitivity

Germany's ZF Friedrichshafen AG has introduced its latest premium sintered metal motorcycle brake pads through its subsidiary TRW. The new TRW Sinter Road & Track (SRT) brake pads have General Certification (ABE) qualification and are said to offer a stable pressure point, consistent and fade-free braking power under high thermal loads, low manual force and optimal sensitivity.

In a direct hot pressing process, the sintered metal pad mixture is applied to the back plate by means of a conductive sintering process. According to ZF, the result is a high-quality, standardised pad structure which ensures that the pads maintain a constant coefficient of friction until the defined remaining pad thickness has been reached. Compared to conventional sintered metal pads, they are also said to exhibit considerably longer durability and more precise sensitivity under high loads.

The TRW SRT brake pads benefit from ZF's patented Nucap Retention System (NRS) technology, in which the brake pad's back plates are equipped with a hook profile that permanently embeds itself into the friction material. The new pads can be combined with a motorcycle's original brake discs, as well as with all TRW discs.

www.zf.com
www.trwaftermarket.com

ZF's new TRW Sinter Road & Track brake pads (Courtesy ZF Friedrichshafen AG)

The back plate of a TRW Sinter Road & Track brake pad (Courtesy ZF Friedrichshafen AG)

Winners announced for Wards 10 Best Engines & Propulsion Systems 2020

WardsAuto has announced the 2020 recipients of its 10 Best Engines & Propulsion Systems awards. For the first time in eleven years, three inline 6-cyl. engines appear on the list, while four electrified powertrains were included for the third consecutive year.

This is the inaugural year of the renamed competition, formerly known as the '10 best Engines' awards, which since 1995 has been recognising new powertrains used in vehicles for the US market. To be eligible this year, vehicles must have a base price no higher than $65,000.

Wards' editors chose the winners after evaluating twenty-six all-new or significantly improved engines and electric propulsion systems during everyday driving in Detroit in October and November 2019. Editors scored each powertrain based on horsepower, torque, comparative specs, NVH management, observed fuel economy and the application of new technology.

This year's winners power two muscle coupes, three family sedans, two luxury cars, two pickups and an all-electric CUV. The winners, listed alphabetically by automaker, are:

- BMW 3.0L DOHC Turbocharged I-6 (M340i)
- Daimler 3.0L DOHC 48V Turbo I-6 (Mercedes-Benz GLE450)
- FCA 3.6L DOHC 48V eTorque V-6 (Ram 1500)
- Ford 2.3L DOHC High-Performance Turbo 4-Cyl. (Mustang)
- GM 6.2L OHV V-8 (Chevrolet Corvette Stingray)
- GM 3.0L DOHC Turbodiesel I-6 (Sierra)
- Honda 2.0L DOHC Atkinson i-VTEC 4-Cyl./HEV (Accord Hybrid)
- Hyundai 150-kW Propulsion System (Kona EV)
- Hyundais 1.6L DOHC Turbocharged 4-Cyl. (Sonata)
- Nissan 2.0L DOHC VC-Turbo 4-Cyl. (Altima)

Drew Winter, Wards' Senior Content Director, stated, "The auto industry is making tremendous strides by continuing to develop innovative internal-combustion engines while simultaneously investing in hybrids, battery-electrics, 48V mild hybrids and hydrogen-powered fuel cells."

"We've had years with several luxury brands making the list, but this year there were only two: BMW and Mercedes-Benz. It's important that our winning picks remain within reach for American consumers and represent a wide range of internal-combustion and electrified propulsion sources."

www.wardsauto.com

Swansea University opens £35 million materials and engineering research facility

Swansea University, Wales, UK, has opened the Institute for Innovative Materials, Processing and Numerical Technologies (IMPACT), a £35 million materials and engineering research facility, at the College of Engineering on Swansea University's Bay Campus, reports *Materials World* magazine.

Offically opened by First Minister of Wales, Mark Drakeford AM in February 2020, the new facility is intended to cater for collaborative research projects between industry and academia. It will reportedly target five core research areas including future manufacturing, next-generation material property measurement, advanced structural materials, thin films and coatings, and data-centric engineering.

According to the university, in order to serve multiple needs, the IMPACT building is split across two sections which include an office and a laboratory, connected via a central corridor. The administrative section in the Engineering North portion houses eighty single-occupancy offices and a hub to sit 150 people, with co-location space for collaborative working.

The functional area has 1,600 m² of open plan laboratories and the building has been fitted with cutting-edge equipment set to serve projects in innovative materials, modelling and manufacturing, and advanced engineering to support both theoretical and applied research projects. The facility also features robotics, cobots and Additive Manufacturing capabilities, and a £1.2 million wind tunnel for testing airflow movements around solid objects.

"IMPACT supports the global engineering economy through collaborative, fundamental and applied research, development and innovation," stated Professor Johann Sienz, Director of Innovation and Engagement at the College and Director of IMPACT. "Our unique colocation facility means we can offer a transformative research environment for academia-industry partnerships."

A £35 million materials and engineering research facility has been opened by Swansea University (Courtesy Swansea University)

"These highly specialised laboratories will bring industry and academia closer together and the funding received from the European Regional Development Fund has greatly contributed to our growth as a leader in our field in the UK and beyond," added Prof Sienz. "This unique facility will, therefore, help further support Wales as a global destination for innovation in advanced engineering and smart manufacturing."

www.swansea.ac.uk

Ellen Brooke named as CEO of newly formed ImphyTek Powders

Following the formation of the new jointly established company, ImphyTek Powders™ SAS in November 2019, Aperam S.A., Luxembourg, and Tekna, a subsidiary of Arendals Fossekompani ASA, headquartered in Sherbrooke, Canada, have nominated Ellen Brooke as CEO of the new company.

Brooke has worked in senior roles at Aperam since 2002 and the companies state that she has demonstrated strong capabilities in achieving revenue and business growth objectives within multiple environments, both in Europe and South America. Brooke has extensive experience in sales and manufacturing, with a deep understanding of critical business drivers in multiple markets and industries, and holds a Bachelor of Law from Hull University, UK.

According to Aperam and Tekna, after pre-notification discussions and short-form CO filing, the companies are in the process of obtaining European Commission clearance to create a full-function joint venture combining their expertise in nickel and speciality alloy spherical powders for advanced Additive Manufacturing technologies.

Upon EU Commission clearance, ImphyTek Powders™ SAS will be based in France and will market the companies' jointly developed high-quality spherical metal powders to meet the growing needs of Additive Manufacturing and Metal Injection Moulding (MIM) in all industrial segments.

Ellen Brook has been named as CEO for ImphyTek Powders (Courtesy Aperam/Tekna)

www.aperam.com
www.tekna.com

Abtex Corporation acquired by The Malish Corporation

Abtex Corporation, Dresden, New York, USA, a producer of customised, integrated machine and brush deburring solutions for the manufacturing industry, has been acquired by The Malish Corporation, Mentor, Ohio, USA, a manufacturer of commercial and industrial brushes, custom plastic extrusions, rotational moulded and other speciality products.

The Malish Corporation was founded in 1945 and is a family-owned business, with Jeff Malish serving as President & CEO. It has manufacturing operations in Mentor, Ohio; Dongguan, China; and Wroclaw, Poland. It acquired Abtex's assets on December 6, 2019.

According to The Malish Corporation, the acquisition of Abtex will further diversify the company's product offering and provide a higher quality service to its customers. Abtex will reportedly remain a standalone entity, with all employees remaining with the company including Jason Saner continuing in his role as president.

www.abtex.com
www.malish.com

Grupo Mess named Mexican distributor for Buehler metallography solutions

Buehler, an ITW Company headquartered in Lake Bluff, Illinois, USA, has entered into a partnership with Mess Servicios Metrologicos S. de R.L. de C.V. (Grupo Mess) a supplier of scientific equipment and services, specialising in metrology, based in Queretaro City, Mexico. As part of the partnership, Grupo Mess has been named Buehler's official distributor for metallographic and hardness equipment in Mexico.

According to Buehler, the partnership will provide customers based in Mexico with local support for their metallographic product and service needs, for product inspection or quality control laboratories. Grupo Mess will offer the company's complete line of metallography solutions for sample preparation, materials characterisation and hardness testing.

Industrial manufacturing quality control labs in Mexico are expected to benefit from Grupo Mess's team of proven industry experts, offering local sales support, quick service response and a stocked consumables warehouse located mainly in Querétaro for fast fulfilment of orders. Grupo Mess is also expected to maintain an onsite Buehler metallography and hardness testing laboratory, where trained staff will provide metallographic tests based on ASTM and ISO standards.

www.buehler.com | www.mess.com.mx

Sandvik reports record twelve months

Sandvik AB, headquartered in Stockholm, Sweden, has reported its results for its full-year 2019. The company stated that 2019 had been a record twelve months for order intake, revenues, adjusted operating profit, adjusted operating margin and cash flow.

Order intake for Sandvik's products was reported to have improved by 1% in North America while it declined by -8% in Europe and -3% in Asia. Changed exchange rates had a positive impact of 4% on both order intake and revenues. Sandvik's order intake amounted to SEK 104,075 million, and revenues were SEK 103,238 million, implying a book-to-bill ratio of 101%.

Adjusted operating profit increased by 3% year-on-year to SEK 19,219 million, positively impacted in the amount of SEK 1,847 million due to changed exchange rates. The adjusted operating margin remained stable at 18.6%. The reported operating profit decreased by -28% to SEK 13,386 million and operating margin was 13.0%. Changed metal prices had a positive impact of SEK 274 million.

During the year seven acquisitions were closed: Sandvik Machining Solutions acquired three round tools companies (Wetmore, OSK and Melin Tooling Company). Sandvik Mining and Rock Technology acquired a battery technology company (Artisan) as well as a supplier of leading technology in wireless connectivity to monitor and provide insights on underground operations (Newtrax). Sandvik Materials Technology acquired a manufacturer of high-temperature furnace systems and metallic heating elements (Thermaltek). In addition, Sandvik Machining Solutions acquired a minority stake of 30% in Italian company Beam IT, a leading Additive Manufacturing service provider.

Progress was made regarding the internal separation of Sandvik Materials Technology. The intention is to increase Sandvik Materials Technology's structural independence from the Sandvik Group, thereby putting greater focus on the business' future development possibilities and creating flexibility. The Board of Directors has also decided to explore the possibility of a separate listing ('Lex Asea') on the Nasdaq Stockholm Exchange, should this be considered to strengthen Sandvik Materials Technology's position and future development.

www.sandvik.com

Yamaha Motor begins accepting orders for high-performance electric vehicle motor

Yamaha Motor Co., Ltd., Iwata, Japan, has begun accepting orders for a high-performance electric motor prototype that it states is capable of producing industry-leading high power density for automobiles and other types of vehicles.

Yamaha's 35 kW prototype electric motor unit (Courtesy Yamaha Motor Co., Ltd.)

The compact unit, an interior permanent magnet synchronous motor (IPMSM), is capable of generating from 35 kW up to 200 kW in output, thanks to a high-efficiency segment conductor and advanced casting and processing technologies. It can use either water or oil cooling.

Yamaha stated that it will customise the prototype to the specific needs of individual customers, deepening its knowledge of evolving market needs. It plans to deliver in short time spans, utilising production technology that the company flexibly adapts to its various product groups, including motorcycles.

This initiative is part of Yamaha Motor's 'Transforming Mobility' business strategy, which the company announced together with its long-term vision to 2030 under the banner of 'ART for Human Possibilities' on December 11, 2018.

https://global.yamaha-motor.com

MPIF announces Edwin Pope as keynote speaker for WorldPM2020

The Metal Powder Industries Federation (MPIF) has announced that Edwin Pope, Principal Analyst at IHS Markit, has been selected as keynote speaker for the co-located conferences WorldPM2020, AMPM2020 and Tungsten2020, which will take place in Montréal, Canada, from June 27–July 1, 2020.

WorldPM is held every two years and in 2018 took place in Beijing, China. The conference is held in North America once every six years, and this will be the second time that it has been co-located with Tungsten2020 and AMPM2020.

During the Opening General Session on June 28, 2020, Pope is expected to discuss outlooks and trends for the global automotive market, propulsion system design, transmission design, electrification and metal Additive Manufacturing within the automotive sector.

Further information and registration details are available via the event website.

www.mpif.org/Events/WorldPM2020

Gevorkyan announces plans for Austrian R&D centre

Gevorkyan s.r.o., based in Vlkanová, Slovakia, reports that it will establish a new R&D centre in Austria. The announcement follows a successful 2019 for the company, which saw increasing turnover of €42 million and EBIDTA of €12 million.

Dipl. Ing. Artur Gevorkyan, the company's main shareholder, explained, "We want to be closer to our customers, who mainly come from Western Europe, and at the same time to simplify the logistics and organisation of meetings concerning new projects between customers and our R&D."

"This idea came after several organised meetings with customers near the Vienna airport," he added. "Thanks to modern technologies, it is basically the same for an R&D engineer wherever they are situated during the development phase of a project. Moreover, engineers will have the additional benefit of a few weeks out of a main office with its routine problems and daily disturbances."

The company produces and supplies metal parts made by PM, MIM and HIP technologies to customers in more than thirty countries worldwide. Its end-user sectors include the automotive, lock and security systems, garden and hand tool, oil, medical, cosmetic and fashion industries. In 2018, it announced plans to install the technology for metal Additive Manufacturing at its main facility through 2019.

Its team develops over a hundred new parts each year and manufactures two thousand different types of component annually. A large part of its component portfolio is made up of PM and MIM components transferred from conventional technologies such as casting or machining. To further automate production, the company added fourteen robots to its manufacturing lines in 2019.

Gevorkyan added 14 new robots in 2019 (Courtesy Gevorkyan)

www.gevorkyan.sk/en

Isostatic Toll Services opens new HIP facility in Spain

Isostatic Toll Services Bilbao SL has officially opened its new Hot Isostatic Pressing facility in Abanto Zierbena, Biscay, Spain. With a total investment of €14 million ($15.5 million), the new plant will reportedly offer the largest available HIP systems in southern Europe. Already installed and operational at the Bilbao facility is an AIP52 HIP unit, with a second identical system due to be installed in December 2020. With a hot zone diameter of 1100 and depth of 2500 mm at 103 MPa, the AIP52 is capable of processing large components, such as engine blades, vanes and integral rings used in the aviation industry. In addition to supporting the high-tech aerospace sector, the facility is expected to serve the region's growing medical implant manufacturing industry.

The AIP52-15H Hot Isostatic Press is a large, production sized HIP system (Courtesy AIP)

The new facility has been granted EN 9100 approval by Bureau Veritas and has been successfully audited and approved by Rolls Royce and Pratt & Whitney. Safran approval is currently underway, with Nadcap approval planned for mid 2020.

In addition to providing toll services, staff at ITS Bilbao will support a new AIP European Competence Centre, established to serve the EMEA region with installation, commissioning, maintenance, inspection and repair of AIP's range of presses and systems.

www.isostatictollservices.com
www.isostatictollservices.eu
www.aiphip.com

American National Carbide invests $4 million in company growth

American National Carbide (ANC), a manufacturer of tungsten carbide products for the energy and metalworking industries headquartered in Tomball, Texas, USA, has invested $4 million in its growth plans.

According to ANC, after a successful reorganisation of the company in 2017, this investment is the culmination of a three-year effort to secure suitable financing for the ANC's growth plans. Infrastructure improvements will reportedly include new hardware and software systems, significant building renovations, and updated lighting and HVAC throughout the operation, while extensive equipment upgrades will resolve capacity constraints in critical production areas.

"We have invested in infrastructure improvements and equipment upgrades to streamline our manufacturing processes, all in order to improve the quality of our products and the overall customer experience," stated D Greg Stroud, President and CEO of American National Carbide. "This investment propels ANC into the new decade, well-positioned to handle current business and take advantage of future opportunities."

The company manufactures all of its products at its Tomball headquarters, including tungsten carbide-cobalt powders, cutting and wear products for the energy industry, indexable inserts and support products for all types of metalworking applications, and various wear products.

www.anconline.com

Horizon appoints Kalen Fitch as Director of Operations

Horizon Technology, St. Mary's, Pennsylvania, USA, has appointed Kalen Fitch as its new Director of Operations. In his new role, Fitch will be responsible for the production supply chain, product quality and improving processes to provide more value for customers.

Previously, Fitch served as a Process Engineering Manager and Site Manager at Morgan Advanced Materials. He has a bachelor's degree in Industrial and Manufacturing Engineering from Penn State University, Lean Six Sigma Black Belt from Greenville Technical College and Dale Carnegie programme experience.

www.horizontechnology.biz

Carpenter Technology reports 12th consecutive quarter of year-over-year sales growth

Carpenter Technology Corporation, Philadelphia, Pennsylvania, USA, has reported its financial results for its fiscal second quarter ended December 31, 2019. For the quarter, the company reported a net income of $38.8 million.

Net sales for the second quarter of the fiscal year 2020 were $573 million, compared with $556.5 million in the second quarter of the fiscal year 2019, an increase of $16.5 million (3%) on 7% lower volume. Net sales excluding surcharge were $471.2 million, an increase of $21.8 million (5%) from the same period a year ago. Operating income was $55 million compared to $55.4 million for the same period last year. Carpenter Technology states that these results primarily reflect a stronger product mix across all end-use markets, partially offset by higher spending in key growth areas.

Cash provided from operating activities in the second quarter of the fiscal year 2020 was $21.8 million, compared to $37.8 million in the same quarter last year. The decrease in operating cash flow primarily reflects additional working capital investments partially offset by higher income levels. Free cash flow in the second quarter of the fiscal year 2020 was negative $34.5 million, compared to negative $90.9 million in the same quarter last year.

The company states that the improvement in free cash flow was primarily due to its acquisition of LPW Technology Ltd. in the second quarter last year, which was partially offset in the current quarter by higher capital expenditures and additional working capital investments. Capital expenditures were $46.7 million in the second quarter of the fiscal year 2020, compared to $40.1 million in the same quarter last year.

"Our second-quarter results reflect a continuation of our consistent year-over-year earnings growth, backlog expansion and record operating performance at SAO," stated Tony Thene, Carpenter Technology's President and CEO. "The second quarter marked our twelfth consecutive quarter of year-over-year sales growth and backlog growth. We generated double-digit year-over-year revenue growth in the Aerospace and Defence end-use market as our leading solutions, sub-market diversity and participation on practically all major industry platforms continue to drive strong performance."

www.carpentertechnology.com

Equispheres receives $8 million funding to scale metal powder production

Equispheres, a materials science company based in Ottawa, Canada, has received $8 million of funding from Sustainable Development Technology Canada (SDTC) to facilitate scaling its metal powder production capacity over the next two years. SDTC is a government foundation that helps Canadian entrepreneurs accelerate the development and deployment of globally competitive 'cleantech' solutions.

As automotive and aerospace manufacturers seek to reduce the carbon footprint of their products, vehicle weight optimisation is a top priority. Equispheres states that its metal powder is designed specifically for Additive Manufacturing and has been optimised for the automotive and aerospace industries. As such, this powder is said to allow parts to be manufactured faster and up to 30% stronger and lighter than parts produced with traditional AM powders.

According to Equispheres, although Additive Manufacturing is not new to the automotive and aerospace industries, it was previously not feasible for use as a mass production tool using aluminium alloy powders. Since aluminium alloys account for a significant amount of material demand in these industries, a powder that allows for faster, more efficient production of stronger and lighter parts has significant implications.

The results the company has achieved reportedly impact not only production efficiency but also part performance as related to carbon footprint. In the automotive industry alone, it's anticipated that Equispheres' powder could improve fuel efficiency by over 10%. Additionally, Equispheres reports that its powder outperformed in aerospace-ready quality tests and has 'proven exceptional' in tests performed by McGill University.

"We are excited to receive this funding award from the SDTC Foundation," stated Kevin Nicholds, CEO of Equispheres. "This support from SDTC speaks to the importance of our powder technology as a key to achieving significant emissions reductions in the automotive sector. The funding from SDTC will help Equispheres to continue to accelerate our production capacity and support this important work by our automotive partners."

Leah Lawrence, President and CEO, SDTC, added, "Canadian cleantech entrepreneurs are tackling problems across Canada and in every sector. I have never been more positive about the future. Equispheres has developed a metal powder that acts as ink for 3D printing and enables automotive and aerospace manufacturers to reduce the weight of their products. With Equispheres' powder set to remove 100–200 kg of mass from an automobile, this would be the equivalent to removing seventy-five million cars off the road!"

www.equispheres.com

Wall Colmonoy celebrates fifty years of production at its Wales facility

Wall Colmonoy Limited, Pontardawe, Swansea, Wales, recently celebrated its fiftieth anniversary since its facility in Pontardawe was established. The Wall Colmonoy Corporation is a leader in materials engineering for aerospace, automotive, glass, oil & gas, mining, energy and other industrial sectors. The UK division exports over 80% of its products into the Eurozone, Scandinavia, South Africa, Russia, the Middle East and India.

The company entered the European market in 1952 with the establishment of a sales office and distribution centre in London which imported products from Wall Colmonoy Canada. As the company grew and the need for local manufacturing became apparent, alloy manufacturing began in Motherwell, Scotland, before transferring to a larger facility in Brackley, England. Due to continued growth in the UK and European markets, William P Clark Sr., Group Chairman, accepted an offer by the Welsh Government in 1969 to establish its European headquarters in Pontardawe, Wales, and construct a larger facility to fulfil the growing demand.

Since then, Wall Colmonoy has increased the capacity of the Pontardawe facility from 3,065 m^2 to 6,503 m^2, and opened a 2,183 m^2 advanced machine shop to support its casting manufacturing facility in 2012. Its current workforce comprises 215 employees, and in 2015 the company launched a tailor-made apprenticeship programme to train and develop a new generation of engineers.

According to the company, it has also invested nearly £500,000 in its Research & Development Laboratory which features state of the art analytical equipment and is reportedly one of the best-equipped laboratories in the UK. In addition to the laboratory, Wall Colmonoy states that it has implemented new technologies in powder processing, automated brazing paste mixing, which its expert engineers designed and developed, and Additive Manufacturing.

Within Precision Components, Wall Colmonoy explains that it is working jointly with local academia to embrace Industry 4.0, by modernising casting equipment and automation techniques through the use of collaborative robots. For rapid prototyping of parts, the team deploys additively manufactured investment patterns and tooling. Additionally, the company recently installed a five-axis CNC milling machine, new Mazak twin spindle CNC lathes, and expanded a precision turning cell to grow its capacity and offerings.

"Wall Colmonoy is proud to be in Wales," stated Bill Clark, Chairman & CEO, Wall Colmonoy Corporation. "We have been there for fifty years and plan to be there for many, many more years. We are growing and look to the local community and universities to build our expanding business."

www.wallcolmonoy.com

ALD's Heat Treatment Services division to open new facility in China

Heat Treatment Services (HTS), a division of ALD Vacuum Technologies GmbH headquartered in Hanau, Germany, has announced that it will establish a new heat treatment services centre in China, which will be officially registered as ALD Thermal Treatment (Suzhou) Co., Ltd.

This will be the fourth ALD Heat Treatment Services plant globally, with the others being based in Germany, the USA and Mexico. The company states that the new centre will be equipped with ModulTherm, ALD's heat treatment system, and will serve the domestic industry with high-quality heat treatment services. The new production hall will reportedly be erected next to the company's subsidiary ALD-C&K Vacuum Technologies (Suzhou) Co., Ltd.

ALD-C&K Vacuum Technologies (Suzhou) Co., Ltd., produces, sells and services ALD equipment and is also experienced in the commissioning and maintenance of heat treatment systems. The close cooperation between these two units is expected to contribute to the performance of the new heat treatment services centre. Start of production is scheduled for Autumn 2020.

www.heat-treatment-services.com

Call for papers issued for the 40th Senafor event in Brazil

The organisers of the 40th Senafor event, which will take place at the Hotel Continental Events Center, Porto Alegre, Brazil, from October 14–16, 2020, have issued a call for papers for presentation during the conference.
This year's edition of the event will include the 24th International Forging Conference – Brazil, the 23rd National Sheet Metal Forming Conference / 10th International Sheet Metal Forming Conference / 7th BrDDRG Congress, the 10th International Conference on Renewable Energy Materials and Processes, and the 8th International Conference of Powder Metallurgy/14th Meeting of Powder Metallurgy.

The event organisers, the Federal University of Rio Grande do Sul (UFRGS), Technology Center (CT), Brazilian Center for Innovation in Mechanical Conformation (CBCM), Mechanical Transformation Laboratory (LdTM), Brazilian Plate Conformation Research Group (Brazilian Deep Drawing Research Group) and the Luiz Englert Foundation, are inviting abstracts covering the following topics:

- Forging
- Sheet forming/BrDDRG – Sheet metal
- Renewable energies
- Powder Metallurgy

The deadline for abstract submissions is May 20th.
www.senafor.com

GKN Automotive collaborates with Delta Electronics on next-generation eDrive technology

GKN Automotive has reported that it will collaborate with Delta Electronics Inc., a provider of power and thermal management solutions, to develop next-generation integrated 3-in-1 eDrive systems of power classes from 80 kW to 155 kW.

Under the collaboration, Delta will supply inverters for integration with GKN Automotive's eMotor and gearbox systems in a 3-in-1 solution. The collaboration will centre on the development of two new integrated eDrive families for application across different torque classes for the next generation of hybrid and electric vehicles.

Within three years, the new 3-in-1 eDrive units are expected to be available for start of production in a multitude of vehicle types, from A-segment city cars to D-segment executive cars and SUVs, supporting a range of torque outputs from 2,000 Nm to 3,800 Nm, with nominal power outputs of between 80 kW to 155 kW.

According to GKN Automotive, it believes this new partnership will strengthen its position as a leading full-system electric powertrain supplier while boosting Delta's position as a dominant force in the design, development and supply of EV powertrain solutions and power electronics products.

"The eDrive market continues to accelerate as manufacturers are required to meet increasingly stringent emissions regulations demanding technological progression and speed," stated Liam Butterworth, CEO of GKN Automotive. "Our collaboration with Delta represents a significant milestone in the expansion of our portfolio of scalable, integrated 3-in-1 eDrive solutions and our capabilities in rapidly bringing new cost-competitive technologies to market."

Simon Chang, COO of Delta Electronics Inc., commented, "Delta is dedicated to enabling low-carbon green transportation by providing EV powertrain solutions and power electronics products, including traction inverters, traction motors, on-board chargers, DC/DC converters and EV charging solutions to the market. We're pleased to work with the leading company GKN Automotive to produce integrated eDrive units for the next generation of electric and hybrid vehicles."

www.gknautomotive.com
www.deltaww.com

Alvier AG PM-Technology appoints Thomas Bühler as its new CEO

Alvier AG PM-Technology, a Swiss-based Powder Metallurgy tooling manufacturer acquired by Sweden's Höganäs AB in 2018, appointed Thomas Bühler as its new CEO effective January 1, 2020. Bühler replaces former CEO, Peter Rauch.

Founded over thirty years ago in Buchs, Switzerland, Alvier currently has around fifty employees across its two production facilities. The company's client base reaches across four continents, with customers in more than twenty countries.

Alvier is said to be highly experienced in the production of all types and designs of press and sizing tools, producing systems for complex, multi-level sintered parts such as synchroniser hubs, belt drive pulleys, sprockets or camshaft adjusters. Also known for its development of helical gear systems, the company offers a wide range of services to the Powder Metallurgy industry.

www.alvier.com
www.hoganas.com

Hilti reports 2019 sales growth despite challenging environment

The Hilti Group, headquartered in Schaan, Liechtenstein, reports that it saw sales grow 4.3% during the full business year 2019, to CHF 5.9 billion (€5.5 billion). In local currencies, the growth was reported to equate to a 6.3% increase against the previous year.

Hilti reported that it achieved an increase of 6.9% in local currencies in the European business region, despite Brexit uncertainties and a substantial downturn in the construction economy in Scandinavia.

Outside Europe, Hilti saw business in North America continue to develop positively, advancing 7.3%. Significant growth was also achieved in Latin America, up 8.5% on the previous year, with the recovery of Brazil's economy contributing significantly to growth.

In the Asia-Pacific region, the company reported growth of 4.3%, said to have been slowed by difficult environments in Hong Kong and South Korea. In Eastern Europe, the Middle East and Africa, sales achieved 3.7% growth, driven by Russia and the Eastern European market, while sales in the Gulf States and Turkey reportedly remained difficult due to political uncertainties.

"2019 was another successful year for us with exclusively organic growth," stated Christoph Loos, Hilti CEO. "The economic environment has become more volatile while global construction growth has noticeably slowed. Additionally, currencies largely displayed depreciation tendencies against the Swiss franc. Against this background we're satisfied with our growth level and are pleased that we gained additional market share."

www.hilti.group

Plansee Japan opens new production hall at its manufacturing plant in Esashi

Plansee Japan Ltd, part of Austria's Plansee Group, recently celebrated the grand opening of a new 5,000 m² production hall. The opening of the new hall, the company explained, is a milestone in thirty years of successful manufacturing development at its plant in Esashi, Hokkaido, Japan.

Plansee Japan Ltd, then Nippon Plansee K.K., was established in 1978 with offices in Tokyo and Osaka, followed by a further office in Fukuoka. The Esashi plant has been operating for thirty years and employs more than 100 staff, producing precision components for the electronics, medical engineering, automotive, lighting and semiconductor industries.

As part of his welcome address at the hall's opening, Ulrich Lausecker, Executive Vice President, Plansee Group, explained that Japan represents one of the most important markets for Plansee and, with this enlarged footprint, Plansee Japan will be able to react more rapidly to emerging industries. Peter Aldrian, Managing Director, Plansee Japan, stated that the additional production space offers new opportunities for the local market, as well as the high-performance manufacturing network.

Plansee Japan recently officially opened its new 5,000 m² production hall in Esashi (Courtesy Plansee Group)

During the opening ceremony, the Esashi production team presented state of the art production concepts and delivered an outlook of the site's development for 'Plansee Japan 2031'. Additionally, employees were thanked for contributing to the success of Plansee Japan and seven staff members were honoured for their service with the 'Plansee 30 years long-term service needle'.

www.plansee.com

GF Machining Solutions appoints Ivan Filisetti as its new President

GF Machining Solutions, Switzerland, has appointed Ivan Filisetti as its new President and member of the Executive Committee by the Board of Directors. Filisetti will assume the position as of July 1, 2020, when current President, Pascal Boillat, retires.

Filisetti, a dual citizen of Switzerland and Italy, graduated as a mechanical engineer in automation and robotics in Italy in 1989. From 1990 to 2000, he served in several management positions at Agie in Losone, Switzerland, part of GF Machining Solutions.

After eight years as Production & Logistics Manager, as well as Operations and Division Manager in two European machine tool companies, he joined GF Machining Solutions again in 2009. As Vice President for Operations, Filisetti assumed global responsibility for the production and R&D activities of the division.

GF stated that under the leadership of Pascal Boillat, the company developed into a global manufacturer of machine tools with a strong focus on digitalisation and new technologies. The Board of Directors and the Executive Committee thanked Boillat for his outstanding work and exceptional commitment to GF and wish him all the best for the future.

www.gfms.com

| contents page | news | events | advertisers' index | email | Industry News

Ipsen offers free furnace evaluations

Ipsen USA, Cherry Valley, Illinois, USA, is offering free evaluations of any brand of vacuum heat-treating system in the US. The company has 10,000 of its own furnaces installed worldwide and maintains a strong focus on customer service and aftermarket support.

During the comprehensive inspection offered by its free evaluation service, an Ipsen Customer Service team member will check all major components of the furnace in a process typically taking under an hour. Ipsen will then provide a written health report with a suggested eighteen-month maintenance plan.

"Finding issues early, and planning for future maintenance, means less unexpected downtime and avoiding costly repairs," explained Matt Clinite, Ipsen Customer Service Sales Manager. "Thanks to proper maintenance and regular service, many Ipsen furnaces built in the 1960s and 70s are still running today."

In addition to the free evaluations on offer, Ipsen's aftermarket services include replacement parts, hot zones, controls and instrumentation upgrades, mechanical retrofits and furnace refurbishments. With a global team of more than 120 field service technicians, Ipsen offers troubleshooting and repairs, preventative maintenance, instrument calibrations and temperature uniformity surveys.

www.ipsenusa.com

Osaka Titanium Technologies receives AS9100 certification for spherical Ti alloy powder

Osaka Titanium Technologies Co., Ltd., Amagasaki, Hyogo Prefecture, Japan, has been awarded JIS Q 9100 (AS9100) certification for its TILOP (Pre-Alloy) spherical titanium alloy powder. AS9100 is a widely adopted and standardised quality management system for the aerospace industry and defence sector.

TILOP (Titanium Low Oxygen Powder) is the brand name given by Osaka Titanium Technologies to its method of producing titanium powder by gas atomisation for Additive Manufacturing and Metal Injection Moulding. OTC produces several titanium powders under the TILOP brand name, including commercial pure (CP) titanium powder and Ti-6Al-4V pre-alloyed powder, both with ranges of powder particle size distribution tailored to the customer's specific applications.

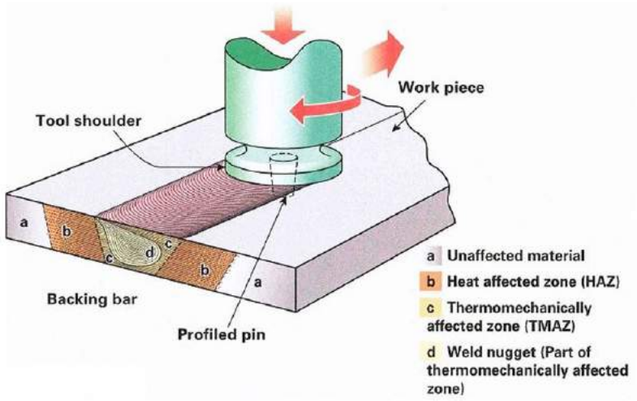
The product's AS9100 certification recognises it as meeting the requirements imposed by the standard for the manufacturing and sale of high-performance materials. Certification was awarded by the Japan Quality Assurance Organization (JQA).

www.osaka-ti.co.jp

Horizon Technology highlights friction stir welding for joining PM components

In a recent blog post, Horizon Technology, based in St. Mary's, Pennsylvania, USA, discussed the possibility of using friction stir welding as a joining process for Powder Metallurgy components. Although not necessarily thought of when first considering joining methods, the PM parts maker states that, in very specific applications, friction stir welding is a viable option.

Friction stir welding was invented in 1991 at The Welding Institute in the UK. As a relatively new joining process, Horizon states that many metal manufacturers have limited or no understanding of its inner workings.



The friction stir welding process was developed by The Welding Institute and is suited to certain PM applications (Courtesy The Welding Institute)

In most circumstances, processes such as sinter bonding, sinter brazing or welding, for example, are recommended for joining PM parts. However, Horizon states that friction stir welding of dissimilar alloys and materials is possible, and sometimes even desirable, if the user doesn't want to fully melt the lower melting point metal.

Friction stir welding keeps the metal in a state that's just short of melting, offering an impressive amount of heat input control, which allows for minute adjustments for the end result. The surfaces of the two parts are in very intimate contact and bond well without the risks inherent to melting. The joints are often as strong as the base metal, creating bonds that are reliable enough for use in rotary engine housings.

On the manufacturer's side, Horizon states that using friction stir welding for joining PM parts also creates a safer work environment, because it creates no toxic fumes. More relevant to the buyer, friction stir welding has minimal tooling needs, which keeps labour and material costs down.

www.horizontechnology.biz

Kennametal employees recognised at Women in Manufacturing STEP Ahead Awards

Two employees of Kennametal Inc., Pittsburgh, Pennsylvania, USA, Robyn Young, Senior Staff Engineer, and Samantha Case, Manufacturing Engineer, will be honoured at the Women in Manufacturing STEP Ahead Awards taking place April 30 in Washington, D.C. Presented by The Manufacturing Institute, the awards celebrate women making an impact in Science, Technology, Engineering and Production (STEP).

Young and Case are among 130 women from 106 companies to receive this industry honour and follow ten other Kennametal employees who have received the award in prior years. Young has reportedly led multiple product launches, process improvements and capital installations during her more than twenty-year career with the company. She has mentored numerous programme engineers across Kennametal locations globally, and implemented standardised best practices to improve operations.

Case is said to have been instrumental in the development and training for several tooling departments and process improvements within Kennametal's US plants. In addition, she is said to serve as a mentor for the company's early-career rotational leadership development programme, of which she is also a graduate.

"Congratulations to Robyn and Samantha on this well-deserved recognition," stated Christopher Rossi, Kennametal President and CEO. "We applaud their leadership and the example they are setting for all manufacturing leaders at Kennametal."

"The STEP Ahead Awards provide a platform to honour role models and motivate them to encourage the next generation of women in the manufacturing industry," added Carolynn Lee, Executive Director of the Manufacturing Institute. "The women being recognised are industry leaders – and inspirations to the women and girls who will follow their example and pursue careers in manufacturing."

www.kennametal.com

Randall German to receive MPIF's PM Lifetime Achievement Award

Dr Randall German has been selected for the MPIF's PM Lifetime Achievement Award (Courtesy MPIF)

Dr Randall (Rand) German, FAPMI, founder of German Materials Technology, has been selected to receive the Kempton H. Roll Powder Metallurgy Lifetime Achievement Award by the Metal Powder Industries Federation (MPIF). The award will be presented during WorldPM2020, the World Congress on Powder Metallurgy & Particulate Materials, in Montreal, Canada, at the Opening General Session on Sunday, June 28.

MPIF stated that German has distinguished himself through his research and teaching of the net-shape fabrication of engineering materials via sintering-based processes. He has promoted the growth of Powder Metallurgy technology, in particular Powder Injection Moulding, during his fifty-year career through his involvement in twelve start-up companies, supervising well over a hundred graduate and post-doctoral students, and prolific PM industry publications. German has also been an active member in APMI International, the American Society for Metals and the American Ceramics Society.

After completing his bachelor's degree in material science and engineering at San José State University, German began his PM industry career at Battelle Lab, Columbus, Ohio, prior to joining Sandia National Labs (SNL). He obtained his master's degree in metallurgical engineering from The Ohio State University and his PhD in engineering at the University of California—Davis before taking a Director of Research position at Mott Corporation, Farmington, Connecticut.

German's nearly forty-year academic career began in 1980 at Rensselaer Polytechnic Institute (RPI), where he earned the Hunt Chair while teaching and conducting research. In 1991, he accepted a position at The Pennsylvania State University where he became the Brush Chair Professor in Materials and the Director of the Center for Innovative Sintered Products (CISP) before retiring as an emeritus professor.

In 2005, he became the inaugural director for the Center for Advanced Vehicular Systems (CAVS) at Mississippi State University prior to joining San Diego State University in 2008 as Associate Dean for Engineering Research until 2013.

German has published twenty books and has twenty-five patents. He has shared his expertise at the MPIF's Powder Injection Molding tutorials since 1990, and co-chaired over thirty conferences. German received the MPIF Distinguished Service to PM Award in 1993 and was one of the first APMI members to be awarded the prestigious APMI International Fellow Award in 1998. He received an honorary doctorate from Universidad Carlos III de Madrid and fellow awards from two additional technical societies.

The Lifetime Achievement Award, named in honour of Kempton H. Roll, founding Executive Director of MPIF, was established in 2007 in order to recognise individuals with outstanding accomplishments and achievements who have devoted their careers and a lifetime of involvement in the field of PM and related technologies. This will only be the fourth time the award has been given since its inception.

www.mpif.org

Dates announced for 20th Plansee Seminar

Plansee Group, headquartered in Reutte, Austria, has announced the dates for its 20th Plansee Seminar, the International Conference on Refractory Metals and Hard Materials, which will take place at its Reutte headquarters, June 7–11, 2021.

Originally established by Professor Paul Schwarzkopf in 1952 as a four-yearly event, the seminar is a global forum for the technical and scientific Powder Metallurgy community to exchange ideas and keep up to date with the latest innovations and market trends in the fields of refractory metals and hard materials. Plansee Group states that the aim of the conference is to provide insights into all aspects of these materials – from materials science to the latest achievements in extractive metallurgy, manufacturing technology, industrial applications and recycling.

Presentations at the 20th Plansee Seminar are expected to cover all market segments where refractory metals and hard materials are playing an important role, or where they may provide promising alternatives to present material solutions.

A call for papers for the 20th Plansee Seminar is expected to be issued in April 2020.

www.plansee-seminar.com

The potential for Industry 4.0 and IoT to monitor and improve powder compaction

The influence of Industry 4.0 can be found in many facets of industrial production and there are very few areas which do not benefit from the application of the Internet of Things, be that in research and development, manufacturing, aftersales or service. As a result, press manufacturer DORST Technologies recently started to implement IoT practice within its own operations, while in parallel developing smart software for use in its products. Here, Lutz Lackner discusses the implementation of Industry 4.0 and the Internet of Things in powder compaction technology.

The majority of Powder Metallurgy products are consumed by the automotive industry, a sector which places high pressure on its suppliers, not only from a price point of view, but also with regard to quality and documentation. Ideally, every part produced is traceable and all production data are available during its entire lifetime. Therefore, part makers must take great effort to record and store as much information as possible from the part production stage. In the field of powder compaction, DORST Technology offers IoT solutions suitable for use in all closed-loop controlled powder and sizing presses (Fig. 1).

The application of electronic devices and related software can contribute substantially to improving the quality of the compacts and the performance of the machines. The DORST system is therefore designed to monitor and optimise the press process, and is based around three core factors: Part quality, productivity and machine condition (Fig. 2).

Part quality

There are a number of different aspects to look at when considering the output of a production machine such as a powder press. A number of influences mean that compacts pressed from powder can vary during every production run. Today's state of the art CNC powder presses record

Fig. 1 DORST Technology offers IoT solutions suitable for use in all closed-loop controlled powder and sizing presses

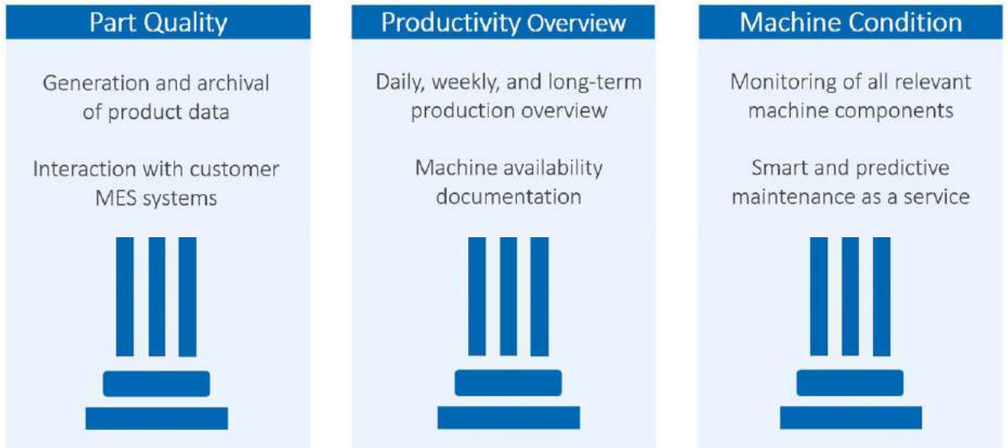


Fig. 2 The DORST system is built on three columns to optimise overall equipment effectiveness

in their control system many parameters of the compaction cycle for every individual part. These data are available to record the part quality.

The hardware architecture (Fig. 3) of DORST uses a separate CPU to handle data in appropriate time during the press-cycle. This CPU transfers the data from the machine to the IoT System, which processes them in the IoT Field Manager (IFM).

Although all data are available from the DORST Control System (DCS), it needs the sophisticated software embedded in the IFM for a correct assignment to the compacts. Individual values, such as pressing forces or pressing positions, are generated at different times during the cycle. Therefore, they need to be read at discrete points of time and can only be compiled into a part-related data file for every stroke at the end of the press-cycle (Fig. 4).

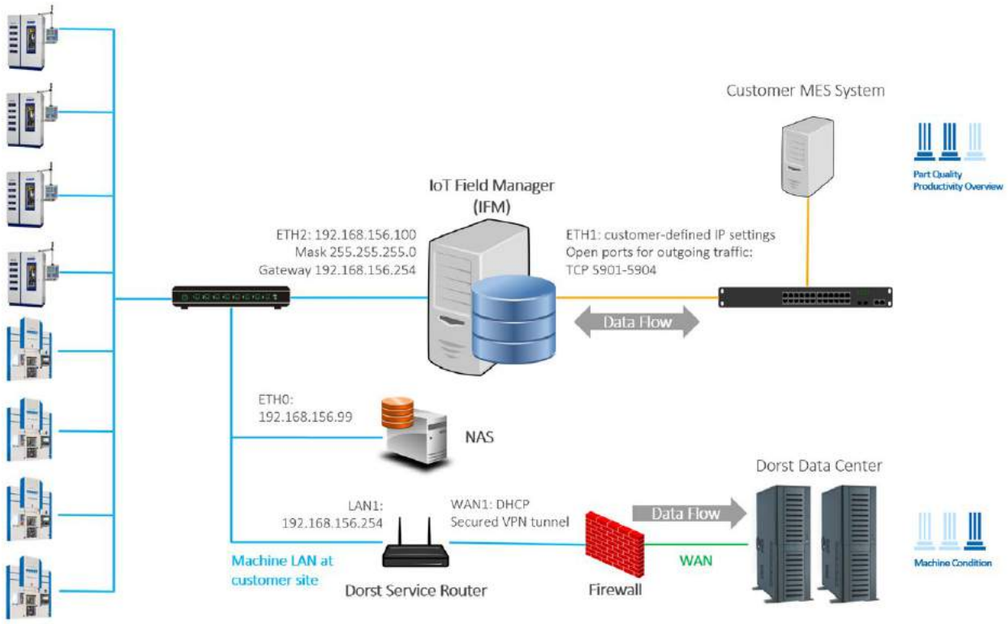


Fig. 3 Architecture of DORST's IoT hardware

A unique fingerprint

Additional parameters from the user may be fed to this data file, which will then, as a whole, establish the unique 'fingerprint' for every compact and store them at one single and safe 'place of truth'. This system makes it possible to easily identify compacts at a later time, if they are marked (e.g. by a laser-system) with a sequential number, because they are firmly linked to the safely stored files in the IFM. This way, the IoT System enables part makers to trace back compacts which show anomalies at a later stage of production, and identify the number of possibly affected parts within the production lot.

In addition to recording machine-related part data, the dimensions of parts are of high interest. To date, random measurement checks have been common in PM mass production. However, this risks some compacts passing even if they are out of tolerance. The high quality requirements imposed by the auto sector, allowing the supply of only a few parts per million of defective parts, is achievable with the support of the IoT System.

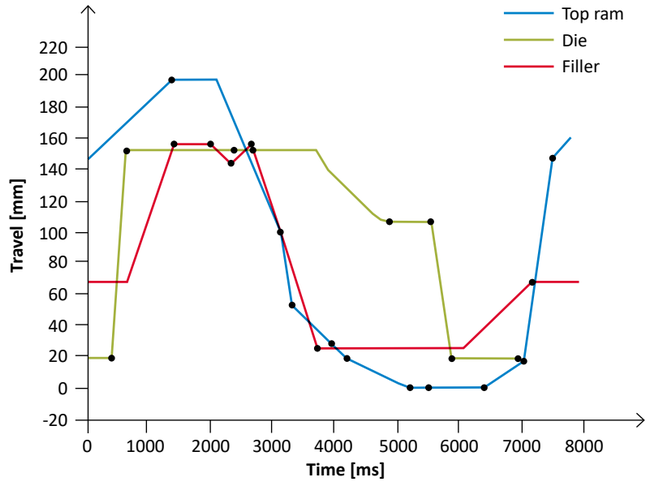


Fig. 4 Within the press cycle, for example, the position of the main axes vary continuously and the values of interest have to be picked individually. They can be added to the data file only at the end of the cycle

Measurement checks

Using this system, sophisticated height-measurement checks are conducted by a laser in real time for every compact and the result fed back into the software (Fig. 5). An automatic sorting device, controlled by the IoT System, then takes care and assures the safe separation of suspect compacts from the main. As this system checks every compact produced, the risk of delivering defective parts is dramatically reduced.

Fig. 5 The laser measuring device checks part height, feeding the data back into control system

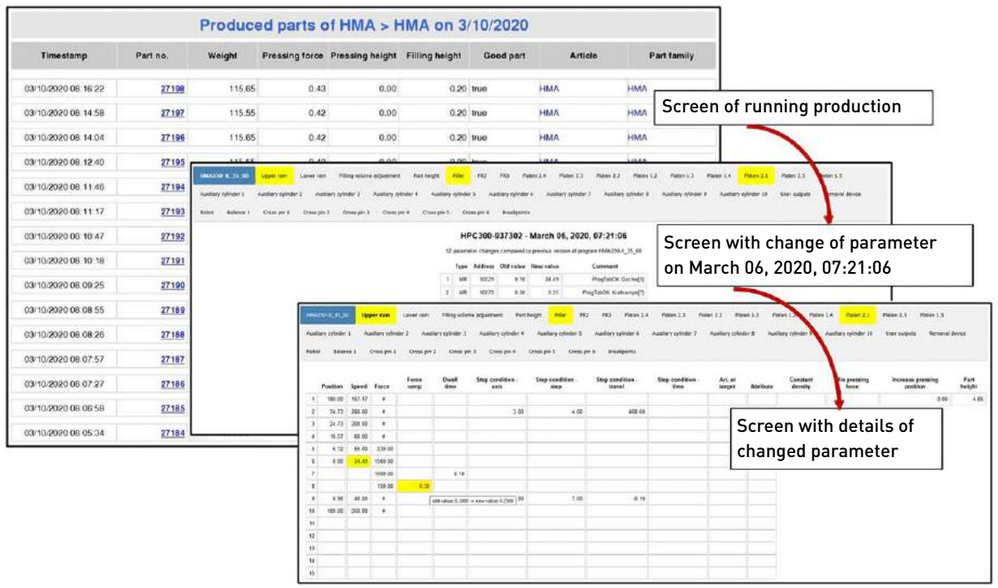


Fig. 6 Documentation of program changes during production

Furthermore, checking more, or eventually all, quality-relevant attributes of the green parts, offers the manufacturer the opportunity to record all the characteristics of every compact produced. This makes it possible to identify every compact not fulfilling the quality requirements, potentially allowing companies to establish a zero-defect quality level in the near future.

As a first step, the results from the above mentioned random check can also be recorded in the IFM-System. Thus, these proven dimensions are recorded at the same time as all other related data, making them easily available for later review. All information generated by, or keyed into the system, is the property of the machine user. This includes some very detailed and sensitive information, such as

- The end-user and application of the compact
- The press parameters
- The geometric dimensions of the part
- and more.

These data represent the individual knowledge of the part maker, and have to be kept strictly confidential. Therefore, the safe handling of data is of highest importance.

The architecture of the IoT System created by DORST ensures the safe separation of the above-mentioned data, guaranteeing that it is fed directly to the MES of the user and thus, is accessible exclusively for the part maker.

Process quality

Besides part-related data, the IFM is able to store further information not generated by the powder press, such as the powder characteristics. These data come from user-based information systems, or the powder supplier for instance. This way, all data related to the quality of the compacts produced can be recorded at one single source, which grants the properness of the values and allows archiving and easy access to the detailed documentation of individual part parameters.

In order to improve process control, there are some options to support part makers immediately following installation of the IoT System. The control-system does not only record the actual machine data; it also manages the programs responsible for the powder press cycle.

During every production run, external influences such as changes to ambient temperature and humidity may affect the green part quality and require fine-tuning of the press cycle. At present, such sophisticated tuning procedures are still undertaken manually by expert press setters. Since production is run 24/7, the need to carry out such procedures may occur during the night shift or at another time when experts are not available, meaning that the readjustment undertaken does not always achieve the desired effect and the compacts produced are subsequently of uncertain quality. To track and find the point of change in the program may be difficult if the individual who executed it did not clearly note it; thus the number of compacts in question is undefined.

The DORST IoT System automatically saves all modifications made during the production campaign and generates a corresponding data file. This means it records all changes made in the production program, making it easy to identify the point of change at a later time. Fig. 6 shows screenshots from DORST's software which clearly indicate, within the list of the produced parts, at what time the modification of a program parameter took place. With a mouse-click, the IoT System displays the related pages of the program, where the user can read the actual parameter and the changes manually made. It can identify:

- What change was made in the program?
- What is the first compact produced after the change?
- How many parts have been produced since the change?

Based on this information, the user can identify which compacts have to be separated for an additional check before shipping to the customer.

Aspects of productivity

To judge Overall Equipment Efficiency (OEE), it is of great importance to know the performance related data.

Machine Performance
The simplest indication, independent from the actual part production, is the status of the equipment within a defined time period (daily / weekly / monthly), as in the example in Fig. 7. States recorded over a period of time include:

- Failure
- Idle time
- Setting / programming
- Ready for production
- Production.

These states are displayable in different charts and thus allow an immediate survey of machine productivity, making it possible to easily identify not only the present status of the machine, but also its previous performance. Each status has a colour and reflects the corresponding time of activity.

The user can then identify cumulative failure time, assigned to individual errors, thus indicating what is the most urgent issue to address. Additionally, when the data are transferred to the user's MES, they can contribute to optimised production planning, because the remaining time until completion of the current production run is not only theoretically calculated, but based on the present stroke rate and part quality.

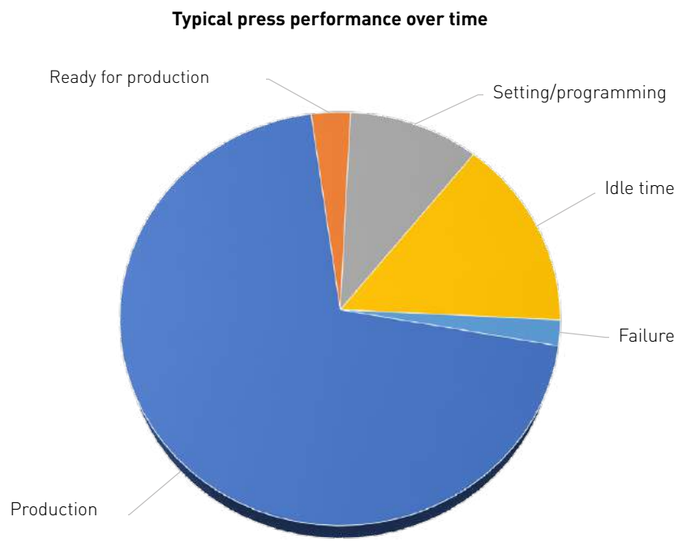


Fig. 7 Monitoring of machine performance over a selected time period

Machine condition
Understanding machine condition is important for the proper production planning and for the constant high quality of the produced green parts, which may be even more important for the user. The data generated by the sensors of the IoT System provide the basis for in depth analysis of the connected press. This allows permanent online monitoring of various machine parameters and constitutes an early indicator, warning the manufacturer when a machine component does not operate properly any longer and before it finally fails.

"The user can then identify cumulative failure time, assigned to individual errors, thus indicating what is the most urgent issue to address."

Every machine is subject to wear from use. The more extensive the use, the higher the wear. Up to a certain level, the designer

of a machine already considers such wear, to assure the accurate function. However, after exceeding a certain level, repair or replacement is imperative to bring the machine back up to its standard capabilities and reliability.

This turning point in the lifetime of a machine is not easy to predict, as it depends on a variety of parameters including total operation time, effective load and so on. Here the IoT System is the perfect instrument to improve the OEE. To evaluate the machine's condition, sensors are installed to check various parameters. As an example, Fig. 8 shows a schematic of the hydraulics of a powder press. This comprises several pumps (P1 – P3) and many more devices to be controlled; the quantity of leak oil indicates the wear condition of the seals in the system, a particle counter indicates the degree of soiling of the hydraulic fluid, etc.

The IoT System collects all data from the installed sensors, evaluates them and displays the results, offering instant information on the actual overall status by live data from the press. Consequently, the manufacturer's maintenance experts are given the opportunity to prepare for necessary work early on, and even to make available the required parts for replacement, prior to any unplanned downtime. This will avoid undesired and unexpected equipment breakdowns, and allow much better scheduling of each machine for production. The improved continuity in machine operation already contributes to a more constant quality of the pressed green parts. Thus the IoT System plays an important role in increasing Overall Equipment Efficiency.

"The IoT System collects all data from the installed sensors, evaluates them and displays the results, offering instant information on the actual overall status by live data from the press"

The next step of optimisation is predictive maintenance, which assists the user in keeping their machine in good working condition. At the machine building company, the experts have built up an in-depth knowledge and long term experience in the wear-performance of the machines. This enables them to analyse and interpret the relevant data on the machine's condition, called up online by a smart software (currently under development at DORST). Without manual interference, this action takes place at fixed intervals. It identifies the current condition of the machine, and based on that calculates the remaining lifetime of various wear parts. In addition, it can identify deficiencies in other components of the machine. This enables machine builders to prepare to take the necessary steps to take care of the equipment in advance of actual failures. The information about the upcoming service required is delivered to the user in advance and thus, they are able to plan production schedules with foreknowledge of the machine's idle time.

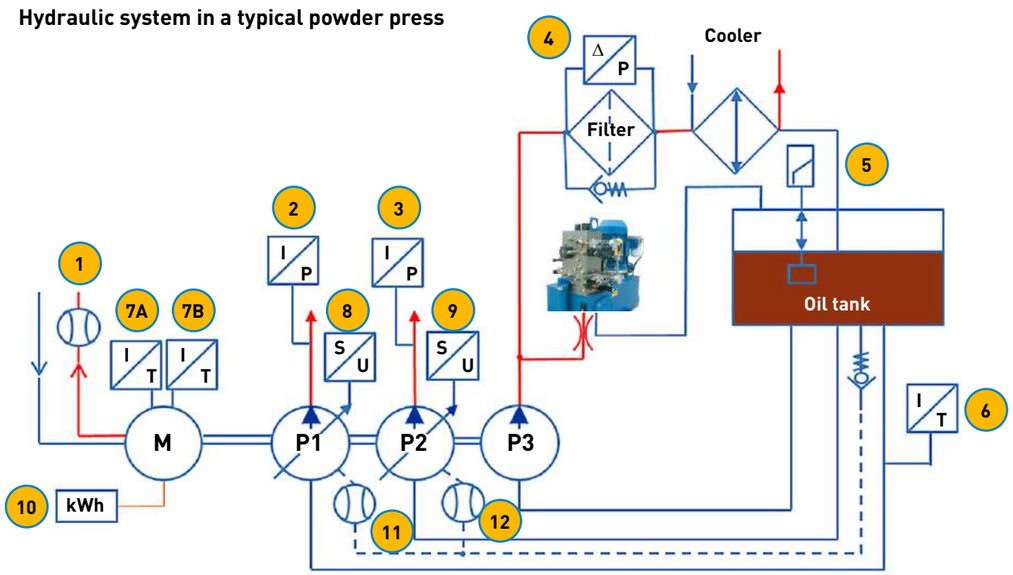


Fig. 8 Hydraulic schematic of a powder press, highlighting the many devices to be controlled

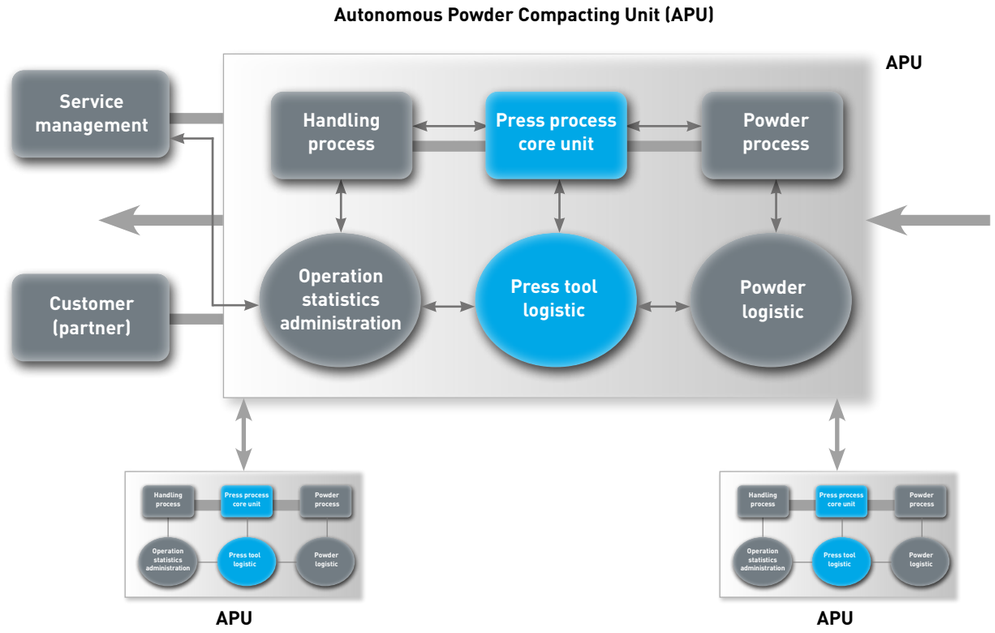


Fig. 9 The Autonomous Powder Compacting Unit, or APU, will be the next stage in a more sophisticated system

Such a procedure assures the maximum machine uptime by minimising downtime, because only the necessary maintenance work, without diagnostic or investigative work, is required. Additionally, service costs are minimised, as all maintenance takes place when the machine's condition requires it and no parts are replaced just because their 'regular lifespan' has been reached.

Conclusion and outlook

The records of individual press parameters facilitate much closer control of the press process itself. With more parameters available, it is possible for the IoT System to keep the process within the desired tolerances. Deviations are detected as soon as the measured value arrives at the IoT Field Manager. Because all data are available electronically, they are transferable into the user's digital systems in real time. The 100% monitoring of every produced part makes it possible to react to deviations immediately and readjust the press process accordingly.

In current practice, this procedure serves to readjust the filling height in relation to the pressing-force or the compact weight. In future, with many more recorded parameters available, additional values such as changes in ambient temperature or humidity can be integrated into the loop, allowing a more sophisticated adjustment of the press-cycle.

This is the task for the future. Although the effects of these parameters are well known, due to their great diversity, we do not know the influence of each individual one on part quality. Today, the user eliminates them by manually fine-tuning pressing procedures – in future, this will be done by appropriate software, containing the human knowledge of press fine-tuning in the form of algorithms, and enabling the powder press to readjust itself according to the measurements logged by the IoT System. It will be possible to solve this task only with the close cooperation of part makers and machine builders; but when achieved, it will initiate an important push towards the Autonomous Powder Compacting Unit (APU) (Fig. 9).

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Osterwalder: taking a new approach to tooling changeover on multi-level presses

Conventionally, tooling changeover on multi-level presses has been done either by using large, costly full die-set changeover systems, or by interchanging tooling and tool holders manually inside the press. In this article, Osterwalder's Stefan Haltner, Michael Sollberger and Alex Wehrli introduce what they describe as a revolutionary new approach to tooling changeover. Using a cartridge system with automatic mechanical coupling combines the advantages of traditional die-set changeover systems with the flexibility and low infrastructure and investment costs of manual tool changes.

Tool changeover on a metal powder press is often a time consuming process, placing the press out of service for the duration of the changeover and requiring skilled operatives. Currently, there are four basic methods to choose from when performing a tool change. The particular method chosen depends on a number of factors, largely dependant on the size and type of press, but also the time and cost implications.

Manual tool changeover
In this process the tooling is assembled and disassembled by the operator inside the press, with clamping done by traditional means using rings, bolts, etc.

External die-set changeover
With an external die-set changeover, without additional infrastructure, only one die-set is used. During the tooling changeover, the die set is removed from the press, at which point the tooling is disassembled and then reassembled with the next set of tools. During this changeover method, the press is stopped.

Semi-automatic or automatic systems
Another option is a semi-automatic or automatic die-set changeover system. In this method, at least

Fig. 1 Osterwalder's OPP2000 servo electric 200 ton press incorporates the company's fast assembly system for tools (F.A.S.T.)

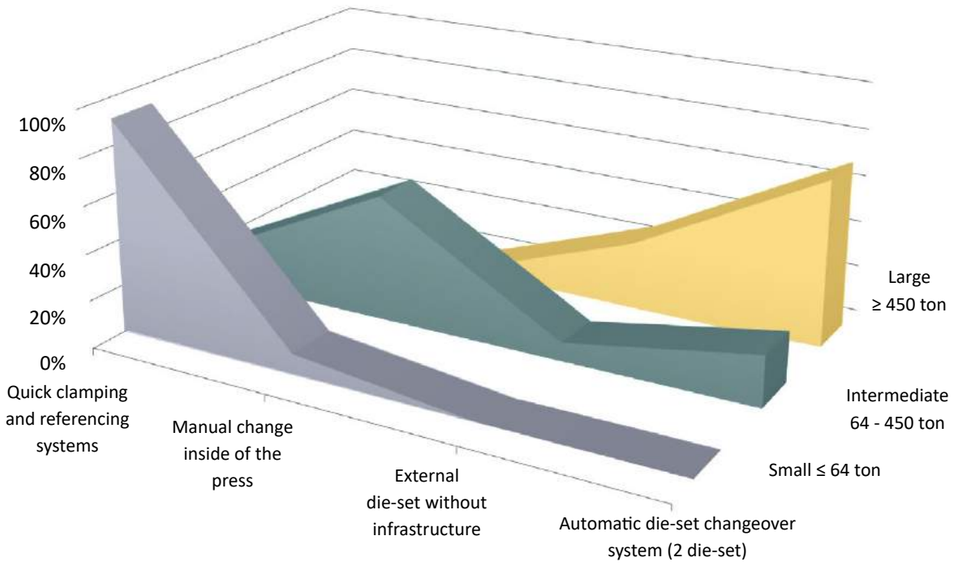

Fig. 2 Distribution of tooling changeover methodology according to press size

two die-sets are required, with tool assembly and disassembly carried out externally. Production is stopped only for die-set changeover.

Quick clamping and referencing systems
Finally, quick clamping and referencing systems may be used. In this case, the tooling is assembled and disassembled by the operator inside of the press. The clamping, and frequently alignment, of the tooling is performed by the chosen clamping system.

Selecting an appropriate tool changeover method

At Osterwalder, research was undertaken to identify the different tooling changeover methodologies used in relation to different press sizes. A sample of more than 300 presses delivered by Osterwalder between 2009 and 2018 was used as the data source. Based on the size of presses in Osterwalder's portfolio, categories of press size were defined as either small (≤ 64 ton), intermediate (64–450 ton) or large (≥ 450 ton).

	Small	Intermediate	Large
	≤ 64 ton	64 - 450 ton	≥ 450 ton
Quick clamping and referencing systems	91%	16%	0%
Manual change inside of the press	9%	54%	0%
External die-set without infrastructure (1 die-set only)	0%	8%	29%
Automatic die-set changeover system (2 die-sets) 0%	0%	22%	71%

Table 1 Distribution of tooling changeover methodology according to press size

The results of this study can be seen Fig. 2 and Table 1. From this data, it can be concluded that on small size presses the use of quick clamping and referencing systems is the most used option, with more than 90% choosing this method. For intermediate size presses, a variety of methods are used, with the majority changing tooling manually inside of the press. On the larger sized presses, the use of die-sets is common, most using semi-automatic or automatic die-set changeover systems.

It is interesting to understand why one particular tooling changeover methodology is chosen over another. Many factors can influence this choice, but three main selection criteria can be identified:

- **Time:** how fast the tooling changeover and set-up can be carried out, and how this impacts machine availability and overall equipment efficiency (OEE).
- **Cost:** the investment needed to purchase the equipment and infrastructure required for the tooling changeover system.

- **Technical & historical:** Technical and historical factors can also influence the final choice. This includes questions of how tool changeover has conventionally been carried out, and if the current tooling is compatible with alternative, more advanced changeover methods.

Another consideration when assessing the technology is the training of personnel required for any new changeover methods. Lastly, a factor of limitation can be if there is not a suitable technical solution for a user's tool typology (for instance, the required clamping forces for the tooling are too high for the available chucks, or the tooling complexity exceeds the preparation of the automatic die-set changeover system).

Time related factors
In order to better understand time as a factor in selecting the correct methodology, a study was carried out to estimate the actual time required to complete a full tooling changeover in each of the four different methodologies and three press sizes previously introduced. Under the study, no data was collected for small-size presses with die-set or automatic die-set changeovers, as the use of these is marginal according to the results seen in Table 1. Similarly, large-size presses were not tested with quick clamping systems.

From the resulting data (Fig. 3), we can conclude that on small size presses, the use of quick clamping and referencing systems enables a tooling change time of 5 min, whereas an average conventional manual tool change takes 30 min. Furthermore, the manufacturing and reshaping of tooling using quick clamping systems is more efficient, having a positive impact on OEE.

On intermediate and large size presses, the use of a double die-set changeover system enables the tooling change in 45 min. Moreover, on intermediate and large size presses, if only one die-set is used

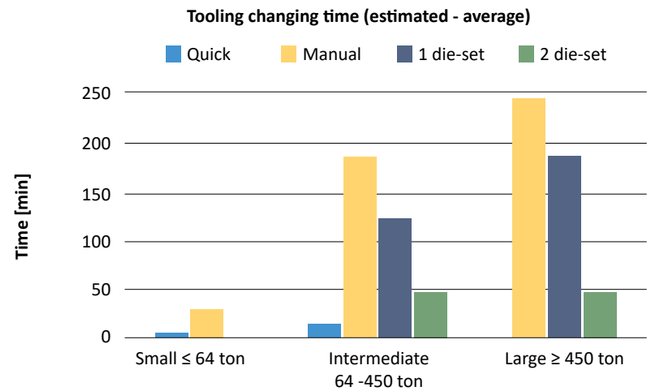

Fig. 3 Estimated and average tooling changeover time on different methodologies and press sizes

the tooling change requires at least 120 min, and if the tooling change is done inside the press without pulling the die-set out of the press, the time increases up to at least 180 min.

Investment costs
A second study was carried out to assess the investment costs for the four different methodologies across the three press sizes. For each press size group, the cost for the equipment with manual tooling changeover inside of the press was defined as 'neutral' (costs 100%).

Taking this as the base, the additional investment needs for the different tooling changeover methodologies were estimated (Fig. 4). The additional investment on quick clamping systems is roughly 10%, or slightly higher in the case of intermediate-size presses (the investment on tooling modifications to automatic clamping is not included). The additional investment on an external set-up station for one die-set is roughly 5% for both intermediate and large size presses, and the additional investment on a second die-set automatic exchange system is over 30%, reaching almost 40% for intermediate size presses.

Technical & historical issues
The third factor, the combination of technical and historical factors, is very complex to estimate, and its quantification was therefore not part of this study.

Fig. 4 Additional investment cost of different tooling changeover methodologies depending on the press size

In order to summarise the time and investment factors, a cross diagram of them in percentage terms is shown in Fig. 5. Once more, manual tooling changeover is used as a comparison base (100% both in time and investment), and hence does not appear on the graphic.

The optimal solution for multi-level intermediate and large size presses
Based on the results so far, it can be seen that on small size presses there is already an optimal solution – quick clamping and referencing systems. This has been proven to be both cost effective and very time efficient, and is already accepted as the standard for most powder press users (see Table 1 and Fig. 2).

On intermediate and large size presses, especially on multi-level applications however, the optimal solution remains to be found. What is clear is that this should ideally combine the following advantages:

- Short tooling change time
- The press should be able to keep producing parts during tooling assembly and disassembly, and only be stopped for tooling changeover
- Low investment costs, both in equipment and infrastructure
- A small footprint; a system that does not require a large amount of space
- Flexibility – a reference change can be programmed upon short notice
- Existing tooling can be used with minimal modifications
- Multi-plate tooling up to 4/4 should be possible.

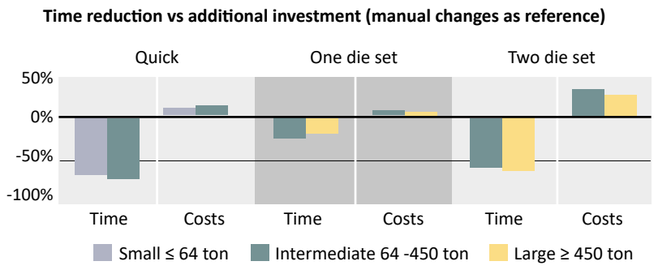

Fig. 5 Time reduction vs additional investment for different tooling changeover methodologies and press sizes

Fig. 6 Rear view of a press with F.A.S.T. system – C-shaped platens and cartridge set

A rapid, flexible, cost effective solution for tool changeover

The Fast Assembly System for Tools (F.A.S.T.) developed by Osterwalder is a tooling changeover system that does not use a die-set to mount the tooling. Instead, the machine platens consist of two elements: C-shaped platens inside the press, which contain all the guiding, force transmitting, hydraulic and electrical elements, and cartridges able to lock into the C-shaped machine platens that act as toolholders for setting the tooling (Fig. 6).

Tooling assembly
For a tooling assembly, two sets of cartridges and roller trolleys are supplied. The upper cartridge set contains the tooling and toolholders for a maximum of four upper punches. The lower cartridge set contains the tooling and toolholders for a maximum of four lower punches, die and core-rod.

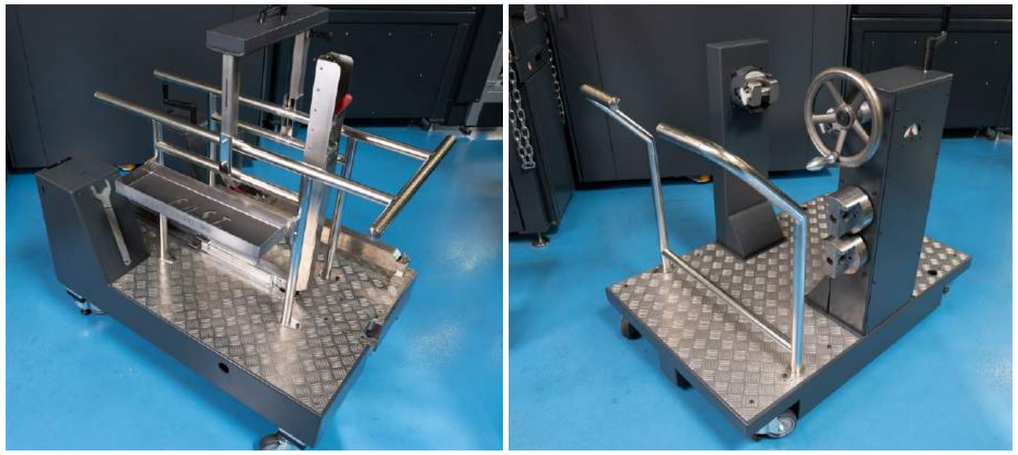

Fig. 7 Trollies are used to transport the cartridge systems to and from the press

During the process, trolley number one moves the lower cartridge set; trolley number two moves the upper cartridge set and has a rotation mechanism to turn the full tooling set 180° for a more comfortable tooling assembly and set-up (Fig. 7).

For tooling installation, the cartridges (containing tooling and toolholders), mounted on the trolleys, are locked to the machine at its rear (Fig. 8). The trolleys automatically move thanks to a lift to the requested position and the cartridges are inserted manually into the machine's C-shaped platens.

Tooling changeover sequence
To remove tooling from the press, first production must be stopped and the tooling changeover programme loaded. The machine platens then move automatically to a predetermined tooling change position, at which point the machine's back door can be opened (Fig. 9). Roller trolley one should then be moved to the machine's rear and clamped to the lift, where it will be automatically raised until in position for the removal of the upper cartridge set (Fig. 10).

Fig. 8 The cartridge trolly is attached to the press

Fig. 9 The lower cartridge is unloaded from the press

Fig. 10 The upper cartridge set is then removed

Fig. 11 The upper cartridge set is unclamped from the press and moved to the trolley

Following the above steps, the upper cartridge set is unclamped from the machine platens and moved to the rail end of roller trolley one. Roller trolley two is then moved into position at the machine's rear and clamped to the lift in the same manner as roller trolley one (Fig. 11).

Roller trolley two and the upper cartridge set can then be removed from the press area, while roller trolley one is lowered automatically into position for the removal of the lower cartridge set. The lower cartridge set is then unclamped from the machine platens and moved to the rail end of roller trolley one. Roller trolley one is lowered to floor level and unclamped from the lift, after which it can be removed from the press area (Fig. 14).

"F.A.S.T. is as quick as any semi-automatic die-set exchange system, making it possible to carry out a full tooling changeover in just forty-five minutes"

Roller trolley one is then lowered with the upper cartridge set, until coupling with the cartridge holder of roller trolley two. The upper cartridge set is released from trolley one, and the trolley lifted slightly again (Fig. 12).

Time and investment benefits

F.A.S.T. is as quick as any semi-automatic die-set exchange system, making it possible to carry out a full tooling changeover sequence (from stopping production to pressing of the first part in the next production run) in just forty-five minutes. Using F.A.S.T., time consuming steps such as coupling and uncoupling hydraulic pipes, coupling and uncoupling electrical plugs for measuring instruments, removing the handling system and removing the filling system are not required. This means that the entire process requires less manpower and, therefore, time.

Furthermore, F.A.S.T. does not require the addition of any infrastructure on the rear side of the press (rails, fixed trolleys, steelwork frames), nor a pit extension, resulting in lower investment and maintenance costs. The cartridge sets and roller trolleys also require less financial investment than the typical multi-platen die-set, thanks to their reduced complexity.

F.A.S.T. allows more flexibility, as the tooling assembly area does not necessarily need to be linked to the rear side of the press. A storage system of cartridge sets with pre-mounted tooling will shorten response times for customers in environments which demand flexibility.

The typical F.A.S.T. layout

A typical set-up for a press with F.A.S.T. includes the following:

- Two roller trolleys for upper cartridges (with rotation function)
- Two roller trolleys for lower cartridges
- Two upper cartridges (one with the tooling to be taken out, one for the tooling to bring in)
- Two lower cartridges (one with the tooling to be taken out, one for the tooling to bring in).

The area behind the press only needs to be used for the tooling exchange, with the tool mounting, cleaning, set up and preparation done in another area of the facility. This set-up contains all the advantages of an automatic full die-set changeover system, with reduced investment costs and improved factory space distribution (Fig. 15).

Given the low investment costs of the cartridge sets, it allows the possibility to work with a higher number of sets. An example of this layout option can be seen in Fig. 16. Using this advanced set-up, the punches and dies, as well as the toolholders, need not be disassembled and stored after each use, but can be stored in complete pre-assembled cartridge sets.

This set-up therefore has the benefit of further reducing manpower on tooling assembly and improving response time as the tooling is already assembled. It offers increased flexibility for production planning and reducing the risk of tooling manipulation and storing.

Conclusions

In this article, the several methodologies available today in the market have been described and analysed according to equipment complexity and size. The factors determining the selection of the different tooling changeover methodologies (time, investment, technical and historical implications) have also been

Fig. 12 The replacement upper cartridge is loaded

Fig. 13 The cartridge set can be rotated on the trolley once removed from the press

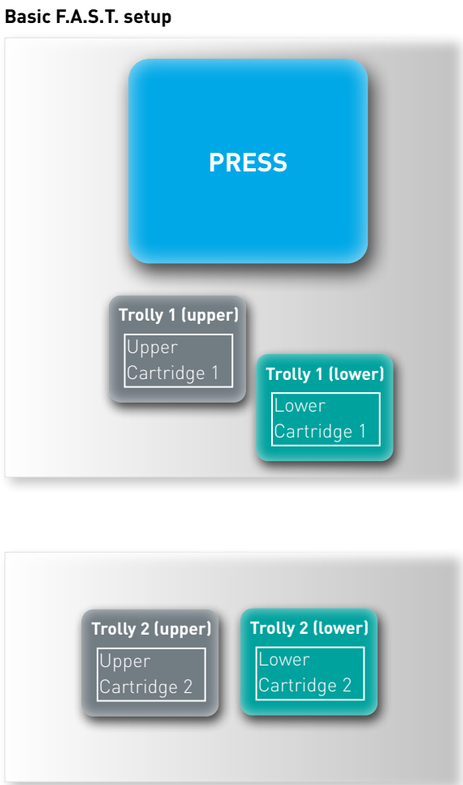

Fig. 15 The standard layout for Osterwalder's F.A.S.T.

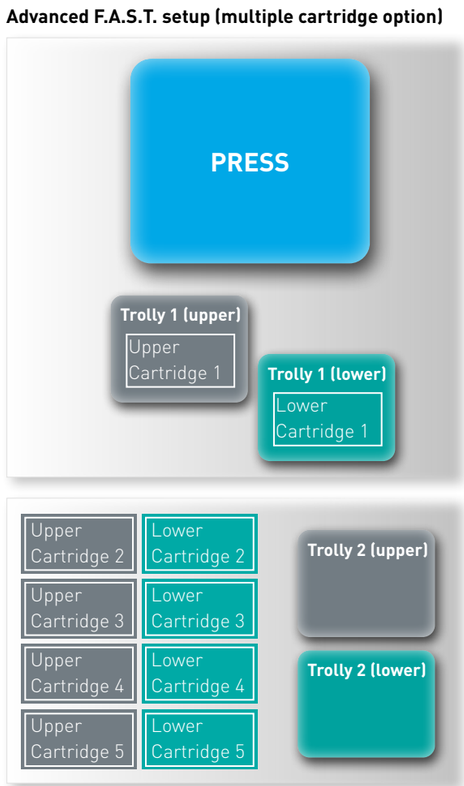

Fig. 16 An alternative layout with multiple cartridge sets offers even more flexibility

described and quantified. As a result of this analysis, we believe the optimal solution for mid to large size presses on multi-level applications should combine the following features:

- Short tooling changing time
- Press continues production during tooling assembly and disassembly, and is stopped only for tooling changeover
- Low investment costs, both in equipment and infrastructure
- Small footprint; a system that does not require large space
- Flexibility – making it possible for reference changes to be programmed at short notice
- Existing tooling can be used with minimal modifications
- Punch lengths can be kept short (similar to traditional die-set changeover systems).

The newly-developed F.A.S.T. changeover system combines all of these features. The machine moving platens are C-shaped and remain inside the press during a tooling changeover. Being plug and play, with no hydraulic couplings, the system also removes uncertainties regarding hydraulic leakages or contamination.

Cartridge sets containing the tooling and toolholders are locked into the C-plate, using an optimised sequence that enables a tooling change time of just forty-five minutes. The system is highly flexible and cost effective, with minimal infrastructure and maintenance requirements. Thanks to the significantly faster changeover time and efficiency, with less downtime, F.A.S.T. also opens up the potential to reach new markets with smaller production batch sizes.

Future expansion and more advanced layouts than typically standard, are possible. With the system, it allows punches and toolholders to not be disassembled and stored after each use, instead they are stored as a cartridge set, already pre-assembled, and easily available.

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Understanding the differences in particle size distribution methods for fine metal powders

In any PM process, the size and shape of the metal powder particles used will have an influence on the properties of the part. However, not all particles are the same size in a given sample of metal powder. The variation in this range of powder sizes is reported as particle size distribution, and among the methods used to measure this, it is often the case that different systems give different results. Here, Tom Williamson and John Dunkley of Atomising Systems Ltd, highlight the differences in results from the main methods used to measure narrow-cut, fine metal powders.

The size distribution and shape of metal powder particles influences the physical properties of the parts created. Within any given sample of metal powder, however, the particle size will vary. Different Powder Metallurgy processes require different particle sizes, with the permitted variation in the range of particle sizes also dependent on the processing method.

The range of this variation is reported as particle size distribution (PSD) and is an important factor when specifying metal powders for any Powder Metallurgy process. For example, metal powder used in Powder Bed Fusion (PBF) Additive Manufacturing typically has a narrow PSD range, as particles above a certain size cannot be spread into the thin layers needed for the process and very small particles degrade flow and can cause dust in the AM machine. Metal powders used in press and sinter PM, on the other hand, are larger and can function with a wider PSD.

There are many methods and systems for measuring the PSD of metal powders; however, different measuring systems can often give somewhat different results. In this article, the team at Atomising Systems Ltd highlight the differences found in results gained from different measurement systems when used to measure PSDs with different breadths and sharpness of cut (e.g. classified vs sieved powders).

Fig. 1 Laser diffraction was carried out on a Malvern Mastersizer 3000E (Courtesy Malvern Panalytical)

Fig. 2 Sieve analysis was carried out on an Inclyno sieve shaker (Courtesy Capco Ltd)

Fig. 3 Optical image analysis was carried out on a Retsch Camsizer X2 (Courtesy Retsch)

Different test methods give different results

Although this article will focus on the PSD of metal powders characterised for Powder Bed Fusion Additive Manufacturing, the differences found between the various test methods are of relevance to the broader range of PM processes. Laser Powder Bed Fusion Additive Manufacturing generally calls for powders in the size range ~15 to ~45 µm. The test methods considered for this analysis were laser diffraction (Fig. 1), sieve analysis (Fig. 2) and optical assessment (Fig. 3).

Testing of the upper limit of this range can be carried out easily by sieving, as 45, 53 and 63 µm test sieves are very reliable and simple to use, but sieving at the lower limit is made difficult by the delicate nature of the sieves involved. So, while a different technique must be used at the lower limit, the convenience, economy and excellent reproducibility of sieving makes it the logical technique of choice for the upper limit.

Atomising Systems Limited has found a variety of approaches to this issue amongst its customers. Some use laser instruments to specify both upper and lower limits, but also specify sieve limits. One such specification states "Less than 5% > 53 µm, trace > 63 µm, D90 < 55 µm." It is obvious from this that the laser (or other) instrument giving a D90 value is not in full agreement with the sieve. So can both be true? How should we specify and test these powders?

"The general observation seemed to be that narrower sieve fractions had the worst agreement with the laser instruments"

An extreme illustration of this problem can be shown using the example of a spherical gas atomised powder, which has been sieved through 45 and 38 µm test sieves. The results are given in Table 1.

In these results, the laser instruments reported a median size close to, or even above, the maximum size determined by the sieves, and also reported that only ~20 and ~40% of the sample lay between the sieve sizes. The cause of this discrepancy was not clear. To investigate the problem further, a series of tests on various narrow cuts was carried out. The general observation seemed to be that narrower sieve fractions had the worst agreement with the laser instruments. The effect of removing a small fraction, say -45 + 38, from an as-atomised powder, was also tested and the laser instrument did not detect the anticipated bimodality. It was only when as much as 50% of the powder was removed in the middle of the as-atomised distribution that two peaks were visible in the laser-reported PSD.

A somewhat wider cut is shown in Fig. 4. These results showed that the laser median was within the sieve range, but that ~30% of the powder was still reported above the maximum sieved size. It was as a result of these experiments that the further work reported in the article was initiated.

Instrument	< ~38 µm	< ~45 µm	D10	D50	D90
Malvern	18.3% < 40.1	59.16% < 45.6	37.6	44.3	51.5
Horiba	21.8% < 39.2	41.3% < 44.9	34.6	49.35	66.5

Table 1 PSDs reported for the -45 +38 µm sieve fraction

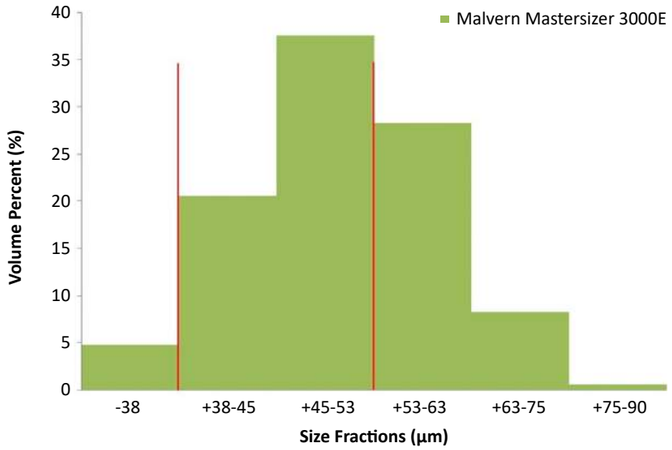

Fig. 4 PSD of -53 +36 µm sieved powder (the red lines show the sieve fraction)

Identifying the correct test method

The powder used in the experiments was from ASL's regular production of 316L stainless steel, sieved to a typical AM distribution, nominally -53 + 20 µm, with the bottom end sieved at 22 µm. The powder was gas atomised using hot nitrogen and an anti-satellite system designed to reduce the incidence of satellite particles adhering to the product. A 10 kg sample from a production batch was divided into eight subsamples for use in the various tests.

Three assessment methods were tested. Sieve analysis was carried out at ASL using 200 mm diameter test sieves of 20, 25, 32, 38, 45, 53 and 63 µm mesh size. The sample weight was only 10 g, and the maximum weight retained on a given sieve was less than 3 g. This small sample size is necessary in order to preserve the very delicate and expensive fine sieves. Tests on the 32, 38, 45, 53 and 63 µm sieves were carried out in a stack on an 'Inclyno' sieve shaker for 15 min, whereas the 20 and 25 µm sieves were hand-shaken and brushed to an endpoint separately.

The laser diffraction instrument used by the ASL QC laboratory was a Malvern Mastersizer 3000E with wet dispersion and ultrasonic assistance. Optical image analysis was carried out by Retsch using its Camsizer X2 instrument.

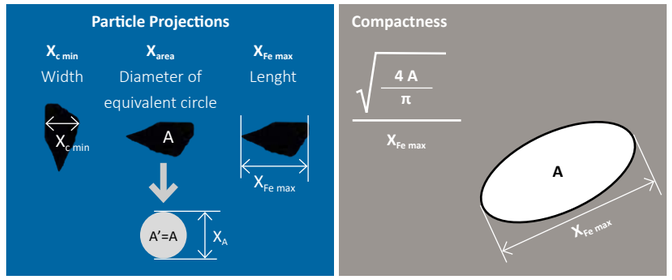

Fig. 5 Definitions of size and shape parameters

Particle shape differences

The determination of PSD can be contentious, as particle shape makes the definition of particle size a problem. Fortunately, AM powders are generally specified to be as spherical as possible. However, even the best powders, such as those produced using ASL's special anti-satellite gas atomiser, are not perfectly spherical, so shape must be considered. Data on shape was obtained from the Retsch Camsizer, reported as compactness, defined in Fig. 5. The oldest and simplest method, sieving, actually measures the shorter dimensions (x_{cmin}) of a particle, as the longer axis (x_{Femax}) can line up at right angles to the mesh to allow the particle to pass through the aperture. Laser diffraction [1, 2] tends to measure all three dimensions, so it is perhaps not surprising that it may report larger sizes than a sieve. Optical or Dynamic Image analysis systems [3, 4] report a number of size (and shape) parameters; the average area derived (x_{area}) is reported to correlate better with laser diffraction data, and the minimum dimension (x_{cmin}) with sieving.

Fig. 6 shows a typical powder in this AM size range. It also shows the problem with shape assessment under a microscope; the effective dispersal of the particles. There are far more clumps and chains of particles in the optical micrograph that are just touching each other than there are genuine satellites. The technique used in the Camsizer X2 is to disperse with pressurised air and this overcomes much of this problem.

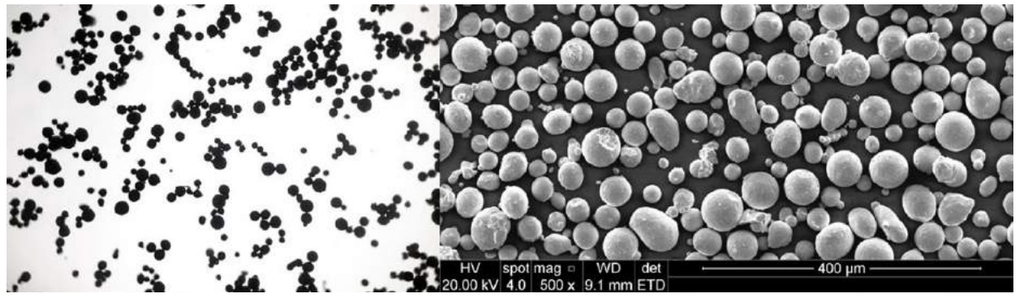

Fig. 6 Optical (left) and SEM (right) micrographs of -53 +20 µm 316L powder

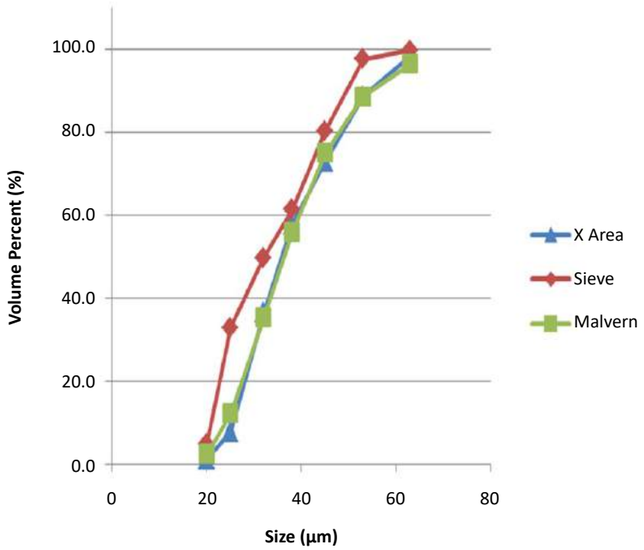

Fig. 7 PSDs of -53 + 20 µm powder samples

Instrument	Sieve	Sieve retest	Malvern	Camsizer (x_{area})
%< 63	99.4	99.7	96.5	99.3
%< 53	98.5	97.5	88.6	89.9
%< 45	93.9	80.3	74.8	74.5
%< 38	68.1	61.3	55.2	59.3
%< 32	56.2	49.6	34.2	36.0
%< 25	34.5	32.9	11.2	7.9
%< 20	5.0	4.8	2.0	1.1
D10 µm	22	22	24.7	25.8
D50 µm	30	32.5	36.7	34.8
D90 µm	43	50	54.7	53.1

Table 2 PSDs of -53 + 20 µm powder samples

Different parameters

Various parameters were reported by the different instruments. The results for some key parameters are given in Table 2. These data demonstrate very clearly the difficulties of using such fine sieves. The first data set reported showed clear signs of damage to the sieves. The amount passing the 45 µm sieve was clearly out of line and the -25 + 20 µm figure also seemed rather large. Having noted this deviation, a further test was conducted with special care devoted to examination of every sieve. The results of this retest, shown in Table 2 and plotted in Fig. 7, along with the Malvern and Camsizer data, appear to be much more consistent.

Log-normal plotting is generally used to represent relatively wide atomised powder size distributions. However, when the powder has been sieved to such a narrow size range, with D90/D10 only being about 2:1 rather than the typical 7.5:1 of a log-normal distribution, the log-normal plot is no longer helpful. Instead, a simple linear cumulative plot can be used as an effective representation of the distribution.

The sieve data now conform quite closely to a straight line, while the Malvern and Camsizer x_{area} data diverge somewhat from this, but largely agree with each other. Compared with the sieves, the instrument methods report a slightly (~10%) coarser median and a very similar slope overall, but show strong disagreement at the fine end of the distribution (e.g. the percentage finer than 25 µm is one third of that reported by the sieves).

Given the very steep gradient of the curves so close to the nominal cut-off point, and the tolerances that can be realistically achieved on a 25 µm test sieve mesh, this is not a surprise. It is deemed wise to accept the Malvern/Camsizer data as more reliable in this area. At the coarse end of the distribution, there is again a difference between the sieves and the instruments. The > 53 µm fraction is reported as only 2.5% by the test sieve, but 10.1% by the Camsizer and 11.4% by the Malvern. This increase may be related to the imperfect sphericity of the powder (see Fig. 6). Sphericity data from the Camsizer are given in Fig. 8.

These data show that 10% of particles have compactness below 0.85 and 80% have compactness above 0.9. These figures could help to explain the higher levels of powder coarser than 53 µm reported by these instruments compared with sieving.

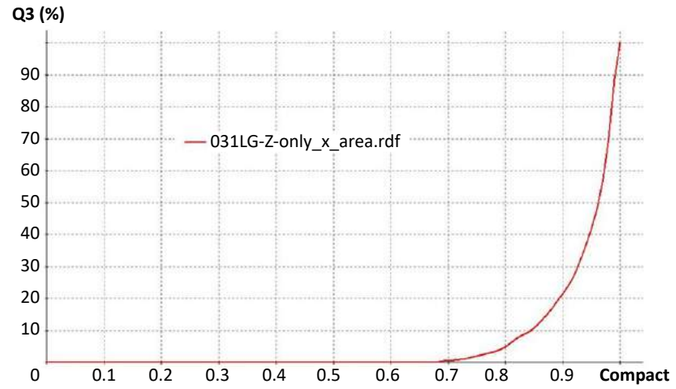

Fig. 8 Particle shape (compactness) of powder (Camsizer X2)

Using different algorithms

To investigate whether the use of different algorithms could generate results closer to 100% between the sieve limits of the powder, the source files from the ASL Malvern 3000E were sent to Malvern Panalytical. Values were reported of 93, 93.2, 92.4, 93.1, 90.8, 92.8, 89.6 and 94%, using different settings. There would therefore be little to be gained from these variations. To test this conclusion, Fraunhofer ('Opaque setting') or Mie scattering ('Spherical setting') settings were used on the ASL Malvern with the same sample, to determine whether they would improve the agreement with the sieves. The D10, D50 and D90 values changed by less than 1 µm and the reported < 20 µm fraction changed only from 1.97 to 2.3%, and the < 53 µm fraction from 88.58 to 89.3%. It was therefore concluded that alteration of the standard settings on the Malvern instrument is not justified.

Fig. 9 plots the two reports of PSD, using size criteria, x_{cmin} and x_{area} together with the laser data, and this confirms the maker's assertion that x_{area} most closely mimics the laser output. The x_{cmin} parameter lies closer to the sieve data (not shown in Fig. 6 for clarity reasons, but shown in Fig. 9). The reported data illustrate some of the problems in defining and testing specifications for the PSD of these powders. Experience, together with the data from this study, show that it is necessary to adopt a somewhat different approach when writing specifications around modern instruments as opposed to sieves.

Conclusions

For sieve specifications, it is quite normal to see specifications such as < 10% -45 µm, < 5% +150 µm trace (or < 0.1%) +180 µm, balance -150 +45 µm. In the case of modern instruments, it is very risky to discuss figures that lie outside the 5–95% range, as there are sources of error that can badly affect the two extreme ends of the reported distribution. This means that any call to report D1 or D99 should be rejected.

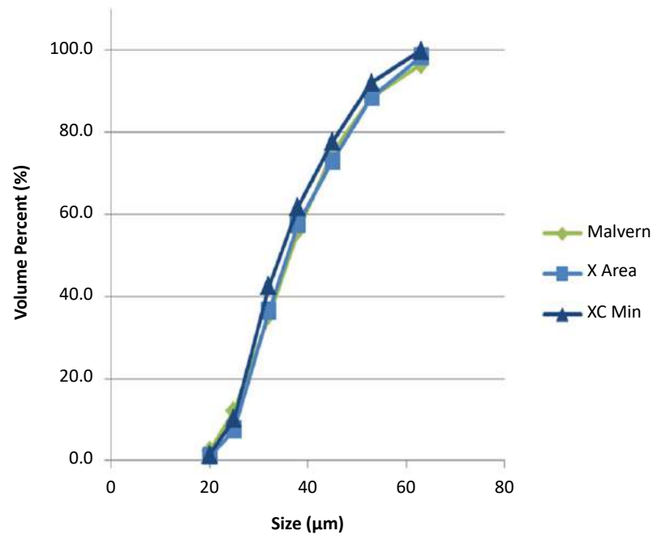

Fig. 9 Effect of Camsizer criteria on correspondence with Malvern data

Also, the inherent variability of the instruments, even with careful sampling, means that all percentages between 10–90% should be considered to be reliable only to +/-2%. Malvern Panalytical advises that the ISO standard for laser diffraction, ISO13320, states that the variation in measurements should be less than 5% (for Dv10 and Dv90) or 3% (for Dv50). The standard then states that, under ideal conditions, the RSDs should be less than 1%. While this may be true, if acceptance/rejection of a product is at stake, it would be unwise to assume 1% conformity, especially between supplier and client laboratories. Therefore, any attempt to specify very tight limits, e.g. 29–31% < x µm, should be viewed with great caution. Also, no significance should be placed on even the first decimal place, let alone the second, in reported data.

It is likely that the severe disagreement of laser diffraction data with those of sieves, shown in Table 1 and Fig. 4 for very narrow fractions, is due to the fact that much of the distribution is close to the maximum sieve size. This means that the shape factor can move a significant proportion of the total out of the sieve range, while, in a broader cut, the proportion of particles close enough to the maximum sieve size is much smaller, so a smaller overall effect on the reported percentage oversize is to be expected.

On the basis of the reported tests, the authors have drawn the following main conclusions:

- The top end of the AM powder size distribution is most practically defined and verified using test sieves
- The bottom end of the AM powder size distribution, if it is below 30 µm, is most practically measured and defined by using modern methods such as laser diffraction or optical image analysis. Similar results have been obtained for these two methods
- Great care is needed in drawing up PSD specifications, as modern methods have their limitations and simply using typical wording and numbers from specifications drafted around sieving can cause confusion.

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Euro PM2019: Novel process developments highlight new opportunities for PM

A technical session at the Euro PM2019 Congress, organised by the European Powder Metallurgy Association (EPMA) and held in Maastricht, October 13-16, 2019, focused on a number of novel process developments in the wider field of Powder Metallurgy. In this report, Dr David Whittaker provides an overview of three papers, including a look at the use of Spark Plasma sintering in the manufacture of aluminium profiles, the use of Additive Manufacturing in the production of soft magnetic components and a new method of inert gas atomisation.

Association Spark Plasma Sintering and KOBO extrusion routes for aluminium matrix composite profiles manufacturing

A novel approach for manufacturing aluminium alloy profiles, incorporating the use of Spark Plasma Sintering combined with KOBO extrusion, was presented by Dariusz Garbiec, Volf Leshchynsky and Filip Heyduk (Łukasiewicz Research Network - Metal Forming Institute, Poland) and Andrea Garcia-Junceda (IMDEA Materials Institute, Spain)[1].

Spark Plasma Sintering (SPS) is a promising PM technology for the production of fully dense sintered metals, alloys and composites. The properties of spark plasma sintered materials can be further improved by applying a subsequent severe plastic deformation (SPD) method. Of the SPD methods available, KOBO extrusion has emerged as a useful processing route to enhance the mechanical properties of profiles produced from aluminium and its alloys. The novelty of the reported research was to demonstrate the effects of combining SPS and KOBO extrusion to enhance the properties of the aluminium alloy, AA7075.

In the experimental study, Alumix 431 powder, supplied by Ecka Granules without a lubricant addition and having the chemical composition shown in Table 1, was consolidated by SPS using a HP D 25/3 furnace (FCT Systeme GmbH).

Fig. 1 The Euro PM2019 Congress welcomed over 1100 participants to the city of Maastricht (Courtesy Andrew McLeish, EPMA)

The powder was heated up to 500°C at 100°C/min in vacuum and held at the sintering temperature for 5 min. The compacting pressure level on the specimens was kept constant at 50 MPa (the compacting force was 63 kN) throughout the sintering process. Cylindrical SPS specimens, with dimensions of 40 mm in diameter and 10 mm in height, were produced. Extrusion by the KOBO method was performed at ambient temperature using a 25 MN press with an extrusion ratio of λ=10, a die oscillation angle of ± 8° and an oscillation frequency of f = 6 Hz. The extrusion force was 400 kN and the selected extrusion rate was fixed at 0.5 mm/s. As a result, rods with a diameter of 10 mm were manufactured. Samples for hardness measurements, microstructure analyses and strength tests were cut by wire electrical discharge machining.

Based on the optimal sintering temperature and holding time reported in earlier work led by Garbiec, the Alumix 431 powder was consolidated at 500°C for 5 min. The spark plasma sintered AA7075 specimens were subsequently KOBO extruded. In order to gain a better understanding of the role of SPS and KOBO extrusion, with regard to the compositional changes and phase transformations in the Alumix 431 powder, X-ray diffraction analyses were carried out, the results being shown in Fig. 2.

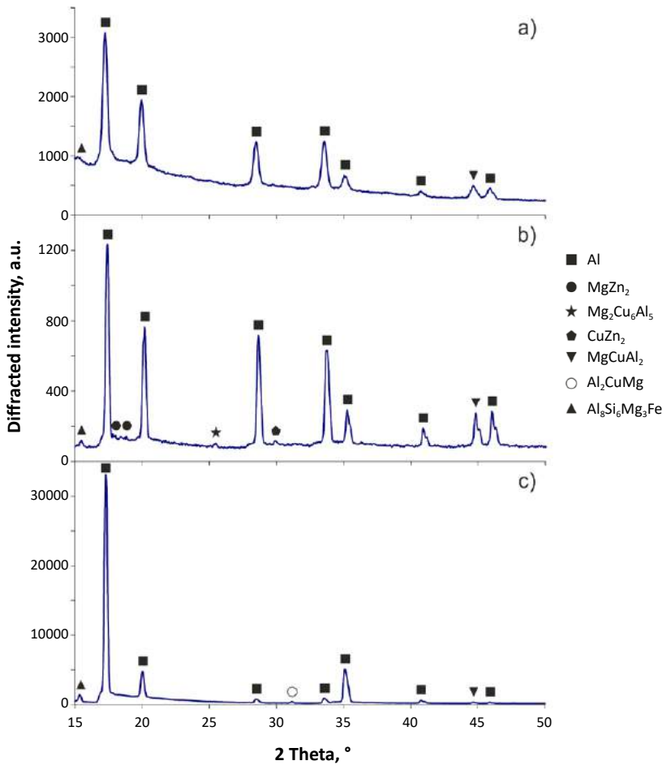

Fig. 2 X-ray diffraction spectra of Alumix 431 powder (a), spark plasma sintered (b) and KOBO extruded (c) AA7075 [1]

Al	Cu	Mg	Zn	Sn
Balance	1.80	2.80	6.40	0.29

Table 1 Chemical composition of the Alumix 431 powder from Ecka Granules [1]

In the multi-component Al–Zn–Mg–Cu–Sn system, there are many possible phases that can be formed. In the powder, all of the visible peaks corresponded to Al, which was the main component of the premix. In the spark plasma sintered compacts, in addition to Al, $CuZn_2$, $MgZn_2$, $AlMg_3$, $Mg_2Cu_6Al_5$ and probably $Al_8Si_6Mg_3Fe$ were also present. Therefore, during SPS of Alumix 431 powder, some reactions occurred and then intermetallic phases were formed. During KOBO extrusion of the spark plasma sintered compacts, further reactions took place and Al, Al_2CuMg, $MgCuAl_2$ and $Al_8Si_6Mg_3Fe$ phases were present in the extruded rods.

SEM micrographs showed that the spark plasma sintered microstructure consisted of nearly equiaxed Al grains with intermetallic layers formed on the grain boundaries, whereas the microstructure of the KOBO extruded rods consisted of Al grains formed during extrusion with elongated bands of intermetallic phases.

To gain a clearer understanding of the microstructural evolutions related to the SPS and KOBO processes, electron back scatter diffraction (EBSD) characterisations were conducted after the SPS and KOBO extrusion steps. According to Fig. 3 (a), fine grains are nucleated during SPS mainly in the areas between large grains. It is interesting to note that sub-grains with low angle grain boundaries (LAGBs) (blue colour) are seen in the small grains. Probably, the processes of recrystallisation and grain growth during SPS result in dissociation of LAGBs in the spark plasma sintered AA7075 alloy. KOBO extrusion of the spark plasma sintered AA7075 alloy leads to a high level of grain strain, this being the reason for the intensified grain refinement as observed in Fig. 3 (b).

The KOBO extrusion technology is a method with a particular scheme of plastic deformation,

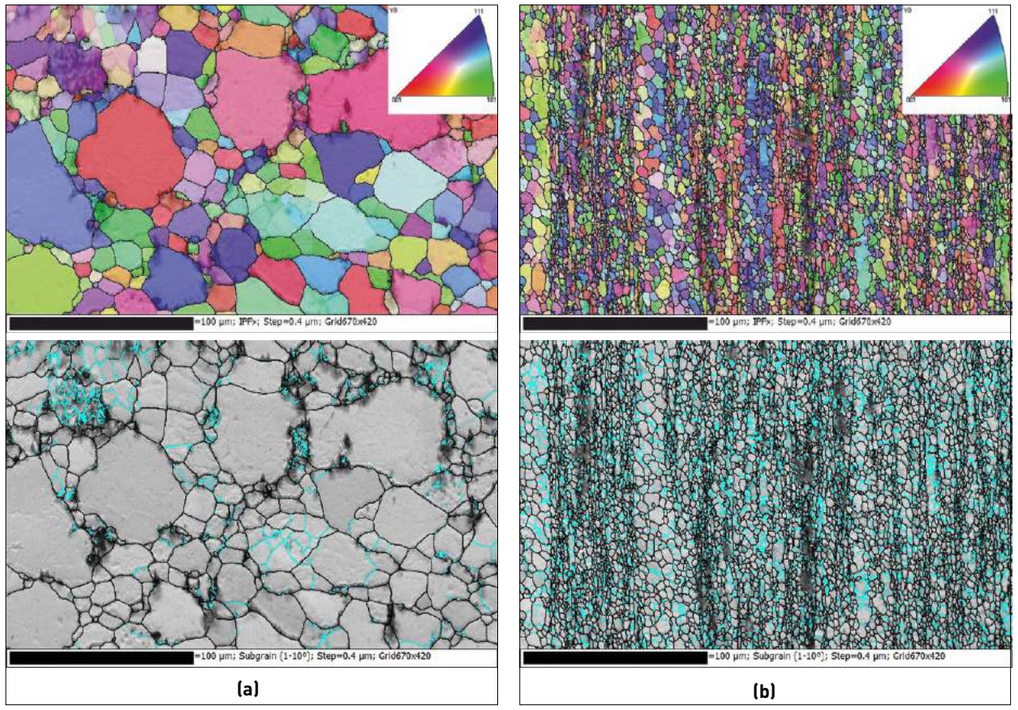

Fig. 3 Orientation and grain boundary maps of spark plasma sintered (a) and KOBO extruded (b) AA7075 [1]

Material	Density, g/cm³	Hardness, $HV_{0.5}$	UTS, MPa	CS, MPa	Strain, %	Grain size, µm
SPS	2.78 ± 0,01	144 ± 4	345 ± 15	618 ± 4	33 ± 1	9.32 ± 0.09
SPS-KOBO	2.80 ± 0,01	98 ± 2	422 ± 14	464 ± 32	30 ± 3	2.57 ± 0.17

Table 2 Properties of spark plasma sintered and KOBO extruded AA7075 [1]

combining monotonic deformation, responsible for the profile shape formation, with reverse twisting. Such processing results in a permanent change of the deformation path and consequent generation of point defects due to the action of dislocation sources and dislocation interaction. An increase in point defect (vacancies and interstitial atoms) concentration over the equilibrium leads to a change in the thermodynamic state of the material and results in the replacement of the crystallographically determined dislocation slip (limited by the grain size) with multi-grain shear (shear bands).

The structural factors and deformation conditions influence grain refining through dynamic recrystallisation processes. Al alloys with high stacking fault energy (SFE) exhibit easy dynamic recovery processes and continuous transformation of sub-grains into ultrafine grains at very high strains. Indeed, enhanced dynamic recovery generally suppresses the discontinuous dynamic recrystallisation (DDRX) of high SFE materials, because the deformation generates relatively low dislocation densities and therefore low driving forces for DDRX. In contrast, during continuous dynamic recrystallisation (CDRX), geometrically necessary low angle boundaries are being formed, which are gradually transformed into high angle grain boundaries (HAGBs). As a result of the continuing deformation, these micro-crystallites increase their mis-orientations and are gradually transformed into grains with HAGBs. This process is observed during both warm and cold SPD of high SFE materials. The development of micro-shear bands and the formation of cell blocks, which are the products of geometrically necessary dislocations (GNDs) and dense dislocation walls (DDWs), seem to be the main reason

for the CDRX of the spark plasma sintered AA7075 alloy. However, it seems that the high amount of grain strain during KOBO extrusion leads to an incomplete transition of LAGB to HAGB, hence a high volume fraction of LAGB is seen (blue lines in Fig. 3 b). Therefore, cold KOBO extrusion of spark plasma sintered AA7075 rods results in considerable CDRX, which leads to uniform grain refinement.

from the microstructure evolutions. The hardness of the spark plasma sintered compacts of 144 HV0.5 was reduced to 98 HV0.5 during KOBO extrusion and reductions were also observed in the compressive strength and strain (from 618 to 464 MPa and from 33 to 30%). However, the KOBO extrusion caused an increase in ultimate tensile strength from 345 to more than 420 MPa.

"...combining SPS and KOBO extrusion could provide an efficient route for manufacturing profiles from aluminium alloys and composites..."

A comparison of the properties of the spark plasma sintered and SPS +KOBO extruded AA7075 is presented in Table 2. The spark plasma sintered compacts exhibit close to full density. Any residual porosity was then eliminated by KOBO extrusion. For this reason, the obtained AA7075 rods were fully dense. The changes in the mechanical properties resulted

Table 2 also shows that KOBO extrusion generated a grain refinement from 9.32 to 2.57 µm.

The authors drew the overall conclusion that combining SPS and KOBO extrusion could provide an efficient route for manufacturing profiles from aluminium alloys and composites and this will be the goal of future work.

Development of flexible laser process chambers for Additive Manufacturing of layered multi-material with tailored electromagnetic properties

A further paper turned attention towards the use of Additive Manufacturing (AM) in the production of soft magnetic components. Specifically, Julian Schurr et al (Aalen University, Germany) reported on the development of flexible laser process chambers for AM and their use for the processing of layered multi-materials with tailored electromagnetic properties.

Laser Powder Bed Fusion based AM (L-PBF) offers the opportunity to produce soft magnetic materials with optimised properties. L-PBF also enables the implementation of inner structures, resulting in tailor-made components for efficient electric motors. For this purpose, the concepts of Powder Metallurgy and rolled/laminated electrical sheet metals have been combined and transferred to corresponding alternating layered structures produced by AM. In addition, the concept can

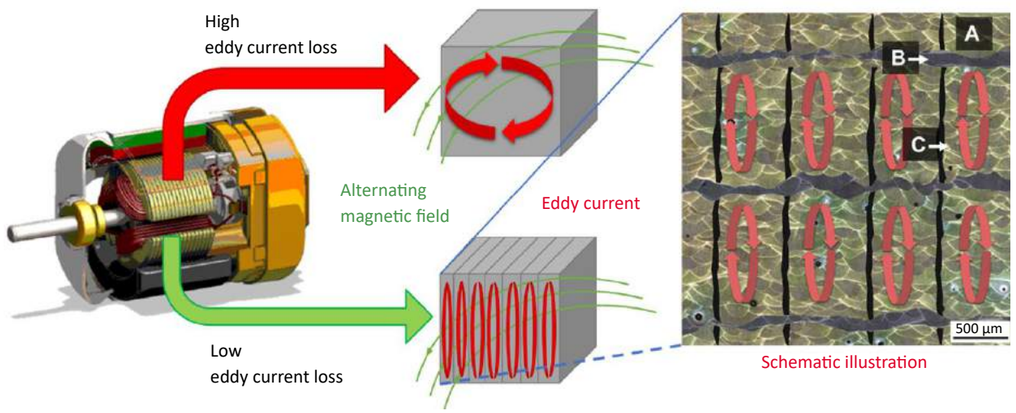

Fig. 4 Electrical sheet stack in an electric motor and schematic illustration of its additively manufactured equivalent (component A corresponds to the electrical sheet, component B to the electrically insulating separation layer. Red arrows represent eddy currents). The inner structures are shown as slits (C) [2]

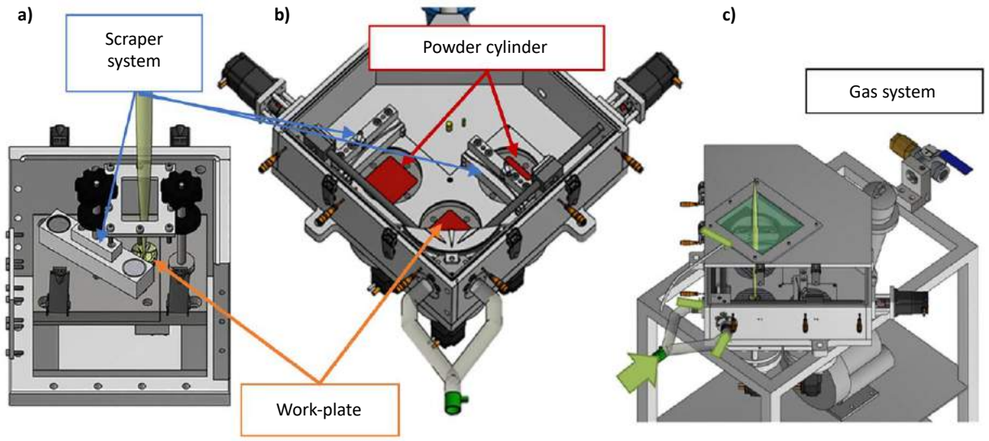

Fig. 5 From left to right: CAD images of the laser process chambers (LPC). a) Manual (LPC) with lifting table and double scraper, oblige view. b) Automated LPC with the powder handling. Three lifting tables representing two powder cylinders and one work plate; scraper system. Isometric view. c) Inert gas system of the automated LPC, isometric view [2]

be expanded by introducing slits in the building direction, which are able to further reduce eddy current losses. The principle of the horizontal and vertical structures, in the form of separation layers and slits, can be seen in Fig. 4 (right).

The principle behind this technology is the use of a bulk material with good electromagnetic properties and the choice of a corresponding material for the separation layers. This material has to provide a high specific electrical resistance and, at the same time, a printability in L-PBF. Furthermore, the two materials have to be compatible with each other in order to create a stable compound.

A bulk material of Fe or Fe-6.5 wt.% Si with horizontal separation layers of Fe-16 wt.% Al or Fe-22 wt.% Al alloys could fit these requirements. In order to fine tune the magnetic properties, the samples must be subjected to a heat treatment, but, at the same time, the layered structure of the separation layers has to be preserved.

In the reported experimental programme, a manual laser process chamber was first set up for initial tests. The automated laser process chamber, shown in Fig. 5 (aLPC), was subsequently developed for the production of ring-shaped samples with more complex structures. This chamber was designed and built in-house at the University. The aLPC consists of three main components; the lifting table system, the scraper system and the housing where the inert gas management takes place. The system is based on L-PBF technology. The base materials (metal powders) are stored inside two lifting tables, are transported to the surface as required and are applied to the work-plate by a scraper. In order to be able to process two materials in one process, the aLPC has two powder-supply lifting tables with separate scraper systems that intersect at the work-plate position.

As the overall manufacturability and the soft magnetic properties of the processed materials strongly vary with oxidation, the processing must be carried out under an inert gas atmosphere. In order to keep the oxygen content of the aLPC at levels below 500 ppm, it is equipped with a measuring system, which is able to regulate the atmosphere. To maintain a stable process atmosphere and to minimise the deposition of evaporated metal on the laser-window, a blower system was installed, which circulates the protective atmosphere inside the chamber. Particles from the process-exhaust fumes are removed by filtration. Compared to conventional SLM machines, the aLPC provides a turbulent gas flow that reaches the interaction zone of laser and metal powder from two sides. This leads to a more even heat dissipation (Fig. 5, right).

In order to verify the feasibility of the project, a pilot test was performed. The materials Fe (A) and Fe-16 wt.% Al (B) or, subsequently, Fe-6.5 wt.% Si (A) and Fe-22 wt.% Al (B) were selected. The specific electrical resistances of the separating layers exceed the resistances of the bulk material by a factor of >2 and >10, respectively. The Fe-6.5 wt.% Si material was a pre-alloyed, spherical powder with a particle size finer than 45 µm. The Fe-Al materials were produced by dry mixing in a tumbler mixer, the base materials being pure Fe and Al powders with particle sizes finer than 63 and 45 µm, respectively.

The alternating layered multi-material samples were built using the aLPC. The laser source used

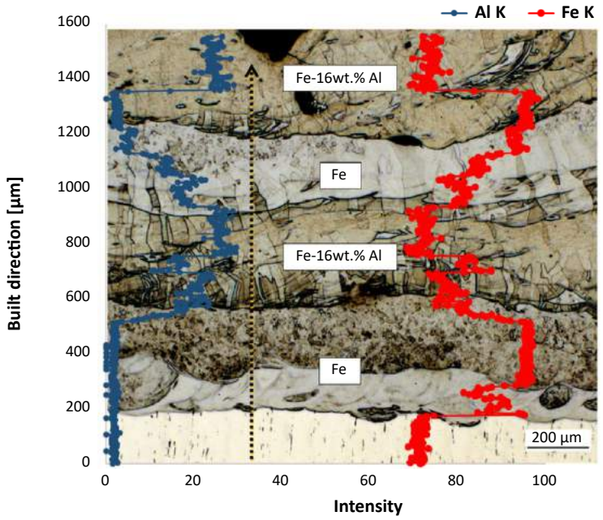

Fig. 6 Microscopic analysis of an alternating layered sample consisting of Fe and Fe-16 wt.% Al alloys. The overlay of the light microscope image with an EDS line scan exhibits a change in chemical composition that correlates with the alternating layers in the light microscopic image [2]

was a disc laser with a wavelength of 1030 nm in combination with the laser processing cell. Ring-shaped samples were constructed at two sizes (large: di = 60 mm, do = 70 mm; small: di = 25 mm, do = 35 mm). Due to the capabilities of the laser processing cell used, a spiral movement with a continuously increasing diameter was chosen as the exposure strategy. The hatch distance was varied between 100 and 400 µm. The hatch distances -50 %, 0, 50 % and 100 % were achieved. A laser power of 200 W with a focus of 200 µm and a scanning speed of 5000 mm/min were used. The materials used were (A) Fe and (B) a Fe-16 wt.% Al alloy with layer thicknesses of 75 and 100 µm, respectively. The structure was set up in the ratio A:B = 8:2.

The internally structured samples were built by increasing the hatch distance to 350 µm and the focal diameter to 300 µm. The macrostructure achieved was a 10:2 stack of (A) Fe-6.5 wt.% Si (80 µm) and (B) Fe-22 wt.% Al (70 µm). Both layers were processed by using a laser energy of 225 W at a scanning speed of 5000 mm/min.

Heat treatment of the slit samples was carried out in a four-stage process, using a tube furnace under an argon atmosphere with constant gas flow. The samples were heat treated for 1 h at temperatures of 600, 900 and 1150°C.

Fig. 6 shows that the L-PBF method is able to produce alternating layered samples with changing chemical compositions along the build direction. Although the microstructure of the manufactured samples exhibited relatively high porosities, most of them showed continuously layered compounds. The samples showed no cracks or delamination. EDS-analysis displayed the changing

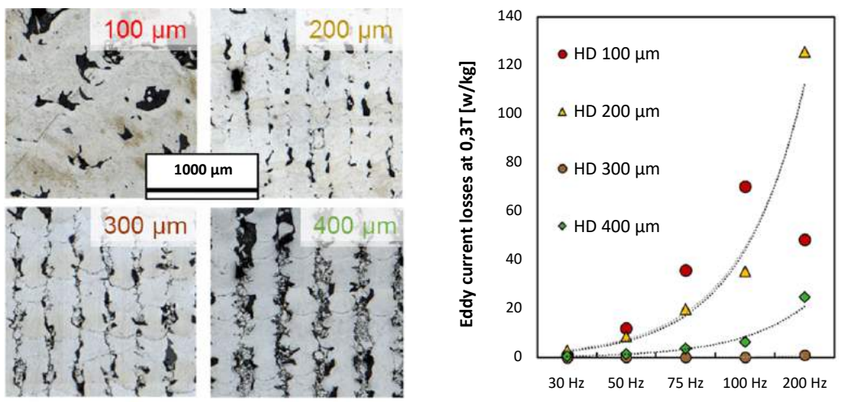

Fig. 7 Left: Light microscope images show the microstructures of the slit samples consisting of alternating Fe/ Fe-16 wt.% Al layers. As the hatch distance increases, clearly visible separations between the individual laser paths become visible. Right: Eddy current losses compared to the hatch distance. Eddy Current losses can be reduced by increasing the hatch distance [2]

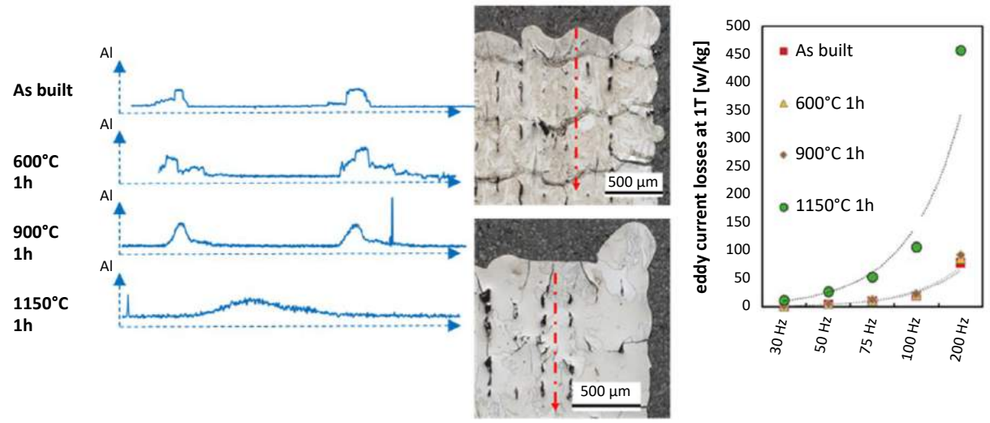

Fig. 8 EDS-analysis of horizontal separation layers (Fe-Al-alloy) after thermal post-treatments (1h, 600-1150°C). Right: effectiveness of the separation layers due to eddy current losses compared to various heat treatments. Heat treatment can be applied up to a temperature of 900°C without loss of performance [2]

amounts of the alloying elements. Transition zones were formed above and below the separation layers in which strong mixing took place. Despite the formation of new alloys during the laser process, the eddy current losses could be significantly reduced compared to the reference sample without separation layers (Fe). The reference sample was produced with the LPC and the same Iron powder. The defects in the microstructure due to the separation layers show only a small influence on hysteresis losses.

The combination of a focal diameter of 200 µm with hatch distances >200 µm led to unbonded lines, with the individual exposed paths touching each other only slightly (Fig. 7). The samples with hatch distances of 300 and 400 µm showed some continuous separations between the individual laser paths. As the hatch distance increased, slits appeared between the individual paths of the laser. Up to a hatch distance of >300 µm, these slits led to a reduction of eddy current losses (Fig. 7 top and right).

Due to the spiral exposure strategy, the remaining slits ran radially through the entire sample. In combination with the horizontal separation layers, the resulting eddy current losses could be reduced further.

For the completion of the feasibility study, the materials used and geometric properties were adapted to the structure of a potential electric sheet stack in an electric motor. The thickness of the separating layers was reduced and the proportional amount of bulk material increased. The promising Fe-6.5 wt.% Si - alloy was selected as bulk material.

Soft magnetic materials require a heat treatment to reduce hysteresis losses. Fig. 8 shows that it is possible to subject alternating layered components to a heat treatment of up to 900°C for 1 h without losing the positive effect of the high-resistance separation layers. EDS line scans showed an increasingly strong diffusion of the aluminium content inside the separation layers as the heat treatment temperature increases. With a heat treatment of 1150°C for 1 h, strong diffusion took place, so that the effects of the separation layers were becoming lost. Consequently, the sample showed significantly higher eddy current losses if heat treated at 1150°C.

In summary, the investigation concluded that a tailored sample had been developed, which consisted of an Fe-6.5 wt.% Si bulk material at a thickness of 800 µm, separated by thin 140 µm Fe-22 wt.% Al layers. In addition to this layered structure, slits were created inside the component by applying a suitable exposure strategy.

The authors stated that the implementation of such layered multi-material components in real motor applications is generally conceivable. The dimensional accuracy of the components is in the 0.1 mm range. For application in a motor, the achieved surface roughness is acceptable.

"...the implementation of such layered multi-material components in real motor applications is generally conceivable...."

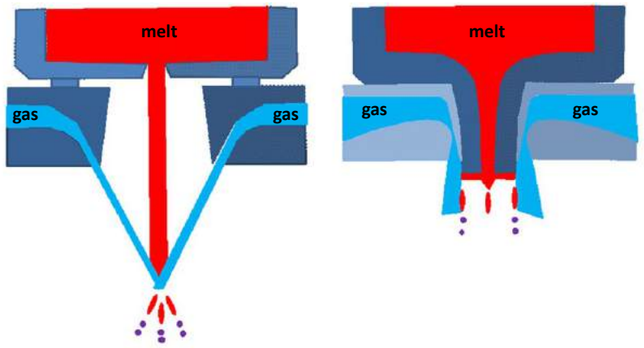

Fig. 9 Free fall atomiser (left) and close coupled atomiser (right) [3]

A new method for the inert gas atomisation of metals and melts

The final presentation discussed here relates to a novel method for the production of fine metal powder, where a hot supersonic gas is used to shear the melt, delivering particle sizes with d_{50} = 10 µm. Humberto Chaves (Technical University of Freiberg, Germany) reported on the development of this new method for the inert gas atomisation of metals [3].

A common feature of all established atomisation technologies is that the metal melt is fed axially and centrally as a relatively thick stream and the atomising gas is introduced coaxially, but with radially inward velocity components, so that it impinges on the melt, either as a thin sheet or jets from a multitude of nozzles. Only in the case of closed coupled atomisers does a recirculation gas flow at the exit of the metal nozzle supposedly create a melt film on its end face. Therefore, for most of the time, atomisation has to begin from large structures (lamellae, ligaments), which break up to drops in the further interaction with the gas.

Aerodynamic forces are the driving mechanism of the atomisation process. These depend strongly on the relative velocity between the gas and the melt particles. Thus, the gas is accelerated to very high velocities and reaches the speed of sound at the gas nozzle exit. It can actually accelerate even further outside the nozzle if the driving pressure is high enough or the nozzle expands even further, see Fig. 9. However, the increase in gas flow velocity implies a decrease in the gas's temperature. For argon expanding from room temperature, the temperature at the nozzle exit would be -50°C. Clearly, this cannot be beneficial for the atomisation of melts, as a cold gas would freeze the melt. The standard measure to counteract this effect, which would lead to freezing of the melt nozzle, is to superheat the melt, i.e. to heat the melt above its melting point, and to maintain a high melt flux, i.e. a thick stream of the melt.

Therefore, there are three fundamental disadvantages of the established inert gas atomisation technologies: the central flow of the melt, the thick stream and the low temperature of the atomising gas.

The presented research provided initial findings in adopting a significantly different atomisation approach, in which the gas flows in the central part of the nozzle and the melt flows as a thin film on the wall of the gas nozzle (Fig. 10) through the thin gap between the stopper rod and its seat at the bottom of the crucible. The height of this gap controls the mass flow of the melt. The gas flows through the stopper rod after being heated in an electric heater. In the gas nozzle, the gas attains the velocity of sound and accelerates further in the divergent part below the melt inlet. The melt film is suddenly exposed to high velocity gas that shears the surface and surface waves are amplified until droplets are stripped off.

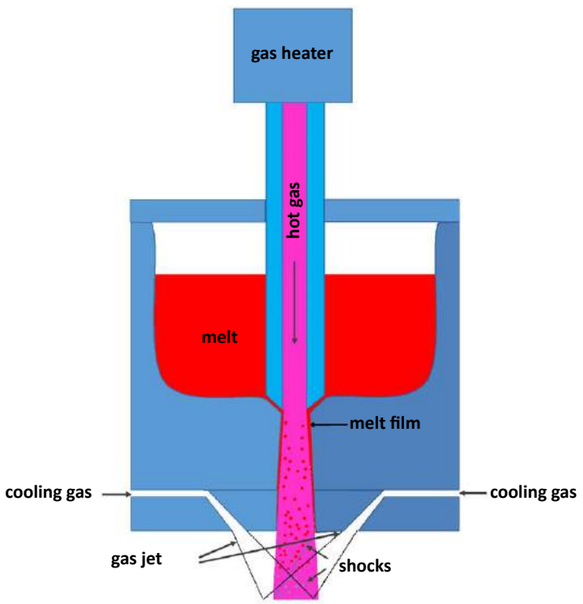

Fig. 10 The new atomising set-up [3]

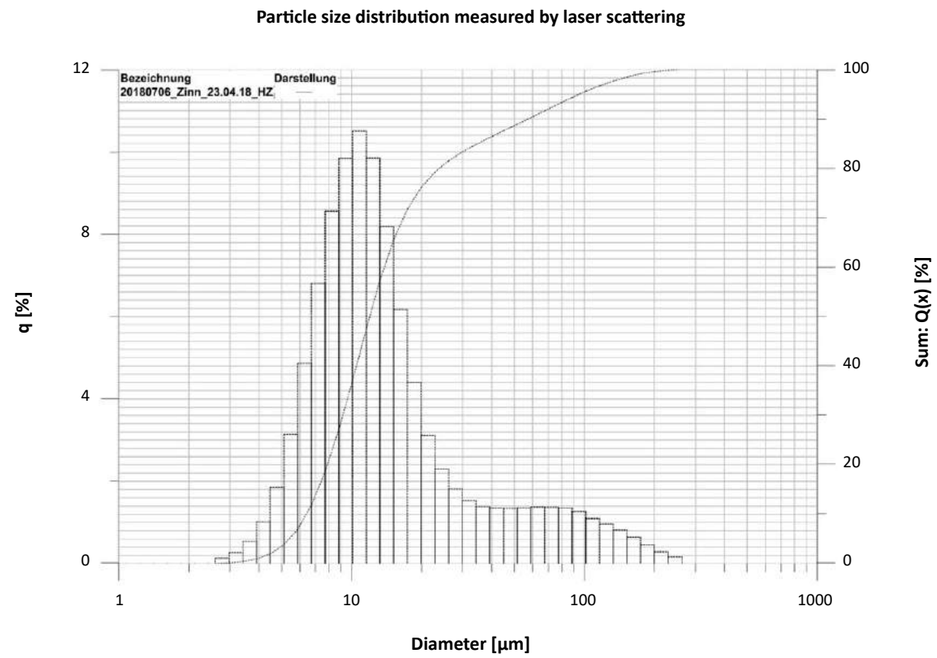

Fig. 11 Particle size distribution, measured by laser scattering [3]

The geometry of the nozzle was chosen so that the exit speed of the gas flow was just above Mach 1, having a value of about Mach 1.2. Therefore, shocks were present in the free jet. Atomisation occurred mainly within the nozzle. The gas temperature at the nozzle exit was set to be slightly higher than the melting temperature by regulating the stagnation temperature of the gas at the heater. This set-up avoids all three of the disadvantages defined above for the established technologies.

The set-up used was designed as a "proof of principle" apparatus. The initial task in mind was to atomise steel alloys, but this poses problems due to the very high temperatures of the melt (1600°C). The crucible and all parts would have to withstand this temperature, i.e. they would have to be refractory materials. In this first step, therefore, tin was used as a low melting point metal, (T_m = 232°C). This allowed stainless steel to be used for the apparatus construction and the heaters to be resistance heaters. This set-up could be used in principle for other low melting point materials.

By applying the formulae for compressible and adiabatic flow of ideal gases, the necessary initial temperature T_0 after the gas heater can be derived. This temperature is needed to compensate for the cooling due to expansion to Mach 1 or more, so that the gas has a temperature at the nozzle exit as high as the melt temperature T_m.

In the case of tin (T_m =232 °C) and nitrogen (with an adiabatic exponent, k=1.4), the stagnation temperature T_0 would be 333°C for Mach 1. For higher Mach numbers, the initial temperature would be higher. In the case of argon (k=1.66), the initial temperature would be accordingly higher, 400°C.

During the experimentation, all temperatures were monitored, i.e. the stagnation temperature of the gas at the exit of the heater and the

> *"...there are three fundamental disadvantages of the established inert gas atomisation technologies..."*

temperature after the nozzle, as well as the melt temperature. Nitrogen was used above the melt and through the nozzle to avoid oxidation of the particles. The experiment was run in batch mode. The crucible was filled with pieces of pure tin (99.9%). Then, the heating of the gas flow was started. Once the gas exit temperature was at the desired level, crucible heating began. This temperature rose until it levelled off at the melting point. The metal temperature then rose again when all of the tin was molten. Next, atomisation was initiated by lifting the stopper rod by a tenth of a millimetre. Atomisation then lasted about 2 minutes for 200 g of tin. The gas mass flow through the nozzle was also set to this value. Once atomisation was complete, the heaters were turned off and the gas flow was used to cool the apparatus and to collect the particles still present in the plenum behind the nozzle. The gas containing the atomised tin particles flowed through a cyclone to separate the particles from the gas and the remaining fines were collected by a 1 µm filter, before the gas exited into the atmosphere.

Once the apparatus had cooled down, the particles that had been deposited on the inner walls of the plenum chamber and tubes could be brushed off and collected, together with the particles below the cyclone and in the filter. Then, the collected mass of particles was weighed and stored in gas tight containers.

Fig. 11 shows the particle size distribution measured by laser scattering. Some large flakes (found in the plenum chamber) had been sieved out by a 125 µm sieve. In total, 70% of the metal mass placed in the crucible was found in the fraction below 125 µm, 56 % below 20 µm and 35% below 10 µm. The percentage of particles finer than 10 µm was much higher than usually achieved by conventional inert gas atomisation.

SEM images of the powder produced were taken to assess particle morphology. These images showed that the particle morphology was not completely spherical and that some coalescence had occurred. This observation meant that there was still room for improvement of the set-up and of the process parameters and planned future work would concentrate on improvements to the nozzle geometry. The extremely fine particles below 1 µm, however, demonstrated the potential present in this atomisation technique.

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[3] A new method for the inert gas atomisation of metals and melts, Humberto Chaves, *et al.* As presented at the Euro PM2019 Congress, Maastricht, the Netherlands, October 13-16, 2019, and published in the proceedings by the European Powder Metallurgy Association (EPMA).

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