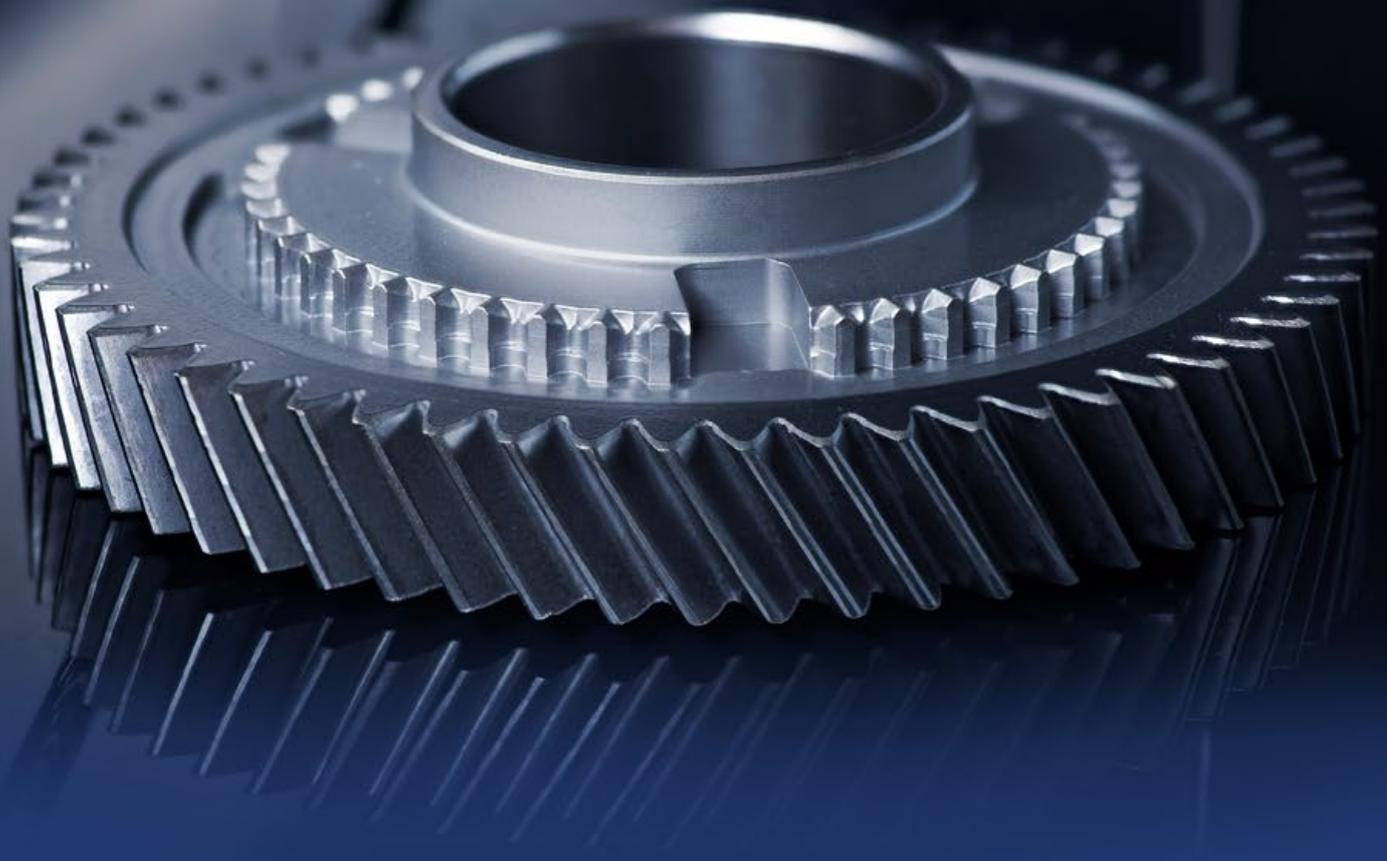


POWDER METALLURGY REVIEW



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CO₂ REDUCTION IN THE PM WORKFLOW



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Submitting news and articles

We welcome contributions from both industry and academia and are always interested to hear about company news, innovative applications for PM, research and more.

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Actually, it's easy being green – it's talking green that's the problem!

PM is a green technology and always has been – it is not subtractive, it produces parts to near-net-shape with little material waste, and consumes comparatively low energy per kg of parts produced. But while it is used to being green, the industry is only just coming to understand the value of talking green. Meanwhile, Additive Manufacturing is sold as the lean, green, planet-saving darling of the 21st century, while PM is seen as rather old-school – and our collective marketing continues to miss the association between PM and AM as two metal powder technologies, even as AM gets closer to PM with the growth of sinter-based technologies like Binder Jetting.

By degrees, PM part makers are either excited by or scared of the potential of AM, but we might be better served to see Additive Manufacturing as a tool of promotion and learn to speak in the same modern, green-focused marketing language as AM companies, who are expert at making eco claims and benefitting from them.

This is the perspective put forward by Barton White, CEO of Kymera International, in this issue's lead article. While admirable work has been put in by the trade associations of the industry to promote PM as green, and some PM companies are already years into green-focused marketing campaigns, White believes it is time for the whole industry to get behind a mass-marketing campaign to sell PM's green credentials to the people that matter.

What is suggested is not empty greenwashing, but a promotion of the genuine advantages of PM's green credentials – aside from their environmental benefits, they make the technology more cost-competitive for all involved. By making this a focus of its marketing to industry, and making its continued (and enhanced) sustainability the focus of research and development, PM can safeguard its place in the modern manufacturing world.

Emily-Jo Hopson-VandenBos
Features Editor, *Powder Metallurgy Review*



Cover image

Automotive winners in the MPIF's 2020 PM Design Excellence Awards, incorporating an MPIF logo used to educate engineers and decision-makers on the environmental sustainability of the technology (Courtesy MPIF)

RioTinto

Imagine a Greener Future Together



Rio Tinto Metal Powders' Commitment to Sustainable Development

The world is getting smaller. The pandemic has made it painfully clear how globally interconnected we truly are. We share one planet and we all need to ensure that our actions today support the generations of tomorrow. At Rio Tinto, the safety of our people is the Number One Priority. We also apply our core values to the communities in which we operate, to reduce the impact of our operations on our neighbors.

Rio Tinto is committed to sustainable development in metals processing. This pledge has been recently demonstrated through investments in the world's first low carbon Aluminum processing technology, Elysis, and in exploring low carbon steel processing technologies. Rio Tinto will invest \$1 billion over the next 5 years to help achieve its Net Zero Emissions goal by 2050.

Powder metallurgy is a Green Technology, a near net-shape process that allows for efficient use of raw materials. Rio Tinto Metal Powders (RTMP) produces iron and steel powders for the industry using carbon-free hydroelectric power generated in the Province of Quebec, Canada. The primary market for our powder products is the automotive industry, which is moving increasingly to electrification and away from internal combustion engines. RTMP is contributing to the development of new powder materials for electric components, from pump assemblies to small electric motors in e-bikes and EV's to create a Greener Future Together.

At Rio Tinto, we produce materials essential to human progress. For more information about Rio Tinto's policies, programs, and commitment to sustainable development please visit the Rio Tinto home page at www.riotinto.com



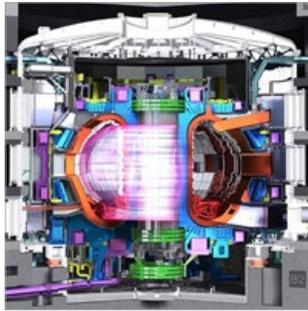
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POWDER METALLURGY REVIEW



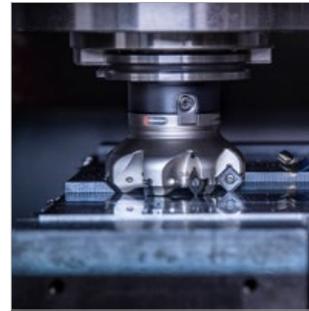
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49 Powder Metallurgy has always been green. Now, we need to learn to talk about it

Being a green technology, PM should be reaping the rewards as the automotive industry seeks to reduce its environmental impact. Instead, the PM industry appears to be preparing for a decline, as the traditional PM parts used in the internal combustion engine fade out of use. Now, when it could most be thriving on its green credentials, press and sinter PM runs the risk of being overlooked as a solution for e-drive applications.

The main reason, believes Barton White, CEO, Kymera International, is a lack of promotion of PM to the C-suite, executive-level automotive manufacturers. Here, he reflects on the changes the auto industry has undergone in recent history and considers how PM can find a place in the new, electrified landscape. >>>

57 39th Hagen Symposium 2021: Sustainable solutions and new markets for Powder Metallurgy

Following a year's postponement as a result of COVID-19, the 39th Hagen Symposium finally took place from November 25–26, 2021. Organised by Germany's Fachverband Pulvermetallurgie, this long-anticipated event brought together the German-speaking PM community for two days of high-level technical presentations on the topic of sustainable solutions and new markets for Powder Metallurgy.

Dr Georg Schlieper attended the symposium on behalf of *PM Review*, and here reports on the key takeaways from a programme whose theme in 2021 aimed to help PM cement its place in a more sustainable future. >>>

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**67 Euro PM2021:
A view to CO₂ reduction across the Powder Metallurgy workflow**

Within the programme of the Euro PM2021 Virtual Congress, October 18–22, 2021, organised by the European Powder Metallurgy Association (EPMA), a double-session Special Interest Seminar (SIS) addressed the opportunities for the reduction of CO₂ emissions across the press and sinter PM workflow through developments in processes and equipment.

Here, Dr David Whittaker provides a summary of each presentation given during the SIS, highlighting key points and findings. >>>

**79 How to make metal powders. Part 2:
Understanding water atomisation and water atomised powders**

In the Winter 2021 issue of *PM Review*, we introduced the first instalment in our four-part series on metal powder atomisation, in which two masters of atomisation, Joe Strauss and John Dunkley, introduced the fundamental principles of atomising technology and atomised powders. Now, in the second instalment in the series, they explore one of the most widely used metal powder production methods – water atomisation. This long-established technology is used to produce a vast range of metal powders for many industrial applications, including press and sinter PM and MIM, and is now making inroads into metal AM. >>>

89 Gasbarre Products, Inc: Three generations of press and furnace expertise in the heartland of North America's PM industry

West-central Pennsylvania, USA, boasts the largest concentration in the world of PM parts manufacturers. As a result, it is also home to many of the largest material, equipment and solution providers that serve them. Among the best known of these is Gasbarre Products, Inc., manufacturer of a range of presses and furnaces that have served as the workhorses of this industry for decades.

Bernard North visited the company headquarters and spoke to Alex Gasbarre (CEO), Mark Thomason (International Sales Manager), Heath Jenkins (president – Press and Automation), and Mark Saline (president – Sinterite and C.I. Hayes), about Gasbarre's history, present, and plans for the future. >>>

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Our advertisers' index and buyer's guide serves as a convenient guide to suppliers across the PM supply chain.

In the digital edition of *PM Review* magazine, available at www.pm-review.com, simply click on a company name to view its advert, or on the company's weblink to go directly to its website.

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

Airbus, Safran and Tikehau Ace Capital to purchase Aubert & Duval

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

Aubert & Duval is a leading supplier of metal powders for Additive Manufacturing and other powder-based part production technologies, serving demanding markets such as aerospace, energy, medical, defence and automotive. The company has annual revenues of approximately €500 million and a workforce of around 3,600, mostly based in France.

The acquisition is expected to enable Airbus and Safran to secure the strategic supply chain (for themselves as well as customers) and new material development for current and future civil and military aircraft and engine programmes. It is also consistent with the initiatives taken in the last few years to support the French aerospace industry's supply chain, and in particular the creation, with the help of the French State, of the Ace Aéro Partenaires fund managed by Tikehau Ace Capital.

"Aubert & Duval is a historical supplier of Safran with unique technical expertise in Europe," stated Olivier Andriès, Safran's CEO. "The planned acquisition will ensure national sovereignty for our most strategic programmes for disrup-

tive civil and military aircraft engines. Given its industrial expertise in metallurgy, Safran will lead the operational management of the company. The transformation programme will reinforce customer confidence and create a national champion with a strong French industrial base capable of serving global markets."

Guillaume Faury, Airbus CEO, commented, "Aubert & Duval, with its critical knowledge and expertise dating back more than a century, is a strategic supplier to Airbus and the entire aerospace and defence industry. Our sector, which has started to emerge from the COVID crisis, needs a solid partner to ramp up production while preparing next-generation technologies in aerospace. With this acquisition and an ambitious transformation plan, we aim to restore the operational excellence and market confidence in Aubert & Duval to create, in the mid- to long-term, a leading European player able

to face global competition as well as to reduce geopolitical risk of supply."

Marwan Lahoud, Executive Chairman of Tikehau Ace Capital, added, "This joint acquisition sends a strong and very encouraging message about the acceleration of the restructuring, the transformation and the consolidation of the supply chain in the aerospace industry. Together with Airbus and Safran, by bringing the capital and top industrial expertise needed to leverage the strategic excellence of Aubert & Duval, we are proud to contribute to support the recovery of the sector at the most critical time, when aeronautical companies have to invest again to accompany the revival of activity and project themselves into the future."

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

www.safrangroup.com
www.airbus.com
www.tikehau-ace.capital
www.aubertduval.com
www.eramet.com ●●●



Airbus, Safran and Tikehau Ace Capital are to jointly acquire Aubert & Duval, a leading supplier of metal powders for Additive Manufacturing (Courtesy Safran Group/M Labelle)

Nichols Portland acquires Alpha Precision Group

Nichols Portland, Inc, headquartered in Portland, Maine, USA, has acquired the assets of Alpha Precision Group, LLC (APG), St Mary's, Pennsylvania, USA. Nichols designs and manufactures Powder Metallurgy components for use in fluid transfer devices and other automotive and industrial applications. It is also a portfolio company of Altus Capital Partners II, L.P., an investment firm focused on middle-market industrial companies.

APG is a metal-forming technology company providing conventional Powder Metallurgy, high-temperature stainless steel PM, Metal Injection Moulding and Additive Manufacturing components and assemblies, as well as high precision valve assemblies to a global customer base. The company is comprised of five manufacturing plants located in Pennsylvania and Michigan, with over 400 employees. The financial terms of the transaction were not disclosed.



Alpha Precision Group offers conventional PM, high-temperature stainless steel PM, MIM and metal AM components (Courtesy Alpha Precision Group)

"The APG acquisition is an excellent complement to our existing value proposition that focuses on being a solution provider to our customers," stated Thomas Houck, president and CEO of Nichols. "The APG network will bring additional and unique capabilities to service an ever-changing marketplace. The acquisition of APG will allow us to further accelerate the depth and breadth of our capabilities and ever-evolving needs of our customers. We feel that our approach to long-term customer relations and growth is highly aligned with the value and mission of Nichols."

Heidi Goldstein, Partner at Altus, commented, "The combination of Nichols' industry experienced management team, APG's management team, skilled workforce, and technical expertise, make us very excited about the growth possibilities of these businesses."

www.alphaprecisionpm.com
www.altuscapitalpartners.com
www.nicholsportland.com ●●●

China's Yangzhou Leader Powder Metallurgy sold to PMG

Powder Metallurgy parts maker PMG Group, headquartered in Füssen, Germany, has acquired Chinese automotive supplier Yangzhou Leader Powder Metallurgy Co, Ltd, (Leader), headquartered in Jiangsu, China. Founded in 1997, Leader currently has around 250 employees and specialises in the production of Powder Metallurgy shock absorber components.

"With the acquisition of Leader, we are systematically continuing our strategic realignment," stated Dr Marius Gutes, CEO of PMG.

"Leader is an effective addition to our production portfolio in the dynamic Chinese market. Our joint customers in China in particular will benefit from this acquisition."

Prior to this addition, PMG had eight production sites throughout Europe, the United States, and one

location in Shanghai, China. The purchase was made as part of the company's strategic growth plan, which is expected to focus on Powder Metallurgy components for the automotive sector and beyond. By offering localised, custom solutions the company anticipates an increase in its value to customers.

PMG will gradually add Leader to its shock absorbers business unit, with Leader remaining a separate production unit under its current management, though supported by PMG's investments and technological innovations. Through this effort, the company aims to make Leader the biggest local Chinese PM shock absorber supplier. During the integration, the two companies will honour all of Leader's existing supply contracts.

"We are looking forward to advancing the development and production of powder metal components under the PMG umbrella even more successfully than before," stated Ge, CEO at Leader. "PMG is going to make Leader's dream of becoming the best and biggest shock absorber supplier in China possible."

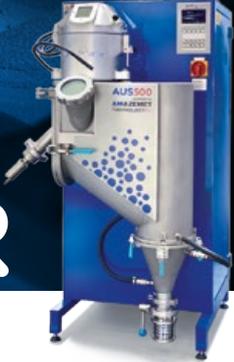
Dr Gutes concluded, "Our success is based, first and foremost, on people – the employees in our companies. This is true for both PMG and Leader. Our claim 'Passion drives us' stands for our passion for entrepreneurial success, for best solutions for our clients, for stable partnerships with our business partners, for motivated teams, and for attractive jobs. Leader is a very good example of entrepreneurial spirit. Therefore, and with this in mind, we warmly welcome our new colleagues from Leader to the PMG family!"

www.pmg-sinter.com ●●●



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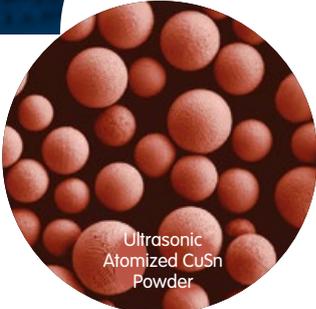
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Equispheres sees \$3.5M investment for metal AM powder production

Equispheres, Ottawa, Ontario, Canada, reports that it will receive a \$3.5 million investment from the Federal Economic Development Agency for Southern Ontario (FEDDEV), Ontario Business Scale-up and Productivity Program to accelerate production of its metal powder materials for Additive Manufacturing. The investment was announced as part of the Government of Canada's commitment to innovation and climate change.

"Equispheres metal powders have unique properties that enable faster production of stronger, lighter and more reliable 3D printed parts," stated Kevin Nicholds, CEO. "This contribution will allow us to scale up our production process and take advantage of an exponentially growing opportunity in the 3D printing space."

The company's metal powders are used for AM parts in the automotive and aerospace sectors, where the need for lightweight, high-precision parts manufactured with high repeatability and mass production speeds is essential.

"Equispheres aims to enable industrial 3D printing to compete with traditional manufacturing," Nicholds added. "Our metal powder technology dramatically reduces the cost of 3D part production such that it is economically viable in volume manufacturing applications such as automotive."

Recent testing by equipment manufacturer Aconity3D demonstrated Equispheres' high-performance feedstock can additively manufacture three times faster than traditional powders and achieve part cost reductions of 50%. Equispheres states that its materials can help Canadian and global manufacturers adopt AM methods that are efficient, sustainable and cost-competitive.

In addition, the company has expanded the automotive expertise of its management team by adding Thomas Bloor to lead global business development. Rob Wildeboer, executive chairman of automotive supplier Martinrea International, has joined the board of directors. Calvin Osborne also joined Equispheres in December as Chief Operating Officer to guide the company's scale-up and commercialisation efforts.

Equispheres adds that three new reactors are expected to come online in 2022, adding production capacity to meet surging market demand and creating new jobs in the Ottawa region.

"We are grateful for the Government of Canada's strong leadership on climate action and programs that support this kind of cleantech innovation. This significant investment by FEDDEV will support the next steps in our growth: working with partners in the automotive, aerospace and defence sectors to qualify our materials for industrial applications," concluded Nicholds.

www.equispheres.com ●●●

Sandvik reports 31% increase in profits during 2021

Sandvik AB, headquartered in Stockholm, Sweden, has released its full-year financial results for 2021. Revenues increased organically by 12% to SEK 99,105 million (Q1-Q4 2020: 86,404), adjusted profit for the period was SEK 14,126, up 31% from 2020 (Q1-Q4 2020: 10,823). Order intake saw organic growth of 26% to SEK 108,898 million (Q1-Q4 2020: 86,287). The year was characterised by high customer activity and strong broad-based demand, with record-high order intake levels in mining and construction. Underlying demand in general engineering was solid throughout the year, while the automotive segment was impacted by component shortages.

"2021 was a very successful year for Sandvik," stated Stefan Widing, president and CEO. "Thanks to our agility and dedicated employees, we

navigated through supply chain imbalances and inflationary pressures while staying focused on our shift to growth strategy. We delivered strong organic and acquisitive growth as well as solid profitability. And we made important acquisitions that were purposely targeted to fill value chain gaps in our offering, enhance our core portfolio and regional exposure, accelerate our digital shift, and consequently strengthen our position going forward. Organic order intake and revenues for full year 2021 rose by 24% and 12%, respectively. Total order intake and revenue growth for the full year, at fixed exchange rates, was 30% and 18%, respectively."

Sandvik Materials Technology saw an increased order intake of 25% and a 4% decrease in revenue for the full period. Organic order intake in Sandvik Materials Technology increased with

improvements across all segments. There was a continued positive trajectory in the oil & gas segments and all major regions noted a favourable order intake trend, with a strong contribution from North America and Europe.

Sandvik Manufacturing and Machining Solutions saw order intake increase by 16% and a 14% increase in revenue. There was solid underlying demand, with organic order intake growth driven by general engineering and aerospace. All major regions contributed to year on year order intake growth, with Europe accounting for 13%, North America 17% and Asia 3%.

Sandvik Mining and Rock Solutions reported an order intake increase of 29% and a revenue increase of 16% for the period. There was solid broad regional demand with organic order intake growth of 60% in North America, 14% in South America, 6% in Europe and 9% in Africa/Middle East. Including major orders, South America grew by 65% and Africa/Middle East by 55%.

www.home.sandvik ●●●

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Stellantis CEO highlights risk of Europe's push towards electric vehicles

Following on from the European Commission's strategy to phase out internal combustion engines (ICEs) in favour of electric vehicles, carmaker Stellantis' CEO Carlos Tavares has expressed his scepticism on the choice in a joint interview with European newspapers *Les Echos*, *Handelsblatt*, *Corriere della Sera* and *El Mundo*.

"What is clear is that electrification is a technology chosen by politicians, not by industry," he told

the papers. "Given the current European energy mix, an electric car needs to drive 70,000 km to compensate for the carbon footprint of manufacturing the battery and to start catching up with a light hybrid vehicle, which costs half as much as an EV."

While Tavares had previously ensured that Stellantis would not be shutting down European production plants, he has since edited the statement to clarify

that the company must remain competitive and, in countries like Italy where energy costs are higher, that may not be feasible. Tavares stated that, although the municipal government in Rome is aiming to bring down these costs, the implementation of strategies may take longer than the company can withstand.

Since merging Fiat Chrysler and Peugeot-maker PSA Group, Tavares has mapped out a €30 billion electrification plan that helped Stellantis shares rise over 60% in its first year.

www.stellantis.com ●●●

GKN Powder Metallurgy announces Diego Laurent as new CEO

GKN Powder Metallurgy has appointed Diego Laurent as its new Chief Executive Officer, with immediate effect. Peter Oberparleiter, who has been leading the company as CEO since 2012, is stepping down from his position after a long and successful career of more than thirty-four years with GKN.

Laurent joined GKN in 1993 and since then has held a number of senior finance positions within the GKN group in Brazil, Mexico and the USA. In 2013, he moved to the UK and was appointed Chief Financial

Officer in 2018 to lead the Finance function for GKN Powder Metallurgy.

"I am very excited to lead our competent and forward-looking team. GKN Powder Metallurgy has been very successful in developing cutting-edge technologies and has become a pioneer in sustainable innovation and digital manufacturing. I look forward to developing the company further with the clear goal of shaping the future of Powder Metallurgy," stated Laurent.



Diego Laurent, new Chief Executive Officer at GKN Powder Metallurgy (Courtesy GKN Powder Metallurgy)

Laurent holds a bachelor's degree in Economics, an MBA in finance, and a postgraduate qualification in production engineering.

www.gknpm.com ●●●

Mimete enters metal powder distribution agreement with ICD Applied Technologies

Mimete Srl, Osnago, Italy, has entered a distribution agreement with ICD Applied Technologies Ltd, Sheffield, UK, who will become Mimete's metal powder distribution partner in the UK and Ireland. Part of the Fomas Group, Mimete specialises in the production and analysis of metal powders.

ICD Applied Technologies is focused on near net shape compo-

nent manufacture using a range of powder metal and metal forming technologies including Additive Manufacturing. It is part of the ICD Group, an international company based in New York, USA, which is focused on the distribution and manufacture of specialist materials.

"We are very pleased to build further on our relationship with

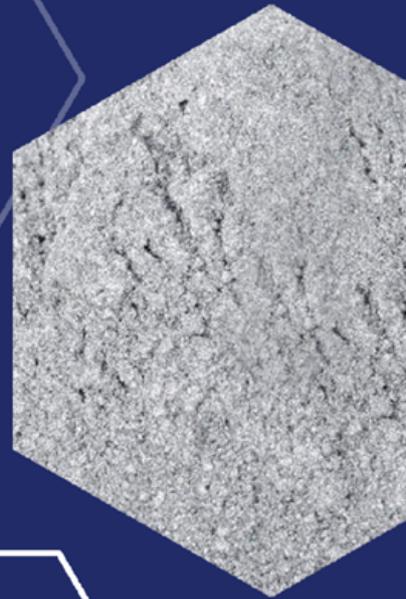
Mimete metal powders," commented Mathew Marsh, Director at ICD Applied Technologies. "This agreement allows for Mimete and ICD to grow and develop further the market for nickel, cobalt and iron based metal powders in the region."

Jacopo Guzzoni, Managing Director at Mimete, concluded, "With this agreement, Mimete enters the British and Irish market with a local based partner ensuring a faster and more thorough service to final customers."

www.mimete.com
www.icd-at.com ●●●

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All German-based Mahle plants now carbon neutral amid sustainability push

Mahle Group, a leading automotive supplier headquartered in Stuttgart, Germany, reports that in 2021 it reached a milestone on its path to carbon neutrality, with all of its German production facilities now identified as carbon neutral.

As part of a company-wide commitment to sustainability, Mahle has adopted binding reduction targets to reach CO₂ neutral production by 2040, including an annual increase of renewable power sources.

“Our technologies are already helping to make individual mobility more efficient, more sustainable, and thus more environmentally friendly,” stated Matthias Arleth, CEO and chairman of the management board at the Mahle Group. “In both the production and administrative areas, we

aim to leverage further potential in environmental protection and overall sustainable corporate governance.”

One example is the action area of energy efficiency where, for instance, Mahle is increasingly using self-generated electricity and will in future be able to partially meet its energy needs with solar power from the company’s own photovoltaic systems. This year, the Group will be launching corresponding projects in all regions of the world in which it operates.

Alongside this is a wider adoption of Additive Manufacturing for the company – in mid-2021, for example, a new AM centre was opened in Stuttgart in order to facilitate the accelerated adoption of climate-neutral drive technologies.

The AM centre houses machines, powder preparation modules, a testing laboratory, and a blasting system for post-processing. It is intended for both internal prototype production and customer orders, with industrial serial production capability ramping up in anticipation of Mahle strengthening its role as a development partner in the automotive industry.

Michael Frick, CFO and deputy chairman of the management board, stated at the time, “The development of new systems and components has to be much faster today than it was a few years ago, especially when it comes to solutions for sustainable CO₂-neutral drive systems. With our new 3D printing centre, Mahle is once again stepping up the pace in its strategic fields – for example, e-mobility.”

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Pensana and Equinor to develop magnet recycling method using hydrogen

Rare earth metals company Pensana Plc, headquartered in London, UK, has signed a cooperation agreement with energy provider Equinor New Energy Limited for recycling end-of-life magnets at Pensana's rare earth hub in Saltend Chemicals Park, Yorkshire, UK. The joint working group will share technical and commercial information on the use of hydrogen in a low-energy method for recycling permanent magnets.

"We are establishing a world-class, independent and sustainable, rare earth processing facility at Saltend Chemicals Park," commented Paul Atherley, Pensana's chairman. "We are also looking to process end-of-life magnets from wind turbine nacelles using hydrogen's properties as a powerful reductant. We very much look forward to working with Equinor using hydrogen from the H2H Saltend project in establishing this innovative process route as a key component in the circular economy for rare earth magnets in the UK."

Recycling permanent magnets utilising hydrogen not as fuel, but as a reductant, whilst benefitting from the decarbonised power supply within Saltend, will use 88% less energy than virgin magnet manufacture.

The partnership with Equinor is said to support Pensana's commitment to the circular economy, as it looks to recycle an addressable annual market of 4,000 tonnes of end-of-life permanent magnets.

Equinor has submitted plans for its 'Hydrogen to Humber (H2H) Saltend' hydrogen production facility into phase two of the UK Government's Cluster Sequencing Process. The facility will be supported by the potential supply of hydrogen to Pensana and other regional hydrogen users.

www.pensana.co.uk
www.equinor.com ●●●

Record EV sales help boost China's auto market

Auto sales in China last year grew for the first time since 2017, according to industry data published by the China Association of Automobile Manufacturers (CAAM). The increase has been boosted by record electric vehicle sales of some 2.92 million.

Total sales in the world's largest car market rose 3.8% year-on-year, to 26.28 million. The sales of alternative energy vehicles, including battery-powered electric, plug-in hybrids and hydrogen fuel-cell vehicles, showed strong growth of 158% to 3.52 million units in 2021. In December alone, some 531,000 alternative energy vehicles were sold, representing a 114% year-on-year growth.

www.en.caam.org.cn ●●●

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Tekna to consolidate European metal powder production into French facility

Tekna Holding AS, Sherbrooke, Quebec, Canada, has announced plans to consolidate its European metal Additive Manufacturing powder production into one new facility in Pont-de-Veyle, France. In a move hoped to strengthen its supply chain resilience, the company has signed a nine-year lease on the facility.

The 8,000 m² building is designed to hold up to 1,500 tons of powder manufacturing capacity for the production of nickel, aluminium and titanium powders. The facility also allows for further expansion of production capacity and for integrating printed electronics and energy storage activities at a later stage.

The plant is part of Tekna's ten-year business plan – launched in 2021 – to develop and accelerate growth in all three of its powder business segments. This facility enables the company to be closer to its portfolio of European customers, including previously announced and upcoming long-term supply agreements signed with major aerospace OEMs.

"This facility will be the centre-piece of a supply chain that is 100% European-based, ranging from feed-stock procurement to manufacturing of advanced powders, and delivery to point-of-use, with fully traceable, closed-loop material recycling," stated Luc Dionne, CEO. "Tekna's

ambition to enable a green economy through the efficient use of resources and the elimination of waste is taking shape. We are strengthening the company's supply chain resilience, reducing our carbon footprint and enabling the industry to operate in a circular economy."

Between this new facility and the recently announced production facility for the printed electronics segment in Sherbrooke, Tekna will have created space to grow production capacity by approximately 2,500 tons of powder annually.

The lease agreement at the Pont-de-Veyle facility started in January 2022 and comes with the possibility of termination after six months, and subsequently every three years. Tekna has the option to expand the leased area to 33,000 m².

www.tekna.com ●●●

Plansee Group acquires Mi-Tech Tungsten Metals

The Plansee Group, headquartered in Reutte, Austria, has signed a definitive agreement to acquire Mi-Tech Tungsten Metals, Indianapolis, Indiana, USA. Mi-Tech was founded in 1978 and is now considered one of the leading suppliers of tungsten-based products in the country. The company employs nearly 100 people and manufactures high-precision, ready-to-use tungsten composite products and components for a variety of sectors, including energy, engineering and aerospace.

The Plansee Group is buying Mi-Tech through its US subsidiary Global Tungsten & Powders (GTP) which specialises in the production of tungsten powder.

"With the acquisition of Mi-Tech, we are further expanding our market position for tungsten products in North America. Customers will benefit from a broader range of products and services in the future," stated Karlheinz Wex, spokesman for the Plansee Group Executive Board. "Mi-Tech will

benefit from the fact that GTP, as a leading Western supplier, guarantees security of supply for tungsten powders."

Mi-Tech's headquarters house its corporate office (including customer service), production facilities and quality control. In addition to Powder Metallurgy manufacturing, the company has grinding, turning and milling capabilities.

The companies have agreed not to disclose the financial details of the transaction. The acquisition is still subject to regulatory approvals.

www.plansee.com
www.mttm.com ●●●

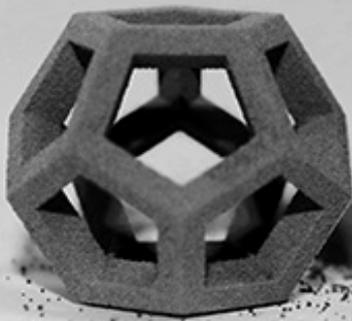
Jiangxi Yuean plans expansion of Carbonyl Iron Powder production

Jiangxi Yuean Advanced Materials Co Ltd, Ganzhou City, China, has begun construction of a new Carbonyl Iron Powder (CIP) production line. The new CIP unit will have a production capacity of 6,000 metric tonnes per year, and is expected to be online by the end of 2022.

The company, which became publicly listed in August 2021, currently has eight water atomised production lines and ten gas atomised lines. Upon completion of the new CIP plant, the company will have a total CIP production capacity of over 10,000 tonnes per year.

CIP is a high-purity iron powder, often selected for the uniformity of its particles, good electromagnetic performance and flowability, and its resulting high-quality end-use parts. Jiangxi Yuean supplies its CIP to a variety of fields, including Metal Injection Moulding and Powder Metallurgy and Diamond Tools.

www.yueanmetal.com ●●●



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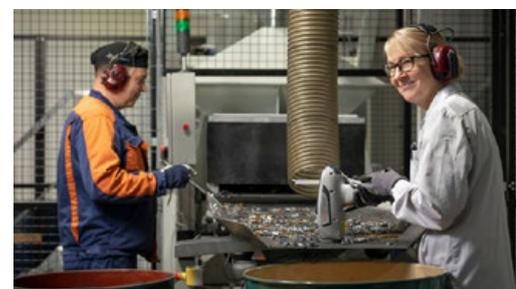
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New China Rare-Earths Group will become world's second-largest rare earths producer

In an effort to strengthen its rare earth element production, the China Rare-Earths Group has formed from the rare earth segments of government owned China Minmetals Corp, Aluminium Corp of China, and Ganzhou Rare Earth Group Co. Chinese state broadcaster CCTV reported that this conglomerate is intended to allow for the better allocation of resources, greener development and hastening mine development in southern China.

Based on issued quotas for the first half 2021, the merged company is in line to be the world's second-largest rare earths producer – in terms of output – after China Northern Rare Earth Group, accounting for around 70% of the country's heavy rare earths production.

Patricia Mohr, independent economist, told The Northern Miner, "The merged company will increase the control over prices in the international market place and could lead to even higher prices in the coming year."

As an example, Mohr noted that the price of neodymium oxide (99% China FOB), for instance, hit \$142,300 per tonne on December 8, a 79% year-on-year increase, and the highest level since May 2012. In mid December, terbium oxide (99.9% FOB China) reached \$1,730 per kilogram (up 68% from 2020), while dysprosium oxide (99% FOB China) has reached \$456 per kilogram (up 57% year-on-year).

"It's great for the business in the sense that I think the West is increasingly realising that there needs to be an integrated localised supply chain," Jim Litinsky, CEO of MP Materials, told Bloomberg. MP Materials is noted as the only US producer of rare earths.

www.minmetalsland.com

www.chalco.cm.cn | www.jxgqd.com ●●●

JSPMIC2022 issues call for papers

The Japan Society of Powder and Powder Metallurgy (JSPM) has announced the International Conference on Powder and Powder Metallurgy, 2022, Kyoto (JSPMIC2022), is scheduled to take place at the Doshisha University, Kanbaikan, Kyoto, Japan, from November 13–15. It has also issued a call for papers for the event.

Last held in 2017, JSPMIC2022 offers the opportunity for scientific presentations and to increase communications among researchers, both in academic and industrial sectors. Technical sessions will cover the entire range of Powder Metallurgy topics. The conference will be in English and awards will be given to outstanding presentations. Authors wishing to make a presentation in the technical programme are invited to submit an abstract in English by the deadline of July 22, 2022.

www.jspm.or.jp ●●●

Center for Powder Metallurgy Technology appoints Thomas Pfingstler as president

The Center for Powder Metallurgy Technology (CPMT) has appointed Thomas Pfingstler of Atlas Pressed Metals, DuBois, Pennsylvania, USA, as its president. Pfingstler succeeds Arthur (Bud) Jones of Symmco, Inc., Sykesville, Pennsylvania, who served as CPMT president since 2018.

A longtime member of APMI International and the Metal Powder Industries Federation (MPIF) Standards Committee, Pfingstler received the MPIF Distinguished Service to Powder Metallurgy Award in 2019. He has a comprehensive understanding of PM technology and unique view of part design, production, and business management,

honed over a career spanning nearly forty years. Previous roles have included various management positions in production, quality, engineering and purchasing.

The Center for Powder Metallurgy Technology merges the academic and corporate Powder Metallurgy worlds together with a joint goal to promote PM industry progress. The not-for-profit organisation was created in the early 1980s as an indirect result of a United States Department of Commerce effort to establish a series of 'cooperative technology programmes' involving several specific technologies. Each was selected by the government as being rep-



Thomas Pfingstler is the new president of the Center for Powder Metallurgy Technology (Courtesy MPIF)

representative of growth technologies capable of enhancing the productivity of America's manufacturing community.

www.cpmtweb.org ●●●





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Fluidtherm marks first sale of TMax 1300°C roller hearth sintering furnace

Powder Metallurgy furnace manufacturer Fluidtherm, Chennai, India, has supplied its first TMax 1300°C roller hearth sintering furnace (RHF) to a multi-national manufacturer of PM and Metal Injection Moulding (MIM) parts for the automotive, power tool, appliance, electronic and energy sectors. The TMax 1300°C RHF has a maximum capacity of twenty 600 mm² graphite trays per hour, processing up to 450 kg per hour.

"Apart from inherent advantages of high temperature sintering, such as superior mechanical properties, improved pore morphology, better diffusion of alloying elements such as in micro-alloyed parts, Fluidtherm provides its customers the features of in-line carbon restoration and a door enclosed CFD designed rapid gas cooling unit, with a high heat extraction capability," stated N Gopinath, Managing Director of Fluidtherm.

The furnace, especially suitable for large, heavy parts, incorporates atmosphere lock doors at both

ends for high atmosphere integrity, a Level 2.0 SCADA (supervisory control & data acquisition) control system. The furnace conforms to ATEX (European directives for controlling explosive atmospheres) and NFPA (the US National Fire Protection Association) directives, and is equipped with features that allow the user to comply with the clauses of AMS 2750D.



The TMax has a max capacity of twenty 600 mm² graphite trays per hour (Courtesy Fluidtherm)

In the course of developing the RHF for TMax 1300°C, the company noted that the RHF design can be easily be applied to a max temperature of 1180°C and thus become an alternative to mesh belt furnaces. While the high temperature capability would be absent from the TMax 1180°C version, the other benefits of RHF, such as low gas consumption, higher atmosphere integrity, higher cooling rates and lower manufacturing cost will be available along with the elimination of mesh belt purchases and saving of the energy required to heat the belt.

www.fluidtherm.com ●●●

VDM Metals adds Powder 59 material for demanding applications

VDM Metals GmbH, Werdohl, Germany, has announced VDM® Powder 59 as the latest addition to the Alloy 59 product line. Alloy 59 is one of the most frequently used nickel alloys for demanding applications in corrosive environments. In recent years, the fields of application of the alloy grew steadily, as new processes have been developed in the chemical and petrochemical industries. VDM Powder 59 has particularly low concentrations of carbon and silicon and is characterised by excellent corrosion resistance.

"All elements of analysis are within the standard chemical composition of Alloy 59," Dr Christina Schmidt, Head of Powder Production, Research and Development, at VDM Metals, ex-

plained. "The material is versatile in use in many chemical processes with oxidising and reducing media. Furthermore, this alloy is more resilient against localised attack in chloride containing media due to its high nickel, chromium and molybdenum concentrations."

"Additionally, based on a balanced chemical composition with a focus on workability, the powder shows excellent printing properties, which makes it possible to realize very complicated geometries without running into risks of crack formation," she continued. "First results of different corrosion tests show comparable results of printed parts with conventionally produced material."

Alloy 59 was initially developed for use in chemical processes and environmental technologies due to this material being able to work in the aggressive areas where nickel alloys of the so-called C series (for example well-known Alloy C-276) differentiate from a large number of commercial nickel alloys, that are not resistant against prevailing conditions. The C series alloys typically exhibit the contents of 55 to 66 wt.% nickel, 16 to 23 wt.% chromium and 13 to 19 wt.% molybdenum. The high content of molybdenum gives them excellent corrosion resistance under reducing corrosive conditions and the high chromium content in oxidising media. Additions of tungsten may have an additional positive effect on the corrosion resistance, but they also impair the thermal stability.

www.vdm-metals.com ●●●

New US magnet factory to supply GM's electric vehicle production

General Motors has announced that Vacuumschmelze GmbH & Co. KG (VAC), a producer of advanced magnetic materials and rare earth permanent magnets headquartered in Hanau, Germany, is to build a new plant in the US to manufacture permanent magnets for the electric motors used in GM's Ultium Platform for its electric vehicles. It was added that the new plant aims to use locally sourced raw materials.

"We are building a resilient and sustainable EV manufacturing value chain in North America from raw materials to components to drive GM's growth and support a mass market for EVs," stated Shilpan Amin, GM's vice president, Global Purchasing and Supply Chain. "Our work with VAC is another bold step forward that will help ensure that we meet our goal to

lead the EV industry in North America in more than just sales."

VAC is a leading global producer of advanced magnetic materials and reportedly the largest producer of permanent magnets in the Western Hemisphere, with nearly 100 years of experience.

Dr Erik Eschen, CEO of VAC, added, "We are thrilled to join forces with GM on this journey into an increasingly electrified world, leveraging sustainable clean energy solutions. As VAC's Permanent Magnet Division is the only industrial-scale producer of rare earth permanent magnets in the Western Hemisphere, VAC brings reliable scale and experience to GM's supply chain. VAC's deep magnetic materials knowledge and extensive e-mobility technology expertise, in partnership



Vacuumschmelze is reportedly the largest producer of permanent magnets in the Western Hemisphere (Courtesy Vacuumschmelze)

with GM, will enable a cleaner global future for our communities."

A non-binding Memorandum of Understanding (MoU) has been completed and both companies expect to finalise definitive agreements in early 2022. The location of the facility will be announced at a later date, with production expected to begin in 2024.

www.vacuumschmelze.com
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GKN Automotive opens Advanced Research Centre for electric drive

GKN Automotive has announced a new £3.5 million Advanced Research Centre to develop next-generation electric drive technology and increase engineering capability to meet its Net Zero commitment. The company is also partnering with the University of Nottingham and Newcastle University to focus on the development of ultra-high-efficiency electric drive units (EDUs) for future electric vehicles.

“GKN Automotive is a pioneer of advanced eDrive development and this new research partnership will play a key role in strengthening the innovation of electrification technologies for future advanced propulsion systems,” stated Gordon Day, Managing Director, GKN Automotive Innovation Centre. “We are extremely proud that this research will be in partnership with Newcastle University and the University of Nottingham, two renowned and respected global leaders in automotive electrification engineering research. Both institutions will also play a leading role in helping us develop a supply of high-calibre engineering talent, which is essential to enable us to put the UK at the forefront of global automotive industry innovation.”

Both universities are part of the Advanced Propulsion Centre (APC), an initiative that brings together specialist academic, technological, and commercial knowledge from across the UK to share best practice for the development of low-emission propulsion technologies. The University of Nottingham is the APC’s ‘spoke’ for power electronics, and home to the Driving the Electric Revolution (DER) Industrialisation Centre – Midlands. Newcastle University is the organisation’s ‘spoke’ for electric motors, and leads the national network of four DER Industrialisation Centres, including the Driving the Electric Revolution Industrialisation Centre – North East.

GKN Automotive has been supported, in part, by the £10 million Melrose Skills Fund. The fund is allocated over five years across the UK; the first phase of investment saw the launch of the Skills Development Programme at the Abingdon Innovation Centre, which aims to support the development of engineering skills through STEM engagement, apprenticeships, training opportunities and internal staff upskilling. This next phase will focus on Research.

The planned research is expected to not only spearhead the development of disruptive technology innovations in eDrives, but support the UK’s technology roadmap set out by the APC. It also further strengthens GKN Automotive’s collaborative links within the UK Innovation Network.

www.gknautomotive.com
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Höganäs and Piab partner to minimise metal powder waste

Sweden's Höganäs AB and Piab AB have formed a partnership to leverage their respective areas of expertise with the goal of advancing automation in Additive Manufacturing, aiming to increase the sustainability and efficiency of the process. Together, they are developing new solutions said to minimise metal powder waste while improving process efficiency and safety.

In many industrial AM applications, manual handling and loading

of materials are still common practice. Piab and Höganäs are working together to introduce a new range of solutions that will enable customers to implement improved automation and optimised AM processes in order to save time, reduce waste, improve efficiency and secure a safer working environment.

Conveying metal powders poses specific challenges, such as the high bulk density and other material characteristics. Höganäs has extensive knowledge of metal powders

and material containment solutions, which will be combined with Piab's existing products, such as the piFLOW® range of vacuum conveying solutions, to optimise both material handling processes and to develop new industrial-scale solutions. This also contributes to a higher level of operator safety.

Today, the partners are offering bespoke solutions for metal powder management which are based on existing piFLOW technology. These solutions are machine agnostic and can be used in multiple applications during the build process, including filling the build chamber with virgin or reclaimed metal powder, filling the sieve or hopper, or reclaiming the excess metal powder for reuse.

The goal of the new common development project is to make the conveying of bulk metal powders even safer and easier, and to ensure that excess powder can be reused immediately, which reduces waste and helps to improve sustainability. This means that not only is waste disposal reduced, but also the amount of powder used is maximised, allowing manufacturers to make more with less. This new line of standardised technology will help further industrialise AM production and facilitate large scale manufacturing and Industry 4.0 plans.

www.piab.com

www.hoganas.com ●●●



Staff from Höganäs and Piab will look to minimise metal powder waste while improving process efficiency and safety (Courtesy Höganäs/Piab)

Equispheres appoints Calvin Osborne its Chief Operating Officer

Equispheres, Ottawa, Ontario, Canada, has appointed Calvin Osborne as its new Chief Operating Officer in an effort to streamline the company's next phase of production at its Ottawa manufacturing facility. In this role, Osborne will leverage his technical skills and business acumen to help with the scaling and full commercialisation of Equispheres' metal powder technology.

Osborne is an established product development and

manufacturing executive with experience supporting research and development teams and applying Lean Six Sigma methodologies. He was previously Assistant Director of Engineering for the solar business of Schneider Electric and Vice-President Engineering for Andronic. As Director of the Kodak Operating System, he oversaw the product commercialisation process for Kodak Graphic Communication Group Canada. He is a professional engineer and holds patents for a

number of medical devices.

"We are entering an exciting phase of our growth, with inflecting market demand coinciding with our business scale-up plans," stated Kevin Nicholds, Chief Executive Officer, Equispheres. "As our output rises to meet global demand, Calvin is the right person to manage that process."

"To our new partners and potential collaborators, we can say 'We are ready.' Ready to scale up and provide the material that will fuel the growth of metal Additive Manufacturing," concluded Nicholds.

www.equispheres.com ●●●

Pensana joins UN initiative to support sustainable rare earths

Pensana Plc, a rare earth metals company headquartered in London, UK, has become a signatory to the United Nations Global Compact, an initiative to encourage CEOs to implement sustainable principles and take steps to support the UN sustainable development goals. The company is in the initial stages of establishing a sustainable magnet metal supply chain to meet demand from the electric vehicles and offshore wind industries.

Pensana joins over 13,000 other businesses committing to uphold the compact's ten principles across human rights, labour, environment and anti-corruption. This commitment follows Pensana's decision to become a partner of the Taskforce for Climate-related Financial Disclosure (TCFD). Chaired by Michael Bloomberg, the TCFD provides a framework for transparency on how businesses are responding to the climate crisis across the areas of governance, strategy, risk management and metrics and targets.

Tim George, Pensana's CEO, commented, "Joining both the United Nations Global Compact and becoming a partner of the Taskforce for Climate-related Financial Disclosure demonstrates our clear intent to develop a world class sustainable supply chain for rare earths. Both the UN Global compact and the TCFD provide externally recognised frameworks to report our progress."

Pensana plans to establish its Saltend site as an independent, sustainable supplier of the key magnet metal oxides to a market which is currently dominated by China. The \$190 million Saltend facility is being designed to produce around 12,500 tonnes per annum of rare earth oxides, of which 4,500 tonnes will be neodymium and praseodymium (NdPr), representing over 5% of the world market in 2025.

www.pensana.co.uk ●●●

PMTi2022 issues call for presentations

The Metal Powder Industries Federation (MPIF) has announced a call for presentations for PMTi2022: Powder Metallurgy and Additive Manufacturing of Titanium. The event is scheduled to take place from August 29-31, 2022, and will be held, for the first time, in Canada.

Topics to be covered by the conference include: powder production; compaction and shaping; Metal Injection Moulding; Additive Manufacturing; sintering; mechanical properties; microstructure vs property relationships; PM Ti alloys including TiAl; PM Bio Ti materials; modelling and applications.

The abstract submission deadline is April 1. Submissions can be made via the MPIF website.

www.PMTi2022.org ●●●



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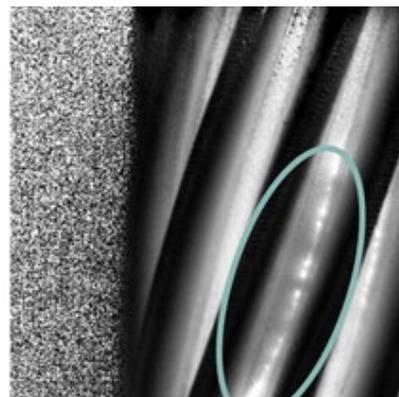
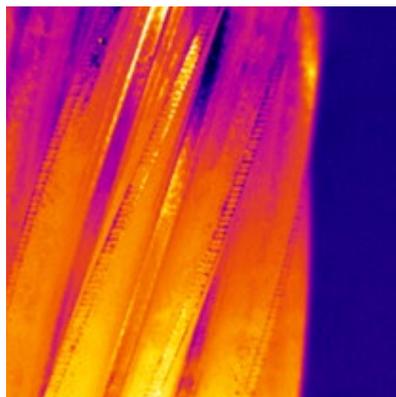
Foerster offers new induction thermography part testing

Foerster Group, headquartered in Reutlingen, Germany, has introduced a new, non-destructive automatable solution for testing sintered components using induction thermography. The technique allows for contact-free crack detection on metal components and is particularly suited to parts with complicated shapes where test areas can be difficult or impossible to access with eddy current probes.

The process is reported to identify open cracks, pores, heat treatment cracks, forging laps, welding defects, etc. It can be used on rough, uneven surfaces and surfaces coated with water or oil, with testing done in less than one second.

The induction thermography method is suitable for the examination of semi-finished products as well as complexly shaped components. A current induced into the workpiece generates localised hotspots at the defects in the material. These hotspots can be detected through their heat radiation with an infrared camera.

A typical system consists of an infrared camera and an inductor, with a generator for high-power pulses. The inductor is positioned such that a magnetic field pulse induces currents in the test area, heating the part by a few degrees Celsius. Simultaneously the camera is recording the area. The camera



Comparison of a pinion in infrared (left) and with induction thermography (right), where a crack is visible in the gear root (Courtesy Foerster Group)

captures the heat radiation, which is emitted as infrared light, and creates a temperature image of the surface.

If there are defects (cracks) in the test area, the induced current is deviated and is locally displaced or squeezed. Consequently, those locations in the part are heated more strongly. When such hotspots form directly at the surface, they emit heat radiation and are visible to the camera. The heat from hotspots within the material can also reach the surface through the heat conduction of the material. However, the range into the material is limited by the penetration depth of the induction.

The thermal recordings are analysed with video and image processing algorithms. On a thermography recording, the hotspots leave a crack signature similar to a string of pearls. In contrast, other surface features, such as roughness and scratches, are suppressed. This way cracks can be detected that would be difficult or impossible to distinguish in a conventional photo.

The high contrast and characteristic shape of cracks in induction thermography images allows for reliable algorithmic detection and enables the full automation of the procedure.

Induction thermography is said to offer a particular advantage on components that have special structural properties, such as threading, gearing, blades or profiles. Suitable parts include those that are forged, sintered and additively manufactured.

www.foerstergroup.com ●●●



Creases on the parts are particularly prone to crack. Such defects are accessible with thermography. However, very deep creases may also pose a challenge for this method (Courtesy Foerster Group)

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Sandvik acquires Dimensional Control Systems to enhance its metrology offering

Sandvik AB, Stockholm, Sweden, has acquired Dimensional Control Systems (DCS), headquartered in Troy, Michigan, USA, a provider of dimensional quality management software and on-site engineering services. DCS's offering is expected to complement and enhance Sandvik's existing portfolio within metrology. The company will be reported in the Industrial Metrology division within the Sandvik Manufacturing and Machining Solutions business area.

"This acquisition is in line with our strategic focus to grow in the digital manufacturing space, with special attention on industrial software close to component manufacturing," stated

Stefan Widing, president and CEO of Sandvik. "Dimensional Control System's offering, in combination with our extensive manufacturing know-how, will enhance Sandvik's overall digital offering – and specifically our industrial metrology solutions."

DCS's software solutions include CAD simulation tools, enabling customers to improve and validate their component design and metrology measurement plan – resulting in reduced scrap, rework, downtime and non-conformance issues. The company has more than 400 software customers in automotive, aerospace, high-tech electronics, medical devices and industrial machinery manufacturing – with 10,000 licenses in total. Software revenues represent 65% of total sales, of which 40% are recurring revenues.

Christophe Sut, president of Sandvik Manufacturing Solutions, commented, "Dimensional Control Systems' software suites have strong underlying growth and will further

strengthen our end-to-end metrology solutions by adding three-dimensional analysis and quality assurance capabilities, as well as deep geometric dimensioning and tolerancing expertise. This will significantly improve quality and productivity for our customers, enabling more sustainable manufacturing. I would like to welcome the DCS team to Sandvik."

DCS has a global network of distributors and resellers. In 2020, the company had approximately seventy employees, revenues of about SEK 92 million (\$10 million) and an EBITA margin neutral to Sandvik Manufacturing and Machining Solutions. DCS's software business has had a historical annual growth rate of approximately 10% – and is expected to grow at a similar pace going forward. Impact on Sandvik's earnings per share will initially be neutral. The parties have agreed not to disclose the purchase price.

www.home.sandvik/en
www.3dcs.com ●●●

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Carpenter Technology appoints Dr Suniti Moudgil as new CTO

Carpenter Technology Corporation, Philadelphia, Pennsylvania, USA, has appointed Dr Suniti Moudgil as its new Chief Technology Officer, effective December 6, 2021. As Chief Technology Officer, Dr Moudgil will be responsible for leading the company's technology strategy and research and development organisation, as well as overseeing its intellectual property portfolio.

"With R&D expertise and a breadth of experience in technology, marketing and sales, and operations, Suniti successfully leverages cross-functional capabilities to deliver business results," stated Tony R Thene, president and CEO. "Suniti's customer focus and demonstrated ability to strategically align R&D with commercial targets positions Carpenter Technology to maintain a robust pipeline and continue to deliver innovative and value-driven R&D investments."

Prior to joining Carpenter Technology, Dr Moudgil was Global Technology Leader in DuPont's Electronics and Industrial business unit, where she led the technology strategy and R&D organisation for several product lines in the portfolio, focusing investments on markets and technologies with the greatest potential to deliver sustainable competitive advantage and revenue growth. Prior to this role, Dr Moudgil held positions at DuPont spanning R&D, product strategy, marketing and operations.

Dr Moudgil holds a PhD in Chemical Engineering from the Massachusetts Institute of Technology (MIT), with a minor in Health Sciences and Technology. She also earned her Executive Education Certification from UC Berkeley Haas School of Business on Leading Innovative Change, and is Six Sigma Black Belt certified.

www.carpentertechnology.com

MPIF launches PowderMet and AMPM retrospective webinar

The Metal Powders Industries Federation (MPIF) has announced a new webinar series featuring key presentations from the PowderMet2021 and AMPM2021 conferences. Beginning January, and carrying on through December, two presentations from the confer-

ences will be available to view on the fourth Thursday of each month.

The presentations are complimentary to all MPIF member company employees. Non-MPIF members can purchase the series, or parts of the series, for a nominal fee.

www.mpif.org

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Max. output voltage [V]	14
Pulse duration [ms]	0.8 - 500
Temperature measurements [°C]	0 - 2500
Vacuum [mbar]	10 ⁻² - 10 ⁻⁶
Maximum pressing force [kN]	350
Max. sintered components [mm]	∅ 85
Max. diameter of graphite die [mm]	200
Additional pause [ms]	0 - 999
Number of pulses	1 - 500



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PM plates used for thermal protection in fusion energy project

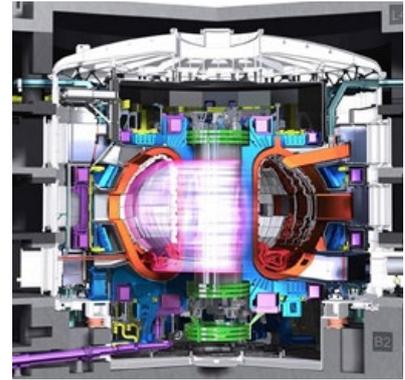
The International Experimental Thermonuclear Reactor (ITER) in Saint-Paul-lez-Durance, France, is a multi-nation project to prove the viability of fusion reaction as an energy source. Thousands of engineers and scientists from across Europe, the United States, China, Russia, India, South Korea and Japan, have contributed to the design of ITER since the idea for an international joint experiment in fusion was first launched in 1985.

Central to the ITER is the tokamak, a device that confines plasma, using powerful magnetic fields, in a doughnut shape known as a torus. The heat from the plasma is then used to produce steam, which in turn powers turbines that produce electricity. For the project, the team are building

the world's largest tokamak, expected to be twice the size of the largest machine currently in operation, with ten times the plasma chamber volume.

First developed by researchers in the late 1960s, the tokamak has been adopted around the world as the most promising configuration of a magnetic fusion device. A key element of the tokamak is the thermal protection in the divertors, components that are designed to maintain the purity of the plasma. To provide the required properties, Powder Metallurgy has been used to produce bimetallic tungsten-copper plates, forming part of the central assembly of the divertor.

Around 5000 of these plates have so far been produced at Polema JSC, a division of Industrial Metal-

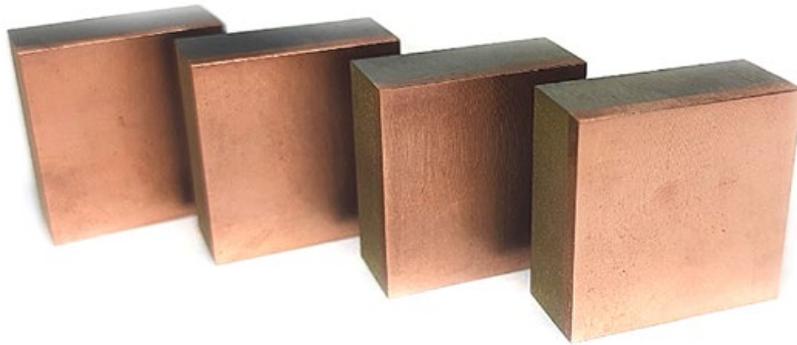


Inside the proposed tokamak, under the influence of extreme heat and pressure, gaseous hydrogen fuel becomes a plasma. The charged particles of the plasma can be shaped and controlled by the massive magnetic coils placed around the vessel (Courtesy ITER)

urgical Holding, headquartered in Moscow, Russia. A prototype divertor was then manufactured at DV Efremov Institute of Electrophysical Apparatus (NIIIEFA) in St Petersburg, and shipped to France in December 2021.

"Controlled thermonuclear fusion is the technology of the future. It is expected that the first industrial thermonuclear power plants won't appear till the middle of the 21st century," explained Aleksei Filippov, Managing Director of Polema. "Participation in such a project is a huge responsibility, but also an indicator of the technological capabilities of our enterprise. Shipment of another 10,000 plates for this project is planned for 2022."

www.iter.org ●●●



W-Co plates are expected to be key to the international experimental Thermonuclear Reactor's divertors (Courtesy Polema)

Registration opens for PowderMet2022 conference and exhibition

Registration is now open for PowderMet2022: International Conference on Powder Metallurgy & Particulate Materials and the co-located AMPM2022: Additive Manufacturing with Powder Metallurgy Conference. Organised by the Metal Powder Industries Federation

(MPIF), the events are scheduled to take place in Portland, Oregon, USA, from June 12–15, 2022.

The event will feature over 200 technical presentations from worldwide industry experts presenting on Powder Metallurgy, particulate materials and metal

Additive Manufacturing. In addition to the conference, there will be a tradeshow with over 100 booths. This marketplace will present leading companies featuring the latest PM and metal AM equipment, powders, products, and services.

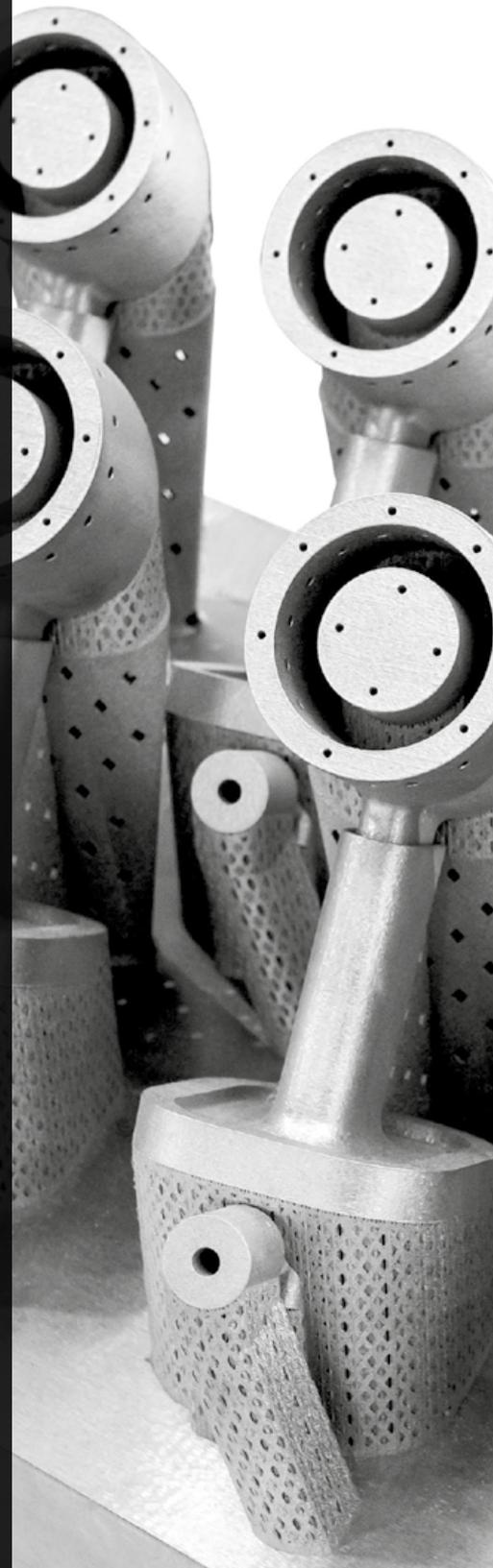
Further programme details and registration is available via the event website.

www.powdermet2022.org ●●●

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Positive 2022 outlook for cutting tools market

In January 2022, Markus Horn, European Cutting Tools Association (ECTA) president, gave a press conference on the economic situation for European cutting tools manufacturers, sharing a positive outlook for the coming year and stressing the need for an expansion of green energy incentives.

The European tooling industry as a whole reportedly increased international deliveries of tools by approximately 20%; 60% of all deliveries were within EU countries. Deliveries to the regions impacted by Brexit increased by only 10%. For ECTA member countries, the top non-EU purchaser, the USA, grew 25%; China, however, only saw a 9% increase.

“The economic situation in the ECTA member countries has recov-

ered, to some extent, over the year until now, albeit with varying degrees of momentum. Despite supply chain issues and the pandemic, toolmakers are mostly optimistic about the future,” Horn stated.

Markets in ECTA countries

Horn considered the situations in Italy and Germany are similar due to the slowing of car production. Thanks to quick capital goods write-offs in Italy, however, investment was supported and the tool business performed well.

Spain recorded a strong recovery, particularly in the first half of 2021. The semiconductor shortage and rising electricity costs, however, saw production stagnate, particularly that of the automotive industry.

Switzerland is said to be seeing the strongest development within the ECTA group, with nearly all industries reporting an increased tooling demand.

In France, the aerospace industry is slowly reviving. Production in the French automotive industry was said to be stable.

In the UK, homemade logistics problems were thought to have dampened the recovery of the manufacturing industry. Here, car production was also substantially lower than a year earlier.

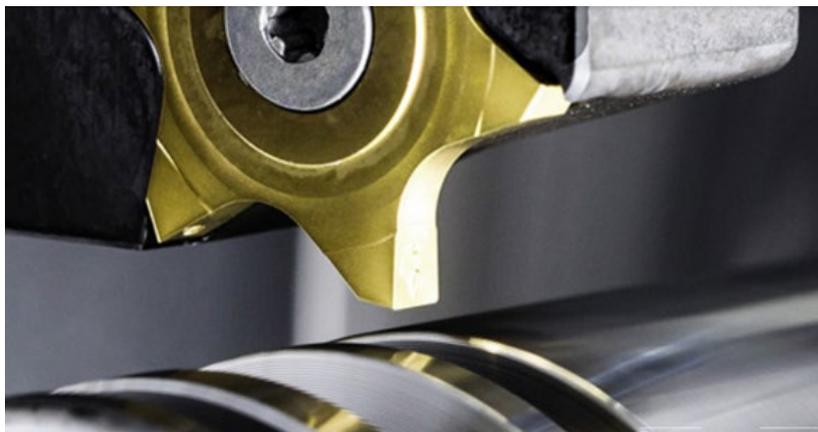
The importance of industry events

One issue faced by the industry as a whole, Horn stressed, was the relative lack, or scaled-down nature, of events and trade shows due to COVID-related regulations. The following events were noted as being particularly important to the industry:

- AMB Stuttgart: The International Exhibition for Metal Working – September 13–17 (Germany)
- IMTS (International Manufacturing Technology Show) 2022 – September 12–17 (Chicago, Illinois, USA)
- JIMTOF (Japan International Machine Tool Fair) 2022 – November 8–13 (Tokyo)

Horn also invited industry members to join the recently re-scheduled ECTA conference. This will now take place June 30–July 2, in Rüslikon, Switzerland, at the invitation of member association SwissMem.

www.ecta-tools.org ●●●



The ECTA reports a positive outlook for the cutting tools market in 2022 (Courtesy ECTA)

Registration open for 20th Plansee Seminar

The Plansee Group has opened registration for its 20th Plansee Seminar, the International Conference on Refractory Metals and Hard Materials. The event will take place May 30–June 3, 2022, at the Group’s headquarters in Reutte, Austria.

Plansee has stressed that the seminar will follow all COVID-related regulations made by the EU and/or

the Austrian government which may be in place at the above dates.

The technical programme will cover the following topics, addressed in key-note lectures, technical sessions and poster presentations:

Refractory metals and composites

- Applications
- Materials

- Powder
- PM processes
- Simulation and modelling
- Characterisation and testing

PM hard materials

- Applications
- Materials
- Powders and PM processes
- Surface Engineering
- Simulation and modelling
- Characterisation and testing

www.plansee-seminar.com ●●●

Höganäs joins the Science Based Targets initiative

Sweden's Höganäs AB has committed to the Science Based Targets initiative (SBTi), which is intended to help create transparency and accountability in the company's target to reduce greenhouse gas emissions to net-zero by 2045 and become the first green metal powder producer.

The near-term target is a 50% reduction of the emissions in Scope 1 and 2 by 2030; the target for Scope 3 is a 30% reduction of emissions from raw materials by 2030. In an effort to achieve these targets, Höganäs is focusing on improving energy efficiency, transitioning to the use of fossil free energy in production and transport, replacing fossil process coals, and rethinking its materials supply. The ongoing initiatives include a plan to complete the prepara-

tion work for the transition to 100% fossil-free electricity from 2023, and to achieve a 40% reduction of emissions from fossil fuels by 2026.

"The commitment to the Science Based Targets initiative is the right way to go in our journey towards becoming the first green metal powder producer in the world and to set the benchmark within our industry," stated Fredrik Emilson, CEO. "Our climate ambition will be better showcased and our commitment and progress more transparent to all stakeholders. A way to demonstrate our accountability, if you will."

Committing to the SBTi is the first step in a process that takes several months. In the next stage, Höganäs will specify its climate targets further and then submit to the SBTi for official validation.

SBTi is a partnership between the Carbon Disclosure Project (CDP), UN Global Compact, World Resources Institute (WRI) and World Wide Fund for Nature (WWF).



Höganäs has joined the Science Based Targets initiative, which supports companies establishing reduction targets (Courtesy Virginie Willet)

The initiative supports companies in establishing scientifically based emission reduction targets.

"Being the sustainability leader will secure our competitive edge and we will be operating with the lowest emission footprint in our industry," continued Emilson. "Through this, we support our customers in fulfilling their respective ambitions to become more sustainable."

www.hoganas.com ●●●





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Hyperion to pursue US listing and name change to IperionX Limited

Hyperion Metals, Charlotte, North Carolina, USA, reports that it intends to file a registration statement on Form 20-F to register its ordinary shares with the United States Securities and Exchange Commission (SEC), subject to review. A Form 20-F, once declared effective by the SEC, allows certain non-US issuers to register securities with the SEC pursuant to applicable US securities laws. If approved, the company's registration of ordinary shares would allow American depository shares representing ordinary shares of the company to be listed on a national securities exchange in the US.

A listing on a national securities exchange in the US is expected to enhance the visibility and accessibility of Hyperion to the US market of retail and institutional investors and enable new and existing US investors to trade Hyperion's American depository shares in US dollars and during normal US trading hours.

As a result of Hyperion's proposed US listing, the company will seek shareholder approval to change its name to IperionX Limited. This name change is said to be the result of a potential conflict in the US with the company's existing

name that has been recently identified. A notice of general meeting will be sent to shareholders shortly.

Anastasios Arima, Chief Executive Officer and Managing Director, stated, "The proposed listing is expected to create greater awareness of our US-focused critical minerals and metals technologies in the United States, providing exposure to enormous investor demand in a market which has a deep understanding for advanced technologies that support global decarbonisation efforts, such as Hyperion's low carbon titanium metal technologies. We believe that access to a much larger pool of capital will provide the potential for increased liquidity and enhanced value for our shareholders."

www.hyperionmetals.us ●●●

Kymera expands tantalum and niobium materials with Telex acquisition

Kymera International, headquartered in Raleigh, North Carolina, USA, has closed its purchase of Telex Metals, Croydon, Pennsylvania, acquiring 100% of the shares. The terms of the transaction were not disclosed.

Telex is a global supplier of tantalum, tungsten and niobium particulates. The company converts raw materials containing tantalum into high-purity products that are supplied to a variety of markets with demanding specifications.

"Partnering with Kymera will allow Telex to propel our growth initiatives to the next level," stated Matt Danish, CEO of Telex. "We are excited to be joining Barton and the Kymera team and anticipate this to be mutually beneficial to our business and key customers."

"Telex is an outstanding company with an excellent product and end-market portfolio that fits in perfectly with our existing business," added Barton White, CEO of Kymera. "Matt

Danish has assembled a highly talented group of individuals in a truly entrepreneurial environment. We love Telex's dedication to ESG initiatives, including being a zero-discharge facility and we will strive to help Matt and Telex accelerate their growth trajectory."

Kymera has been owned by affiliates of Palladium Equity Partners, LLC, a middle-market private equity firm with approximately \$3 billion in assets under management, since 2018. This is the fourth acquisition for Kymera under Palladium's ownership.

www.kymerainternational.com ●●●

Carpenter Technology makes changes to its leadership team

Carpenter Technology Corporation, Philadelphia, Pennsylvania, USA, has made changes to its leadership team which see Brian Malloy named as senior vice president and group president of Carpenter Technology's Performance Engineered Products (PEP) segment, and Marshall Akins promoted to vice president and Chief Commercial Officer.

In his new role, Malloy will lead the PEP portfolio of businesses (Carpenter Additive, Dynamet Inc. and

Carpenter Distribution) and related services. He will be responsible for leading PEP's safety performance, driving growth, ensuring operational performance and enabling commercial excellence. In addition to the leadership of the PEP segment, he will also lead the company's marketing organisation and electrification efforts. Malloy assumed interim leadership of the PEP business segment in July 2021, while serving as senior vice president and Chief Commercial

Officer, the role he held since August of 2020.

Akins will oversee the company's commercial operations and execution of key commercial growth strategies. This includes commercial strategy, market development, and sales and customer support across Carpenter Technology. He will also join the company's executive leadership team. Akins joined Carpenter Technology in 2016 as vice president – aerospace, where he led the company's aerospace and defence market. Prior to joining Carpenter Technology, Akins worked for the Boston Consulting Group.

www.carpentertechnology.com ●●●

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Short course on Atomisation for Metal Powders to return in October

After a thirty-month COVID-induced delay, UK-based Atomising Systems Ltd and CPF Research Ltd have announced the return of the popular short course Atomisation for Metal Powders. The event is scheduled for October 6-7, 2022, in Manchester, UK.

The two-day course will consist of presentations from Atomising Systems' John Dunkley, Chairman; Dirk Aderhold, Technical Director and Tom Williamson, Research & Development Manager, as well as Andrew Yule, Emeritus Professor at the University of Manchester.

The course combines up-to-date practical information with theory and is expected to be of value to engineers working in both metal powder production and R&D. In line with the interests of many participants, the organisers have expanded the event's coverage of powder manufacture and properties for Additive Manufacturing.

www.atomising.co.uk
www.cpfresearch.com ●●●

Fredrik Spens named president of Gränges Europe

Aluminium technology company Gränges, headquartered in Stockholm, Sweden, has announced that Fredrik Spens will assume the role of president for Gränges Europe effective March 1, 2022. He will succeed Jörgen Rosengren, who has held the position on an interim basis. Spens will also become a member of the Group Management Team of Gränges.

Gränges is a global supplier of rolled aluminium products for heat exchanger applications and other niche markets. The company recently established a Powder Metallurgy business unit as part of its aim is to become a leader in the manufacture of custom Additive Manufacturing-grade aluminium powders for a range of applications.

"I am delighted to be able to welcome Fredrik as our new president for Gränges Europe," stated Jörgen Rosengren, Gränges president and Chief Executive Officer. "His broad industrial background and experience from a variety of senior general management roles speak for themselves. He is also a very well-liked leader and respected colleague in our group, who embodies the Gränges values by being committed and action oriented."

www.granges.com ●●●

SAS Sinterizzati obtains IATF certification

SAS Sinterizzati SRL, Bolognese, Italy, has obtained certification from the International Automotive Task Force (IATF) for the production of sintered parts, verified by quality assurance and certification company RINA SpA.

This follows on from the company's certification in quality assurance for the production of sintered components, specifically the production, assembly & trade of pneumatic accessories, by the International Certification Network (IQNET).

Established in 1978, SAS Sinterizzati exports its products to over seventy countries. Currently, the company manufactures the following sintered components: sintered bronze and stainless steel; cams and levers; pistons for shock absorbers; lobe and gear pumps; components for locks; gears and components for the automotive industry.

www.sassinterizzati.com ●●●



A selection of sintered parts produced by SAS Sinterizzati (Courtesy SAS Sinterizzati)

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Jeol's new electron microscope offers built in automation and live elemental and 3D analysis

Jeol USA Inc, headquartered in Peabody, Massachusetts, USA, a wholly-owned subsidiary of Jeol Ltd. Japan, has introduced its JSM-IT510, a new scanning electron microscope (SEM) featuring automated imaging, automated montaging (both image and EDS map) and live EDS analysis (spectrum and map).

The IT510 is the successor to the popular Jeol IT500 InTouchScope SEM, with its large sample chamber and tungsten or LaB₆ filament. The IT510 features Jeol Intelligent Technology that is reported to enable seamless navigation from optical to SEM imaging, Live EDS

and 3D analysis, and auto functions from alignment to focus for fast, clear, and sharp images.

A new Simple SEM function automates image collection at multiple locations on a sample, and sets the various conditions required, including magnification and settings. Simple SEM is said to simplify and automate workflows for routine tasks.

The new Live 3D function constructs 3D images of the sample surface during observation, showing surface shape and depth information in real time. A Signal Depth automated function calculates the X-ray generation depth to support understanding of the analytical spatial resolution within a specimen under the conditions set. Useful when conducting elemental analysis.

A new Low-vacuum Hybrid Secondary Electron Detector collects both electron and photon signals, providing an image

with high S/N and enhanced topographic information. This detector also supports photon imaging with specimens that give a cathodoluminescence response.

Live Mapping displays the elemental map simultaneously with SEM imaging, made possible by a new Integrated SEM and Energy Dispersive X-ray Spectrometer (EDS) System. The user can switch seamlessly between the live map view and spectrum view during SEM image observation. Then they can overlay the element maps of interest on the live SEM image for enhancing understanding of element distribution within a specimen.

Zeromag software seamlessly navigates to the area of interest from an optical image of a larger general area of the sample. The user is never lost and can easily navigate to the desired observation area by simply clicking on the optical image.

www.jeolusa.com ●●●

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Seco opens new European distribution centre

Seco Tools, headquartered in Fagersta, Sweden, has announced that it will open a new, fully automated facility in Den Hoorn, the Netherlands. The new distribution centre will service all of Europe in an effort to strengthen the company’s customer support, while providing capacity for future growth.

“With the new distribution centre, we heighten our sense of responsibility and pride in providing the best services customers have come to expect,” stated Jeroen de Waaij, Logistics Manager Region Europe. “As operations at the new centre get underway, we will make the transition as smooth as possible for customers.”

Expected to be completely operational by February 2022, the 15,000 m² facility will utilise an automated Order Storage and Retrieval System (OSR) to ship about 30% less packaging ‘air’ to customers and reduce the overall use of packaging materials – and, because the OSR system is modular, the facility is expandable for future business needs.

“The new Distribution Center is an extremely important project for Seco and completing it as quickly as possible and on schedule was imperative,” stated Stefan



The facility’s automated workstations are tailored to Seco work processes and requirements (Courtesy Seco Tools)

Steenstrup, president of Seco Tools. “From the onset, the project was a top priority for us and a total group effort to further boost our efficiency and provide our customers with the best possible service.”

The location of the new distribution centre was selected to provide the best possible logistics for highly systemised order fulfilment. To ensure employee sustainability, the design of the facility’s automated workstations are expected to boost the vitality and well-being of employees.

www.secotools.com

AP&C to supply Airbus with titanium powders for aerospace applications

AP&C, a GE Additive company, has signed a new agreement with Airbus to provide titanium powders (Ti6Al4V) for use in metal Additive Manufacturing.

“The adoption of metal additive technology in aerospace continues to gather momentum,” stated Alain Dupont, CEO at AP&C. “And one of the challenges of matching that pace in a highly-regulated industry like aerospace is building a robust supply chain that can meet both the industry standard for conventionally and additively manufactured parts, but also add value.”

AP&C has grown its capacity to more than 1,000 tons of titanium powder per year. This large-scale production is performed in more than a dozen powder production lines at two manufacturing sites.

Dupont added, “Our approach is to be more than just a supplier of metal powders to our customers. To scale metal Additive Manufacturing, acceleration can only be achieved by sharing knowledge best practice to lower risk and increase stability. One way we have supported Airbus in recent years, for example, has been to help its in-house Additive Manufacturing team establish its own methods and processes to qualify Ti6Al4V powders.”

www.advancedpowders.com

www.ge.com/additive

www.airbus.com



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AlphaSTAR awarded Phase II DoD programme for design of new alloys

AlphaSTAR Corporation, Irvine, California, USA, has received the Department of Defense (DoD) Phase II programme award by the Defense Logistics Agency (DLA) for the design of new alloys for Additive Manufacturing entitled 'Grain Boundary Engineering for Additive Manufacturing.' The project is in collaboration with GE Research, University of Southern California (USC) Viterbi Center for Advanced Manufacturing, University of Michigan (UoM) Aerospace Engineering and Quadrus Corporation. The award intends to continue Phase I efforts in the development of technologies that can predetermine the microstructure of AM metal parts with optimal grain boundaries, resulting in predictable mechanical properties, including mode of failure for enhanced AM fabrication.

Due to the variability in the mechanical properties of metal AM parts, understanding the microstructure development & evolution during the AM process of metallic alloys is an important precondition for the optimisation of parameters to achieve desired mechanical properties.

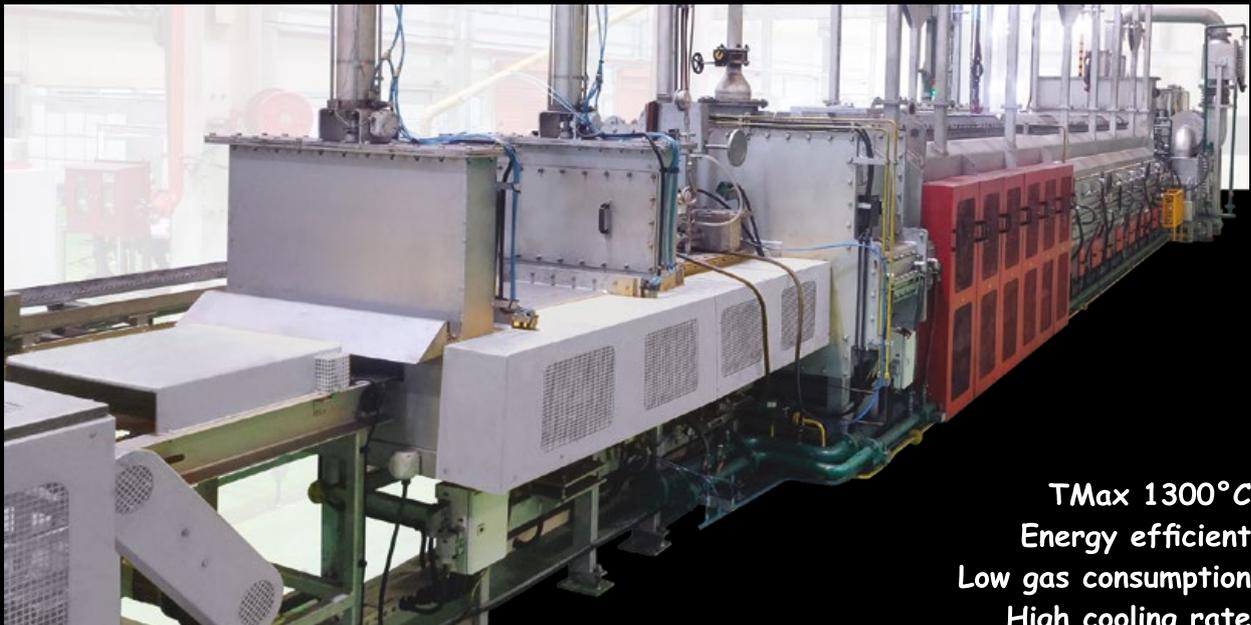
Dr Rashid Miraj, Director of Technical Operations at AlphaSTAR, explained, "Metallic alloys consist of individual crystallites commonly referred to as grains. Individual grain connections (grain boundaries) are formed through recrystallisation during metal part fabrication and heat treatment. A grain boundary is the interface between two grains, or crystallites. Grain boundaries influence the mechanical properties of the metal; hence, certain grain boundaries are preferred over others.

"Grain boundary engineering (GBE) in Additive Manufacturing refers to methodologies and technologies associated with the build process or post-build heat treatments that drive and generate preferred microstructure outcomes associated with an AM fabricated part," he continued. "At its simplest, AM GBE may be achieved through variation of the build process that address both heating and cooling and triggers nanoprecipitation and material transformation. This technology will result in significant advancements related to the design of new parts and the repair of old parts associated with DoD supply chain. GBE for AM has the potential to increase the flexibility, scalability, and capability of AM produced parts."

The ultimate objective is to establish material performance screening, selection and improvement of AM driven legacy parts. Furthermore, it will continue to improve the developed ICME software which reduces trial and error in the AM process.

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EPoS raises over \$1 million to advance its electro-sinter-forging technology

EPoS, an Italian start-up specialising in developing new electro-sinter-forging technologies, has raised a CHF 1 million (\$1.09 million) late seed funding round led by Nivalis Group, an investment company based in Villaz-Saint-Pierre, Switzerland. EPoS designs, develops and implements a unique electro-sinter-forging technology to produce parts used in various industries. Commonly referred to as eForging, the company's

technology enables the production of new materials, said to be, until now, impossible to manufacture, and to produce parts with excellent precision, density and strength. Additionally, processing time and energy consumption is said to be greatly reduced.

"EPoS is truly one-of-a-kind," stated Nicolas Corsi, Nivalis Group CEO. "Their technology is so unique and disruptive, EPoS has the potential to create a demand the industry doesn't

know yet it needs. We are confident that this leaner, cleaner process will be the go-to technology for key industry players in the foreseeable future."

The investment from Nivalis Group marks the start of a new development phase for EPoS, which will accelerate R&D, grow its team, and prepare for industrialisation and market implementation. EPoS will relocate its offices, R&D centre and production workshop from Rivoli, near Torino, Italy, to Switzerland's Le Vivier Technology Park in January 2022.

Alessandro Fais, EPoS CEO, commented, "With its entrepreneurial core and exceptional experience in industrial automation, I consider Nivalis Group as a rare hybrid creature of entrepreneurship and the perfect partner for EPoS. The injection of new capital allows us to reinforce the company with competent, fast pacing and dedicated people, and to prioritise on industries for which eForging is the perfect solution: watchmaking, permanent magnets and diamond abrasive tools. I'm very excited to move the business to Switzerland, the land of high-tech innovation."

www.nivalisgroup.ch

www.eposintering.com ●●●



EPoS uses a unique electro-sinter-forging technology to produce parts (Courtesy EPoS)

Alloyed collaboration results in high-strength alloy for automotive sector

Grainger and Worrall, Bridgnorth, Shropshire, UK, has partnered with Alloyed, Oxford, UK, to develop a new aluminium alloy, ABD®GWA3, with improved strength, maintained ductility and good castability at production scale. The specifications for this application also aligned with a wider global push for lighter, more efficient propulsion systems.

Grainger and Worrall is a family-owned company that provides a range of manufacturing processes, including small-series, high-integrity structural castings. Since its beginnings in 1946, the company has aimed for continuous growth in its manufacturing processes to maintain and improve the quality of its castings as new technologies emerge. As part of

this, the company sought to improve the performance of a complex cast-aluminium engine block.

The existing aluminium alloys used for this application – designated GW133® and GW116® – have been through extensive approvals and validation of the material. The aim was to improve on the specified properties of these alloys within the existing validation framework. Using Alloyed's ABD® platform – a simulation platform that provides optimisation and heat treatment options based on performance predictions – Grainger and Worrall identified three optimal alloy compositions in line with its targets. Designated ABD GWA3.4, ABD GWA3.9 and ABD GWA3.11, the ABD models for these compositions pre-

dicted that the strength and ductility would hit the target requirement for the engine block application.

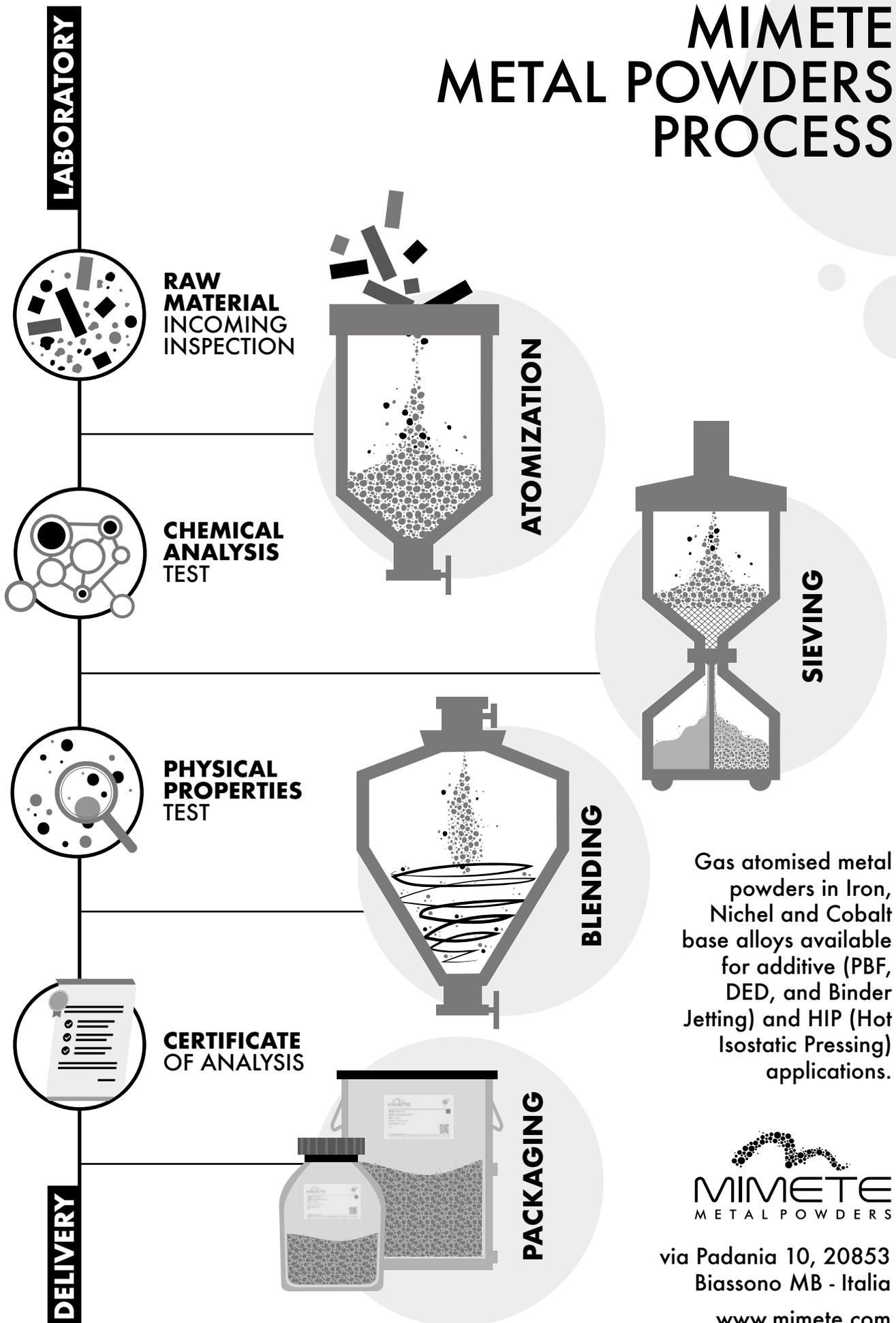
Alongside developing the alloys, Alloyed also developed new heat treatment cycles utilising ABD's simulation and empirical validation capabilities to further improve strength and ductility in the alloys whilst balancing additional manufacturing costs. The new alloy compositions were then tested under full casting production conditions, under which the proprietary alloy, ABD GWA3, when coupled with a unique heat treatment, provided a 30% improvement in yield strength without sacrificing ductility.

Since development, these new compositions have been validated to operate successfully within the approved manufacturing tolerances and are said to greatly exceed the performance of the GW133 and GW116 alloys.

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Velo3D qualifies new superalloy for use in Sapphire AM machines

Velo3D, Inc, headquartered in Campbell, California, USA, has qualified the nickel-base superalloy powder Amperprint® 0233 Haynes® 282® for use in its Sapphire® range of metal Additive Manufacturing machines. The powder was produced by Höganäs AB under license from Haynes International, Inc, and is designed for high creep strength, thermal stability, weldability, and fabricability uncommon in other alloys. The material is said to be ideal for high-temperature structural applications like energy generation, gas turbines, and space launch vehicles to build parts like heat exchangers, combustors, nozzles, combustion liners, rocket engines, and shrouded impellers.

The first Sapphire AM machine utilising the Amperprint 0233 Haynes 282 powder will be operated by Duncan Machine Products (DMP), a contract manufacturer based in Duncan, Oklahoma, USA. The machine will be the seventh in DMP's fleet of Velo3D Sapphire AM machines.

"Our goal at Velo3D is to enable engineers to build the parts they want without compromising on the design

or quality," commented Benny Buller, Velo3D CEO and founder. "Qualifying new powdered metals, like Amperprint 0233 Haynes 282, for use in our end-to-end solution further expands what's possible with our Additive Manufacturing technology. Our partners at Höganäs provide materials of the highest quality and I look forward to seeing what our customers build using this amazing alloy."

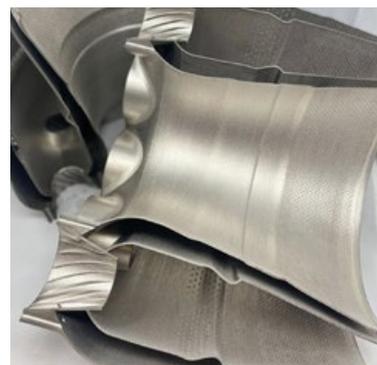
Powdered nickel-base superalloys, such as Amperprint 0233 Haynes 282, are often used to additively manufacture parts for use in high-temperature applications due to the alloy's resistance to cracking and its ability to operate at near-melting-point temperatures. This tolerance allows parts produced with the alloy to be used in vacuum, plasma, and other demanding applications. Its high weldability makes the powder ideal for parts in larger systems because of its ability to be welded to other components.

Jerome Stanley, Höganäs Director of Global Sales, Customization Technologies, stated, "It's inspiring to see what engineers have been able

to build using metal powders from Höganäs and Velo3D's support-free Additive Manufacturing process. The first parts printed using our Amperprint 0233 Haynes 282 powder are impressive, and I believe customers are only scratching the surface of what is possible with this superalloy. The powder, combined with Velo3D's end-to-end metal AM solution, is an extremely effective combination for consolidating parts into monolithic structures to eliminate coefficient of thermal expansion in large, high-performance systems."

Velo3D states that it is one of the first AM technology companies to offer Amperprint 0233 Haynes 282 powder to its customers. Many of Velo3D's customers use its end-to-end solution to produce parts for use in aviation, energy, oil and gas, space, and other high-performance applications, making the powder a good fit for Velo3D's portfolio. In addition to Amperprint 0233 Haynes 282 powder, metal powders qualified to be additively manufactured with Velo3D's technology include Hastelloy X®, Inconel 718, aluminium F357, Ti 6Al-4V Grade 5, and several other materials.

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www.velo3d.com ●●●



The combustor liner (left & centre) is made using Amperprint 0233 Haynes 282 powder from Höganäs. A cut-away view of the combustor liner (right) highlights the 23,000 unique holes included to optimise air-to-fuel ratios, and internal channels used for regenerative cooling (Courtesy Velo3D)

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APMI International names Dean Howard 2022 Fellow

APMI International has announced that the winner of the 2022 Fellow Award is Dean Howard, PMT, president of North American Höganäs Co. Howard will receive elevation to Fellow status during the Opening General Session at PowderMet2022 on Monday, June 13, in Portland, Oregon, USA.

Howard is a third-generation Powder Metallurgy professional who has worked in the PM industry for over thirty years. His career started with a sales position at Abbott Furnace Company in St. Mary's, Pennsylvania, before transitioning into metal powder sales with Pyron Corporation in Niagara Falls, New York. After Pyron was acquired by Höganäs AB, Sweden, Howard was credited with helping to position North American Höganäs

in the North American market by promoting the PM industry through active engagement with MPIF and APMI.

As VP of Sales, he is said to have strongly encouraged his team to engage in MPIF and APMI activities, supporting his team to have active roles on the APMI Board of Directors, MPIF Industry Development Board, MPIF Technical Board, and present and exhibit at the annual PowderMet Conferences. Howard was appointed president of North American Höganäs/Höganäs Americas in 2017 and has continued to support and promote their activities for PM growth.

Established in 1998, the Fellow Award recognises APMI members for their significant contributions to the goals, purpose, and mission of



APMI International has announced Dean Howard will receive elevation to Fellow status (Courtesy MPIF)

the organisation. Fellows are elected through their professional, technical, and scientific achievements; continuing professional growth and development; mentoring/outreach; and contributions to APMI International committees.

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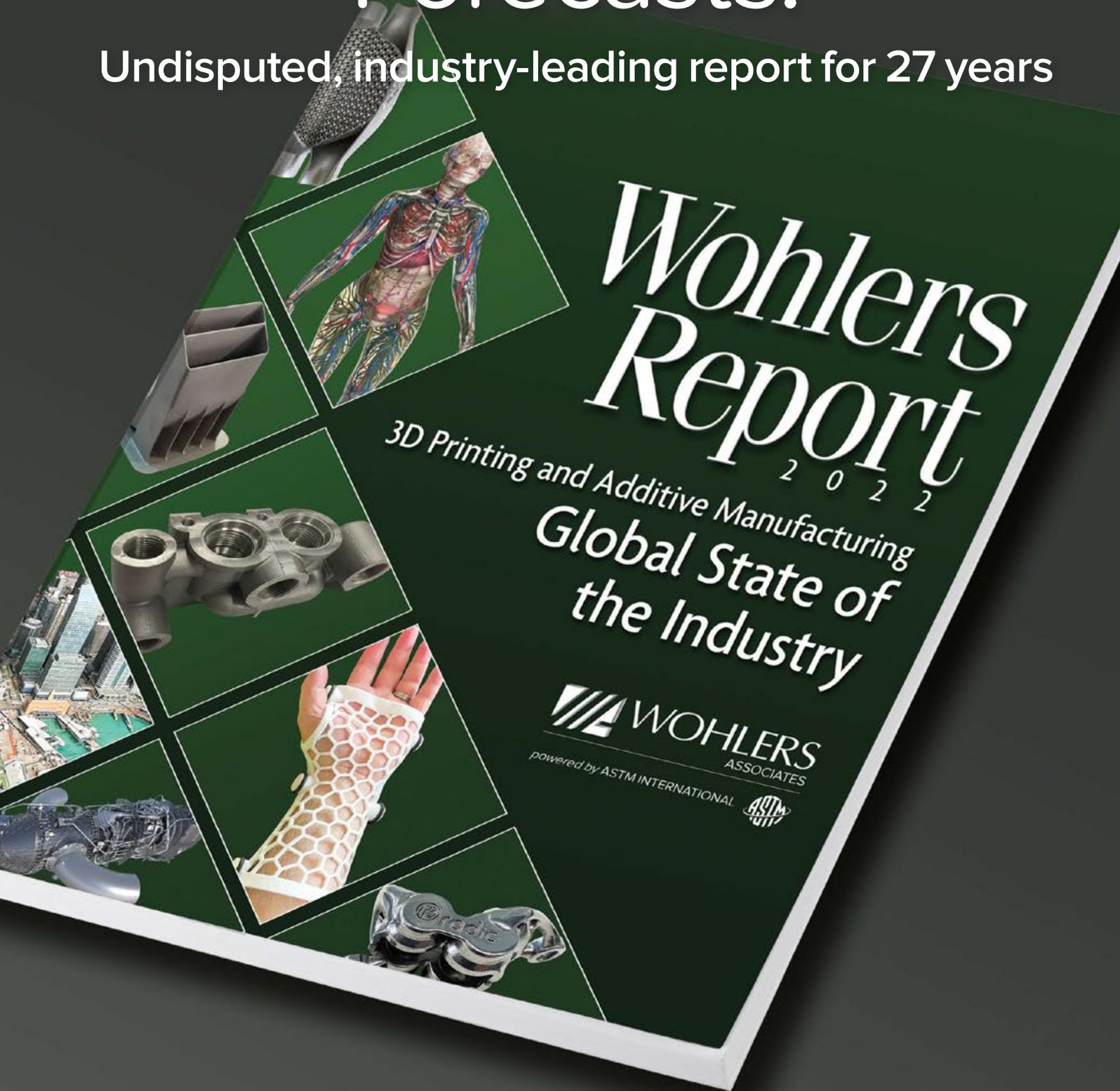
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Powder Metallurgy has always been green. Now, we need to learn to talk about it

Being a green technology, PM should be reaping the rewards as the automotive industry seeks to reduce its environmental impact. Instead, the PM industry appears to be preparing for a decline, as the traditional PM parts used in the internal combustion engine fade out of use. Now, when it could most be thriving on its green credentials, press and sinter PM runs the risk of being overlooked as a solution for e-drive applications. The main reason, believes Barton White, CEO, Kymera International, is a lack of promotion of PM to the C-suite, executive-level automotive manufacturers. Here, he reflects on the changes the auto industry has undergone in recent history and considers how PM can find a place in the new, electrified landscape.

Growing up in Canada, my dad was a salesman, and he would change his car every few years, mainly due to wear-and-tear from rough Canadian winters. 1976 is fixed in my memory as the year he brought home a used Lincoln Continental. It was our first car with electric windows and air conditioning. You could sink into the comfortable leather seats, and there was enough room to make it difficult for me and my brother to complain about invading each other's space - although we still managed to fight!

This thing was a beast. The sticker price was around \$12,000, equivalent to around \$55,000 today, which was a bargain compared to the cost of today's luxury sedans. Ford Motor Company manufactured the V8 automobile, and it weighed over 5,000 lb (> 2,200 kg), with a paltry fuel efficiency of 10 mpg (4.3 km/l). Remember that this was the average fuel economy, and so city driving would have been closer to 8 mpg (3.4 km/l). Unbelievable!

In the late 1970s, emission control was garnering some attention, but it wasn't exactly a newsworthy topic. However, the US Clean Air Act of 1970 had, at least, pushed manufacturers to change from leaded to unleaded fuel and add an emission control exhaust device known as the catalytic

converter. The 'problem' was that Americans and Canadians love their big cars, and the price of fuel in the late 1970s was certainly no deterrent at \$0.65/gallon (\$0.17/litre). Granted, from a purchasing power standpoint these numbers would be higher today due to inflation,



Fig. 1 Barton White, CEO, Kymera International



Fig. 2 A 1970s Lincoln Continental (top) and a 1990s Ford Expedition. Whilst manufactured twenty years apart, the differences in fuel economy between the two vehicles were modest (Top image courtesy Greg Gjerdingen, lower image courtesy Ominae / Wikimedia)

“... in 1999, I inherited a large SUV, a Ford Expedition, from my former General Manager. This was by far the most luxurious vehicle I had the pleasure of driving... However, in terms of fuel efficiency it was not much better than my father’s mid 1970s Lincoln.”

but comfort certainly outweighed environmental concerns.

Despite consumers' attraction to large vehicles, US automakers were starting to pay more attention to fuel efficiency. The 1973 fuel crisis in the US accelerated the development of compact and subcompact cars, and was instrumental in many owners changing to foreign cars and, more specifically, Japanese vehicles, since the US versions were more expensive and not as advanced.

During the two decades following the fuel crisis, several advancements in efficiencies and emissions were made, but the price of fuel was still largely the decision driver (pardon the pun) for consumers. When I started my Powder Metallurgy career in the mid-1990s, compact cars were gaining traction, sightings of large sedans and station wagons were fading, and the introduction of the sport utility vehicle (SUV) took the US by storm. Even though SUVs came to prominence in the 90s, they actually started their 'life' after World War II, as Americans needed an off-road car that could transport passengers as well as equipment. However, I doubt anyone would have envisioned SUVs being driven daily as the family car.

This significant change in the consumer buying pattern towards SUVs did not help with improving fuel consumption, and resultant emissions issues continued. As an example, when I moved to the US in 1999, I inherited a large SUV, a Ford Expedition, from my former General Manager. This was by far the most luxurious vehicle I had the pleasure of driving. It was uber-comfortable, with plush leather seats and a smooth ride, but could barrel through poor weather with its 4-wheel drive capability. However, in terms of fuel efficiency it was not much better than my father's mid 1970s Lincoln, with a fuel efficiency of a combined 15 mpg.

Electrification: Not as 'clean' as people may think

The electric vehicle is powered by a battery and emits no exhaust from the tailpipe, making it an extremely attractive solution to improving the environment. Great! However, there are several fundamental issues with electrification that have not been widely publicised.

Let's begin with the battery itself. Cobalt is found in most lithium-ion batteries, the primary type of battery used in electric vehicles. Currently, more than 70% of the world's cobalt is mined in the Democratic Republic of Congo (DRC), a country whose mining industry, due to civil war and political unrest, is currently blighted by violence, corruption, and child labour - largely in artisanal and small-scale mining [1]. Human rights groups have been trying for many years to improve the conditions in the DRC, but with limited success. In November 2021, a report was published that revealed widespread worker exploitation, violence and human rights abuse prevalent at five of the largest cobalt mines in the DRC [2].

Demand for cobalt is expected to increase from 140,000 MT in 2020 to 270,000 MT by 2030, and so there will be a long-term dependence on the DRC [3], making it difficult, if not impossible, to exert financial pressure on the country's industry by limiting trade with known offenders, etc. Automakers, including Tesla, are working to reduce and perhaps eliminate cobalt in their batteries, and Japan has recently had success extracting cobalt from its seabed, but these efforts are in their early stages, and shifting demand away from the DRC's mining industry is still no easy task and is certainly not going to happen in the next few years.

Now let's tackle electricity in the US. To charge batteries, consumers need electricity. While renewable energy sources such as solar and wind are options, according to the US Energy Information Administration, in 2020 these sources only accounted for 20% of US energy consumption.

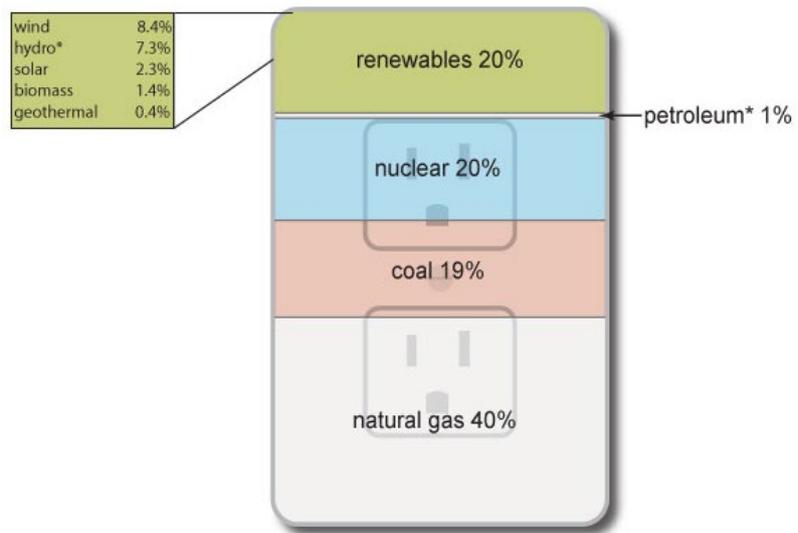


Fig. 3 Sources of US electricity generation in 2020 (Note: Electricity generation from utility-scale generators. *Hydro is conventional hydroelectric; petroleum includes petroleum liquids and petroleum coke, other gases, hydroelectric pumped storage, and other sources) (Courtesy U.S. Energy Information Administration, 'Electric Power Monthly', February 2021, preliminary data)

“Looking ahead, automakers could have an out if they blame their failure of full conversion to electric on the government due to a lack of infrastructure.”

60% of electricity came from fossil fuels and 20% from nuclear [Fig. 3]. While the nuclear energy process does not emit carbon dioxide emissions, the process of mining and refining uranium and producing fuel for nuclear reactors requires a vast amount of energy [4]. Therefore, until the US drastically changes its energy sources away from fossil fuels to renewable energy, electric vehicles are by no means emission free.

I think it is important for the general public to understand the promises that automakers have made regarding electrification. When the OEMs talk 'electric', many do not mean 100% electric, because hybrids may be included [5]. However, this is a little murky, because GM has stated that they will have zero tailpipe emis-

sions by 2035 [6]. Going all-electric means that the US infrastructure would have to completely change.

Looking ahead, automakers could have an out if they blame their failure of full conversion to electric on the government due to a lack of infrastructure. Think about the amount of electric charging stations that would have to be installed in the next few years to make a fully electrified automotive industry possible. In addition, how will the average consumer react to taking a long trip to a charging station and having to wait there until their car is recharged?

The importance of the oil and natural gas industries and their associated contributions to the US economy should also not be underestimated. Oil and natural gas

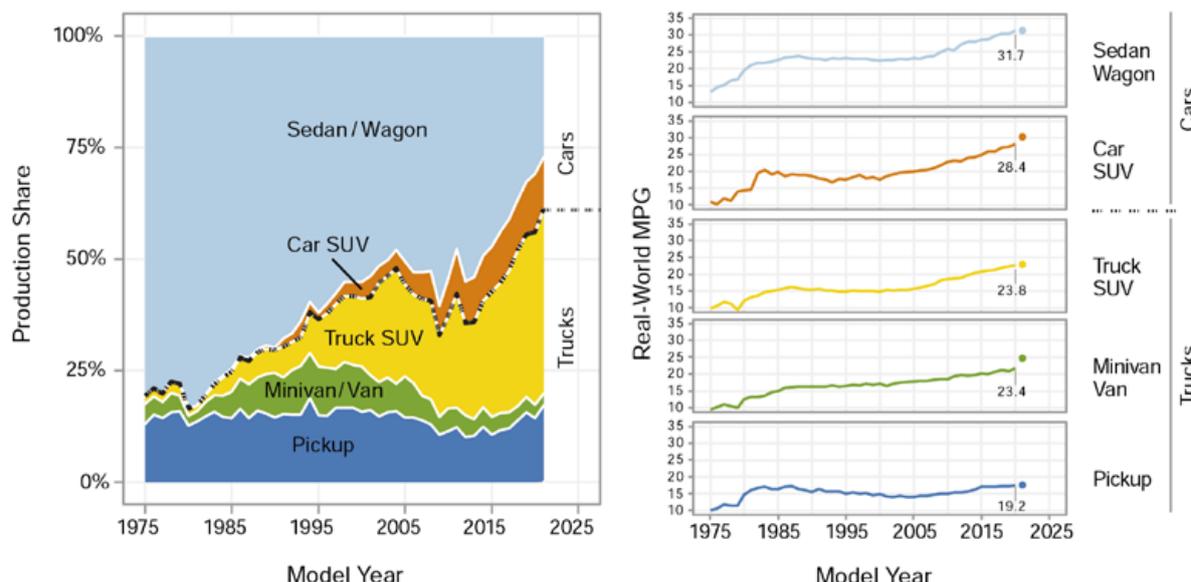


Fig. 4 Production share and fuel efficiency of cars and trucks from 1975–2021 (Courtesy US Environmental Protection Agency, '2021 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975')

support over 10 million jobs in the US and represent 8% of US GDP [7]. The establishment of electrification infrastructure will of course create jobs, and their advocates claim that renewable energy will create more jobs at higher wages compared to fossil fuels, but, as you can imagine, this claim has been refuted by the other side, claiming, "[there is] better

project variety, trades opportunities, skill development, and project consistency in oil and gas... than in corresponding jobs in the clean energy industry" [8].

It can be tough to know who is correct, but certainly the incumbent will have more sway with politicians – and voters – compared to the relative unknown.

“Being a green technology and at such an advantage over other technologies in this area, it is surprising to me that PM has not increased its presence in light-duty vehicles.”

Powder Metallurgy and its impact on the automobile, today and tomorrow

In the past twenty plus years, advancements in automotive technology have resulted in improved fuel efficiency (Fig. 4), and it would be rare to see many gas guzzlers on the road today. Even SUVs have improved their fuel efficiency; and, in fact, when compared to other vehicle types, small SUVs have shown the most improvement, increasing their fuel efficiencies by 165% since 2000 [9].

Improving the fuel efficiency of cars has been on the minds of PM researchers for over fifty years. In 1970, Dudas and Brondyke of Alcoa Research Laboratories published an article on aluminium PM parts, showing their advantages over their heavier steel counterparts [10]. In recent years, ferrous parts have been redesigned and reformulated to reduce overall part weight. Being a green technology and at such an advantage over other technologies in this area, it is surprising to me that PM has not increased its presence in light-duty vehicles; and in fact, the quantity of iron powder (a strong correlation to overall PM parts production) peaked in 2005 (Fig. 5),

	*Iron powder shipments (Short Tons)	**Vehicles Sold	Iron powder as a percentage of vehicle sales
2005	439,000	16,948,000	2.6%
2020	314,000	14,472,000	2.2%

Table 1 US retail light vehicle sales (Courtesy *MPIF and **www.statista.com)

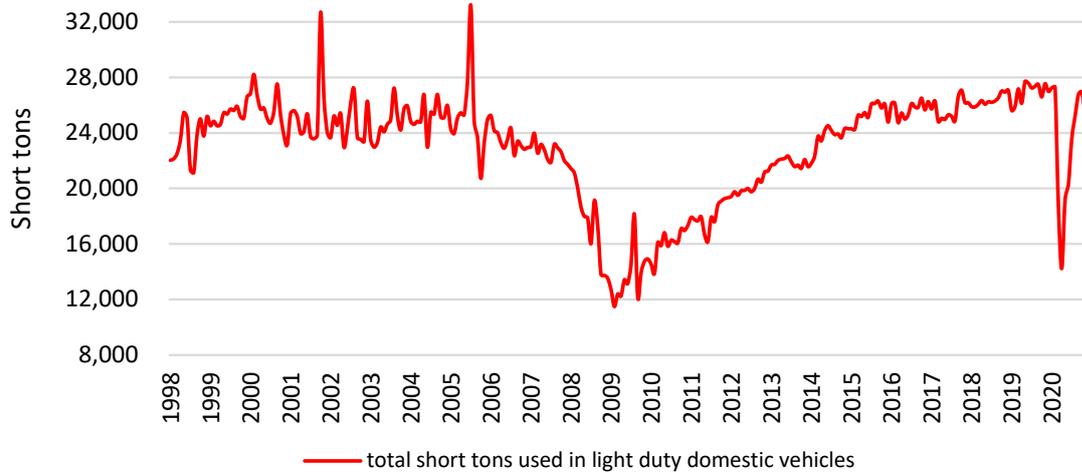


Fig. 5 Estimated monthly iron powder in US vehicles (sold) [Courtesy MPIF, '2021 Late December ECON Monthly Report']

and has decreased as a percentage of vehicle sales in the most recent periods (Table 1).

The influence 'Big Oil' has on the US, the fact that electrification is not as clean as people may think, and the infrastructure challenges that face America are just a few reasons why I am sceptical that the automakers will meet their aggressive timeline to changeover to production of 100% electric vehicles in the next decade. However, while there is a lot of uncertainty around timing, the commitments made by many companies around carbon neutrality make it inevitable that a significant reduction and even the elimination of tailpipe emissions is on the horizon. What we as an industry need to do is ensure we are part of that plan. Over the years the industry has come together to help promote the benefits of Powder Metallurgy – for example, through the Industry Development Board of the MPIF – but I think we, collectively as an industry, have to spend more time and money today and find novel ways to promote PM to the masses, and especially the environmental, social and governance (ESG) benefits of our industry.

My concern is that if we don't spend the money and time necessary

“... the commitments made by many companies around carbon neutrality make it inevitable that a significant reduction and even the elimination of tailpipe emissions is on the horizon. What we as an industry need to do is ensure we are part of that plan.”

to raise awareness now, the PM market/process could end up being a trivia question in the future (“name the auto parts technology that had so many advantages but faded away in 20XX?”), if automakers make good on their promises to switch exclusively to electric vehicles and our industry does not find a way to identify new applications in current and future platforms.

What is frustrating is that PM has been around for more than 100 years, and manufacturing near-net shape parts has a tremendous advantage over forging and casting, creating complex parts in an efficient manner with less waste. In addition,

many powder suppliers use recycled materials as their feedstock, making PM a truly sustainable and green technology.

The question, then, is why has PM not continued to grow? As vehicles have gotten smaller and begun to change to hybrid and more recently electric, less PM parts are required. Applications for Powder Metallurgy rely on relatively small, intricate parts, largely found in combustion engines. The smaller the engine (or type) the less PM required.

Okay, let's pack our bags and go home, right? Of course not. But, unless we as an industry take a step back and develop a long-term



Fig. 6 Winners in the Automotive Category of the MPIF's 2020 PM Design Excellence Awards. From left to right: Back row – PM cam (from stator assembly, PMG Indiana Corporation), VVT sprocket (Porite Taiwan Co. Ltd. and Schaeffler Technologies AG & Co. KG), vane pump rotor (Nichols Portland LLC). Middle row – Cable guides, park lock lever manual override (both Indo-MIM Pvt. Ltd.), camshaft bearing cap (MPP). Front row – Actuator arm (Phillips-Medisize – Metal Injection Molding), min-flow setting devices (Indo-MIM Pvt. Ltd.), sear pin assembly (Allied Sinterings Inc.) (Courtesy MPIF)

“While engineers may be aware of PM, I doubt senior executives of auto companies understand the technology, and certainly the average consumer has never heard of it.”

sustainability strategy, we will be left behind. I think we do a decent (not great, but good) job in promoting PM technology to engineers, but we do not do a sufficient job of promoting the benefits of the technology to the macro sector. While engineers may be aware of PM, I doubt senior executives of auto companies understand the technology, and certainly the average consumer has never heard of it. My view is that, if the top-level people in the auto companies appreciated the benefits of PM, it would help their Environmental,

Social, Governance (ESG) initiatives, which have become increasingly critical in their overall strategy.

Unfortunately, most global automakers have already publicised their intention of largely switching to electric vehicles, but electric vehicles pose more ESG problems than people may realise, and there has been recent pushback against this all-electric approach to the future of automotive. In fact, using alternative, cleaner fuels, improving the efficiency of the combustion engine and optimising hybrid technology would be a better outcome.

Significant improvements to the combustion engine are already underway, with Toyota and Mazda producing engines with thermal efficiencies – a measure of the percentage of burned fuel an engine can convert to propulsion – in the 41% to 42% range. This compares to a more typical high 20% to low 30% range [11]. Other technologies, such as turbocharging and cylinder deactivation, where the engine shuts off fuel to a portion of its cylinders when they are not needed, can also significantly improve fuel efficiency [12].

Has PM ‘missed the boat’ to be part of this new wave of automotive technologies? I don’t think so. The technology is there and, in the US, the MPIF Industrial Development Board (IDB) has worked diligently on promoting PM, particularly with automotive engineers and including initiatives to promote the technology’s green credentials (Fig. 7), but let’s face it – we are a

bunch of scientists who dabble in marketing. The industry would benefit from a mass-marketing campaign targeting top level auto executives (and, quite frankly, the general public) to get them familiarised with the benefits of PM.

This is going to be expensive, but look at how much money has been poured into Additive Manufacturing. Perhaps people outside our industry may be more familiar with the term 3D printing, but it is well publicised that venture capital firms are willing to invest millions into AM companies, many of which have still not seen a profit to date.

Let's also not forget that AM is not exactly the new technology it promotes itself as – it has been around for more than twenty-five years. It started with stereolithography using polymers, and in the late 1990s started using metals. Even though metal AM itself has a long history, it has taken a long time to resolve the numerous technical issues it faced, and even today still faces mass production challenges. However, many companies are making tremendous progress and are starting to see a real path to commercialisation. The point is that, while AM may not have reinvented itself, it has certainly taken time for the technology to be accepted on a large scale and to the masses, so why can't PM do the same?

Our industry is excited about AM (and we should be), but PM is viewed as an older technology that end users may feel is not worth pursuing. In order for the industry to see growth (not steady as she goes GDP growth) it has to become a known technology outside our micro-environment. Let's reinvent PM. There is nothing wrong with riding the coattails of AM and the positive press it has received!



Fig. 7 The MPIF has worked to promote PM as a green technology through the creation of a number of resources, including the above logo, which can be used to educate engineers and decision makers on the sustainability of the technology (Courtesy MPIF)

References

- [1] www.cfr.org/blog/why-cobalt-mining-drc-needs-urgent-attention
- [2] <https://african.business/2021/11/energy-resources/workers-report-colonial-era-abuse-at-congolese-cobalt-mines/>
- [3] www.theassay.com/articles/feature-story/cobalt-the-blue-metal-forecast-to-help-green-the-planet/
- [4] www.eia.gov/tools/faqs/faq.php?id=427&t=3
- [5] www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php#:~:text=Nuclear%20power%20reactors%20do%20not,require%20large%20amounts%20of%20energy.
- [6] www.caranddriver.com/news/g35562831/ev-plans-automakers-timeline/
- [7] www.nytimes.com/2021/01/28/business/gm-zero-emission-vehicles.html
- [8] www.api.org/news-policy-and-issues/taxes/oil-and-natural-gas-contribution-to-us-economy-fact-sheet
- [9] www.forbes.com/sites/jimmagill/2020/10/26/oil-gas-vs-clean-energy-which-will-have-best-jobs-in-the-future/?sh=3b6b472f5738
- [10] www.energy.gov/eere/vehicles/articles/fotw-1195-july-19-2021-small-suv-segment-has-seen-greatest-improvement-fuel
- [11] SAE International, Vol. 79, Section 1: Papers 700010–700182 (1970), pp. 573–579
- [12] www.cspdailynews.com/fuels/how-internal-combustion-engine-keeping-pace

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39th Hagen Symposium 2021: Sustainable solutions and new markets for Powder Metallurgy

Following a year's postponement as a result of COVID-19, the 39th Hagen Symposium finally took place from November 25–26, 2021. Organised by Germany's Fachverband Pulvermetallurgie, this long-anticipated event brought together the German-speaking PM community for two days of high-level technical presentations on the topic of sustainable solutions and new markets for Powder Metallurgy. Dr Georg Schlieper attended the symposium on behalf of *PM Review*, and here reports on the key takeaways from a programme whose theme in 2021 aimed to help PM cement its place in a more sustainable future.

The annual Hagen Symposium, organised by the German PM trade association Fachverband Pulvermetallurgie e.V (FPM), is attended by engineers, researchers and students looking to discover the latest advances in Powder Metallurgy, maintain contacts and make new ones in the PM community. The technical lectures presented during the event allow delegates gain a deep insight into many sub-areas of Powder Metallurgy. The accompanying exhibition showcases the latest developments from research institutes and suppliers of raw materials, production equipment and quality assurance facilities.

The theme for this year's Hagen Symposium was 'Powder Metallurgy – sustainable solutions and new markets,' and this topic of sustainability and the search for new markets was addressed in some form in almost all of the sixteen technical presentations given. In particular, the shift in the automotive industry towards electromobility was

dealt with, and opportunities for the PM industry to find its place in this electrified future were sought. As is well known, the PM industry has been closely aligned with the internal combustion engine (ICE) and trans-

mission, and so is highly affected by these changes.

Also of note was the long-awaited presentation by Skaupy Prize winner Dr.-Ing. Christoph Broeckmann, RWTH Aachen. In 2020, Broeckmann



Fig. 1 Presentation of the Skaupy Award to Christoph Broeckmann, RWTH Aachen, (centre), by Herbert Danninger, TU Vienna (left), and Werner Theisen, TU Bochum (right) (Courtesy Fachverband)

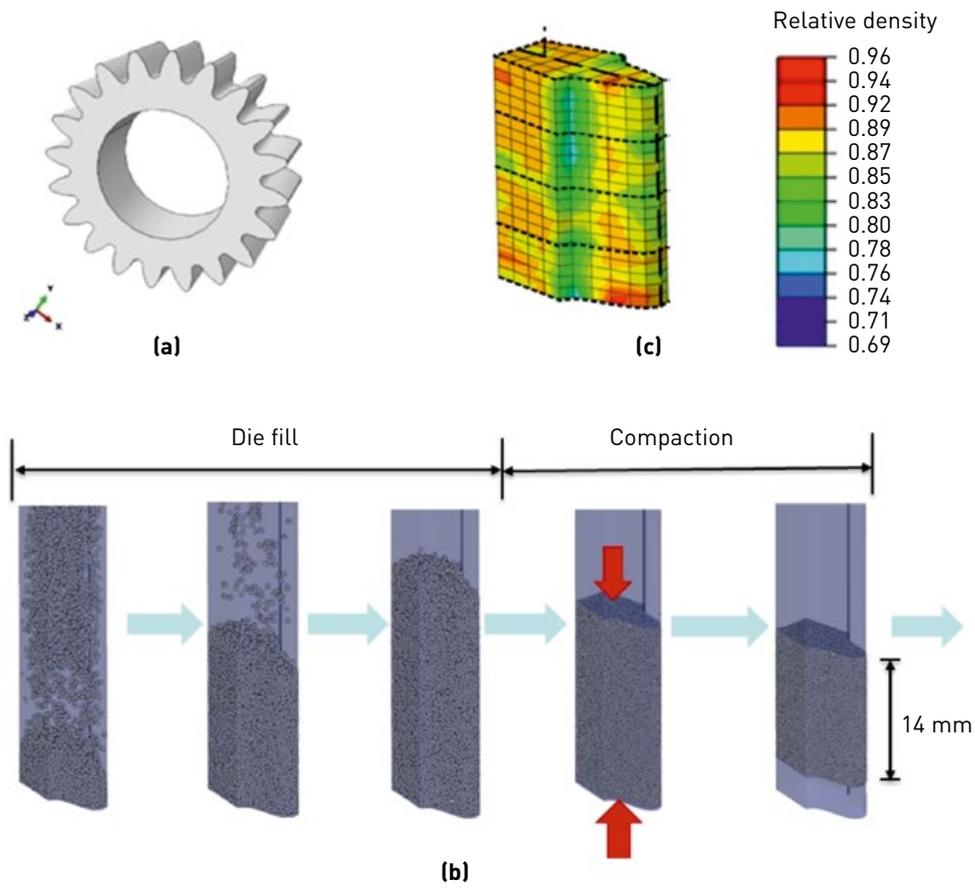


Fig. 2 Simulation of die filling and pressing of a gear. a) gear, b) DEM simulation, c) density distribution after pressing (Courtesy RWTH Aachen, IWM)

was selected by the Committee for Powder Metallurgy as the winner of the Skaupy Prize, but was unable to receive the prize due to the Hagen Symposium's cancellation in light of COVID-19. This year, Broeckmann was finally able to present his lecture and receive his honours (Fig. 1).

Digitalisation in Powder Metallurgy

Broeckmann dedicated his Skaupy lecture to the topic of 'The digital twin in Powder Metallurgy.' Digital twins are computer models that depict technical processes so precisely that

new insights into these processes can be derived from them. Computer models are already available for many sub-steps of the PM process chain. Broeckmann described some of these, and also detailed difficulties associated with the development of digital twins.

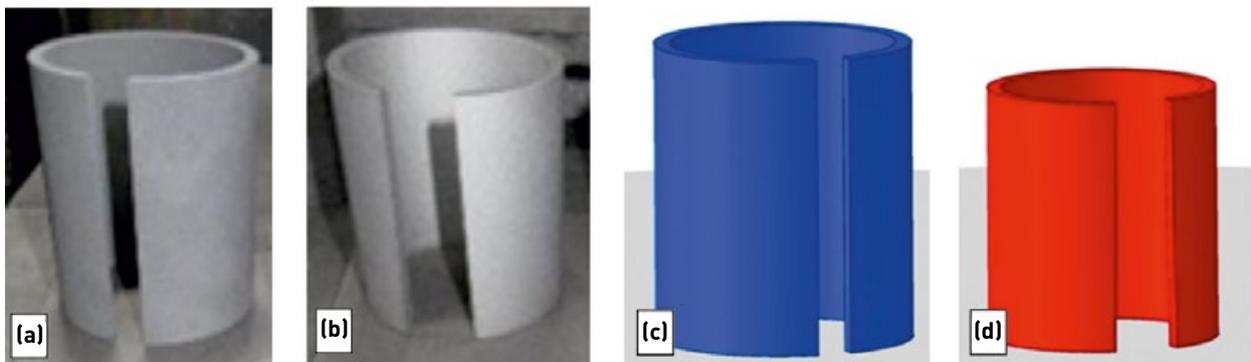


Fig. 3 Sintering a slotted sleeve made from hardmetal, a) green part, b) sintered part, c) FEM model green part, d) FEM model sintered part (Courtesy RWTH Aachen, IWM)

The first examples described by Broeckmann were the filling of capsules for Hot Isostatic Pressing (HIP) and the filling of a mould for die pressing of a gear. With the help of the Discrete Element Method (DEM), the movements of the individual powder particles are calculated. Although this method is successful, it requires extremely high computing power and the ability to store very large volumes of data. Fig. 2 shows the DEM simulation for the die compaction of a gear. Because of the symmetry of the component, the calculation was reduced to a tooth segment. The calculation is based on 85,000 particles defined as fixed agglomerates with a size of 200 μm .

The density distribution after pressing can serve as an initial condition for modelling the sintering process. Depending on the task (e.g., whether changes in the microstructure and pore structure or the dimensions and geometry are of primary interest), very different simulation methods are used. According to Broeckmann, the Finite Element Method (FEM) was used to simulate the component geometry. He demonstrated the performance of this method on a slotted sleeve made of WC-Co hardmetal (Fig. 3).

The outer diameter of the sleeve was 72 mm before sintering and about 63 mm after sintering, with the sleeve being slightly conical after sintering. The calculated outer diameter differed from the actual measurement by less than 0.5%. The slot width, originally 10 mm, grew to 17-18 mm during sintering. The calculated slot width was more than 2% too small at the upper end, but in the middle and bottom the deviation was less than 1%. In the height, which was 84 mm before sintering and about 70 mm after sintering, there was a deviation of about 1%.

Broeckmann also discussed a method for the computer simulation of case hardening of sintered gears with a compacted surface layer. First, the density profile was determined metallographically and the carbon diffusion was calculated as a function of the local density. Then, the

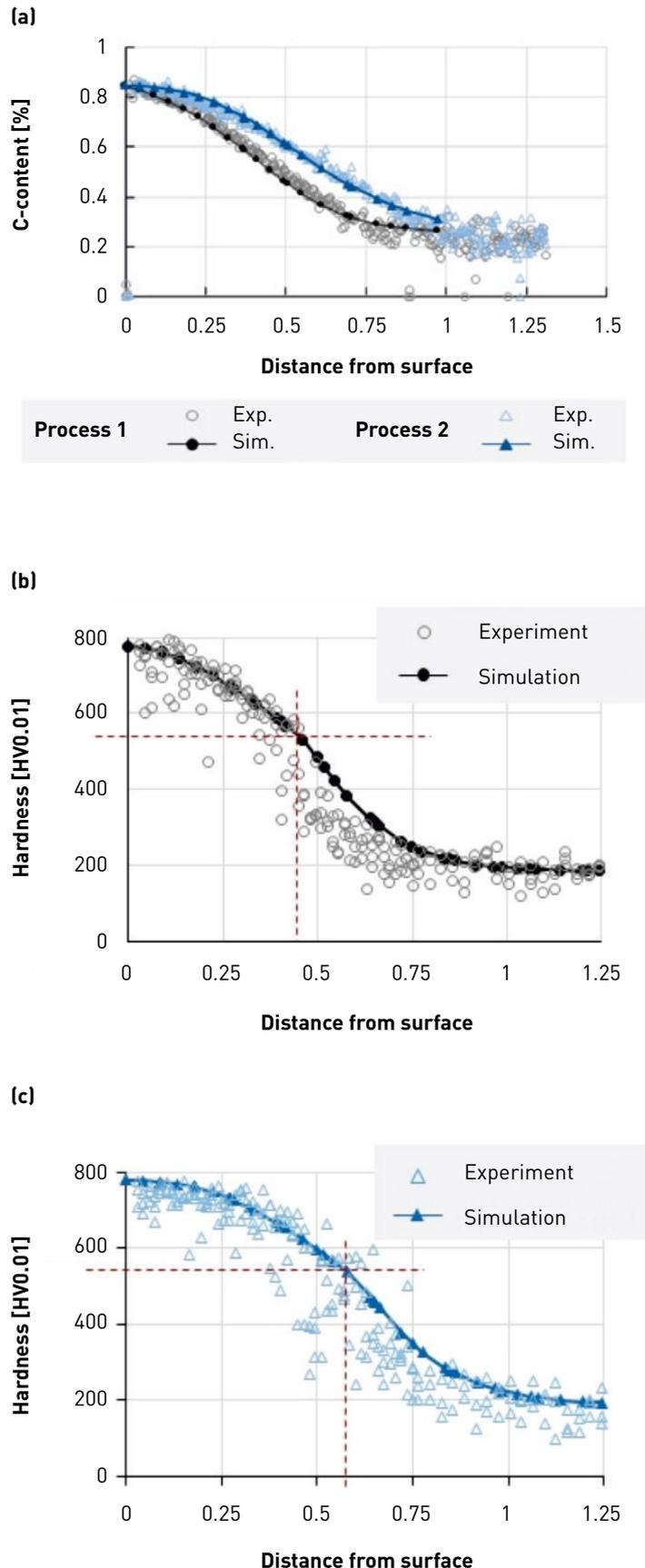


Fig. 4 Comparing simulation and experiment for case hardening, a) carbon profile process 1 and 2, b) hardness profile process 1, c) hardness profile process 2 (Courtesy RWTH Aachen, IWM)

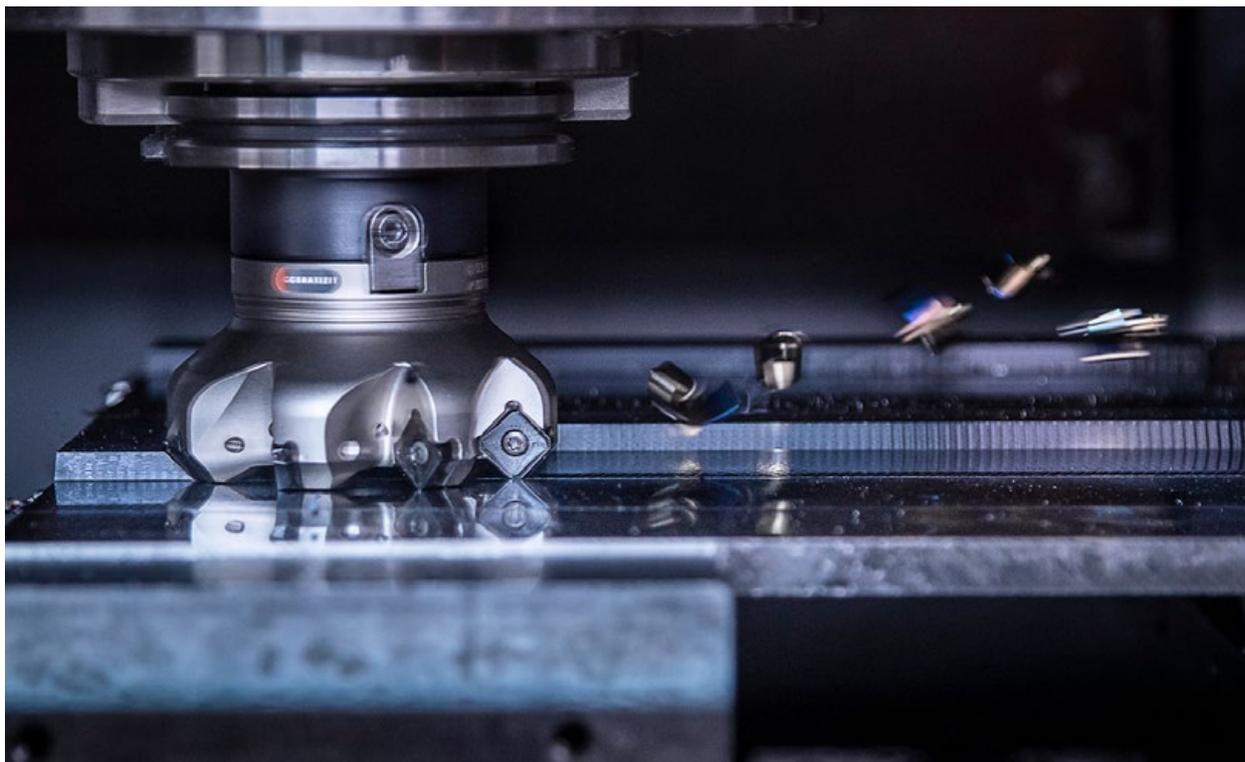


Fig. 5 MaxiMill 271 face milling system from Ceratizit with eight cutting edges per indexable insert (Courtesy Ceratizit)

local cooling rates achieved during quenching and the structural transformations and residual stresses taking place were calculated. In the third step, the hardness profile was calculated on the basis of an empirical relationship (Fig. 4). Experiment and simulation were in good agreement.

Broeckmann anticipates advantages in the DEM method for the simulation of powder preparation and shaping, while the widely used and well-established FEM is better suited for the simulation of the subsequent process steps in the production of PM components.

The assessment of sustainability

The assessment of sustainability in industrial processes was the subject of the contribution by Michael Ritthoff, of the Wuppertal Institute for Climate, Environment and Energy. Depending on the purpose of sustainable assessments, different methods are used, some of which

are contained in standards. In this way, individual aspects – such as primary energy use, raw material expenditure, greenhouse gas emissions or the water footprint – can be examined, or a complete lifecycle assessment (LCA) can be drawn up in accordance with DIN EN ISO 14040.

As Ritthoff demonstrated with examples, the path to a meaningful sustainability assessment is full of pitfalls. While many methods have proven themselves in practice, Ritthoff warned that the results are often fraught with great uncertainty and that not enough attention is paid to the assumptions under which the results were obtained. This can lead to serious misunderstandings when interpreting the results.

Sustainability in hardmetal production

Various aspects of sustainability in the production and application of hardmetals were addressed by

Uwe Schleinkofer, Ceratizit Austria. “Sustainability means preserving the natural regenerative capacity of the resources used,” he stated. Since the most important resource in the production of hardmetals is tungsten, the extraction of which requires a very high expenditure of energy, the recycling of hardmetal makes a significant contribution to reducing the consumption of resources.

Today, about a third of the tungsten used is obtained by recycling. According to Schleinkofer’s research, the recycling rate could rise to 80% for solid hardmetal tools, 55% for indexable inserts and about 35% for wear applications in the medium term.

Improving the precision of machining and increasing the service life of cutting tools has a positive effect on cost and sustainability. Schleinkofer presented some innovative cutting tools from Ceratizit, including the MaxiMill 271 face milling system, the indexable inserts of which each have eight cutting edges (Fig. 5). The system

is characterised by perfect smoothness and the highest surface quality of the machined surfaces.

Digital recording of usage data of cutting tools can also be used to improve profitability and sustainability. Ceratizit's ToolScope software system is used for process monitoring, detects tool fractures and records tool downtimes and machine downtimes. In this way, machine damage can be minimised while its use is optimised.

Powder Metallurgy in fuel and electrolysis cells

Norbert H Menzler, Forschungszentrum Jülich, presented the results of materials research for Solid Oxide Electrolysis Cells (SOEC). These systems, also known as fuel cells, can be used both to produce hydrogen by electrolysis with input of electrical energy and the reverse: electrical energy from hydrogen. These abilities mean SOECs are expected to become a central element of a sustainable economy that largely does without fossil fuels. SOEC systems that operate at operating temperatures around 800°C already have an efficiency of around 70%. This can be increased to over 90% under favourable conditions, which makes these systems extremely efficient.

The components for fuel/ electrolysis cells developed in Jülich, so-called SOC stacks, consist of the cell, the contacting materials, the metallic interconnectors, the glass-ceramic seal and, if necessary, protective layers on the metal components (Fig. 6). Menzler identified two components of the SOEC that can be produced by Powder Metallurgy. The cell consists of several functional layers which are often produced by film casting and screen printing. A nickel-base cermet is usually used as the metal substrate. The interconnectors could be made via press and sinter, but must achieve a closed porosity after sintering so that they are gas tight.

Powder Metallurgy electrodes for fuel cells

Christian I Bernäcker reported on work at the Fraunhofer Institute IFAM in Dresden on the development of PM components for fuel cells. He described routes for the PM production of electrodes with targeted porosity (Fig. 7). The metal powder – steel, nickel or titanium – is mixed with a placeholder powder that creates defined pores and is consolidated either by Spark Plasma Sintering (SPS) or by press and sinter. In the first case, the placeholder is removed with a solvent; in the second case, it escapes during sintering. In this way, flow-through electrodes with a porosity of up to 75% can be generated. In order to make the electrochemical process of electrolysis efficient, the electrodes are coated with a catalyst material such as gold or platinum.

Self-lubricating gears

The principle of self-lubrication of PM components has been known for many decades. It is technically used, for example, in sintered sliding bearings and gear pumps, applications which operate in areas of

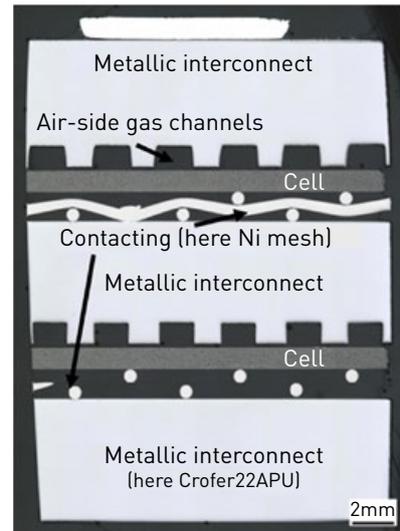


Fig. 6 Design of the planar SOC stacks developed at Forschungszentrum Jülich GmbH (Courtesy Forschungszentrum Jülich GmbH, IEK-1)

relatively low load. Nicolai Sprogies of the Technical University of Munich demonstrated in a systematic study how the principle of self-lubrication can also be transferred to higher loaded gears and rolling contacts.

Sintered steel Sint-D31 (Fe+0.85% Mo+0.3% C) was tested in tribological tests against a case-hardening steel 16MnCr5. At a density of 7.0 g/cm³, corresponding to 10% porosity,

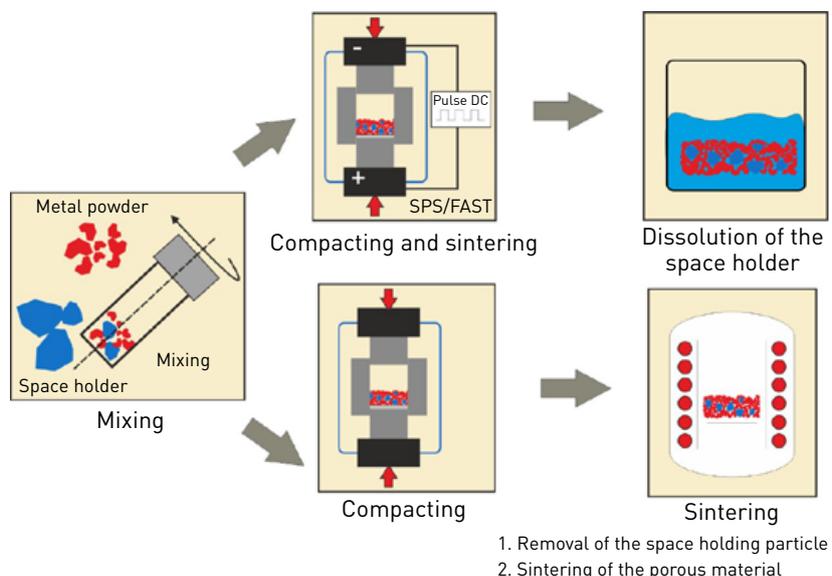


Fig. 7 PM production routes for a PTL electrode unit using placeholders in the sintering process (Courtesy Fraunhofer IFAM, Dresden)

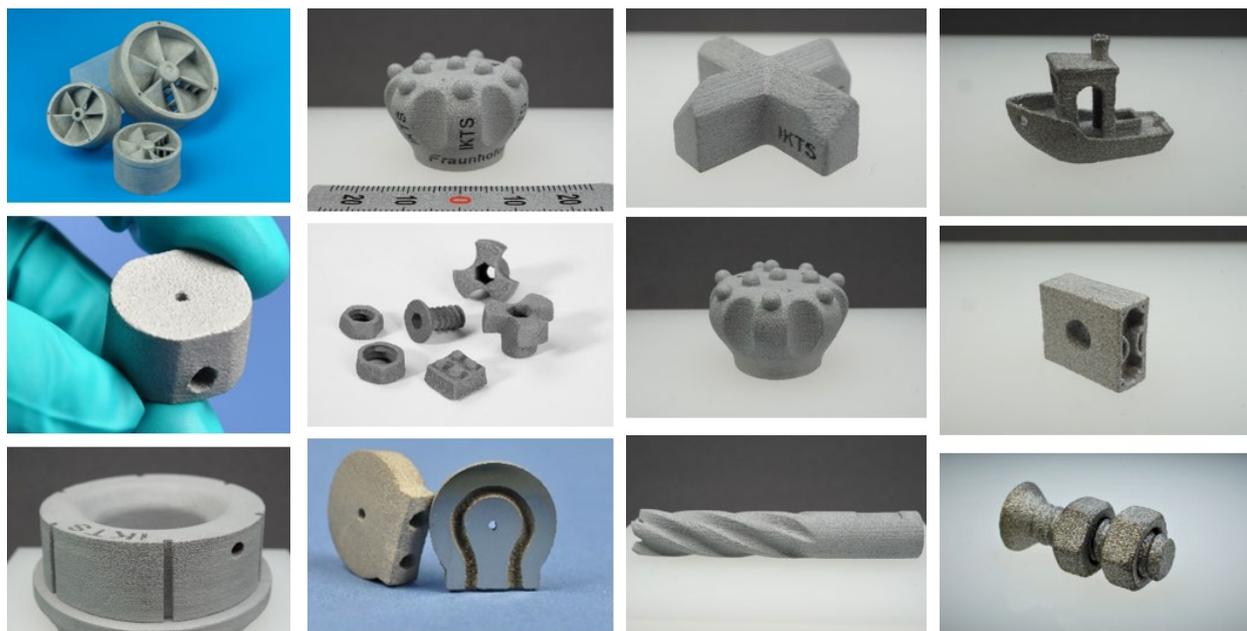


Fig. 8 Hardmetal parts made by Binder Jetting (Courtesy Fraunhofer IKTS, Dresden)

the sintered steel had the optimal ratio of load capacity and lubricant reservoir. If the density is higher, the load-bearing capacity is also higher, but the lubricant supply is not sufficient for self-lubrication, and vice versa. Under a Hertzian pressure of 492 N/mm^2 , a stable operating behaviour of the material pairing mentioned above was determined.

Plasma nitriding of sintered steel

Over the years, plasma nitriding (i.e., the alloying of the surface layer of a component with nitrogen) has proven itself in practice as an environmentally friendly and low-distortion process for surface hardening of PM components. This process is particularly effective for sintered steels containing nitride forming elements. In Powder Metallurgy, chromium, molybdenum and vanadium are used as nitride formers. Uwe Huchel, Eltro, reported on a study of the nitriding behaviour of sintered steels with up to 3% Cr. In the tests, surface hardnesses of more than 600 HV1 were achieved. Huchel also reminded that, where hardness measurements on PM steel parts are concerned, it should be borne in mind that the

significance of hardness measurements on PM materials is severely limited by the pore content.

Plasma nitriding has advantages over other nitriding methods; this is mainly due to the environmental friendliness and a better dimensional and shape-preserving behaviour. The cost effectiveness of the process can be significantly improved by integrating the de-oiling operation of sized parts into the plasma nitriding process. This also has the effect of creating white layers with low porosity and, thus, high wear resistance.

The benefits of high-temperature sintering

Volker Arnhold, a PM consultant, old friend of *PM Review* and major actor in the industry, focused his presentation on the high-temperature sintering of low-alloy PM steels. In a comparative study, it was determined that the belt furnaces predominantly used today, with sintering temperatures of 1120°C , have an approximately 20% higher energy consumption per kilogram of sintered material than roller hearth furnaces with a sintering temperature of 1250°C . A further advantage

of roller hearth furnaces is improved material properties. In addition, if the alloying elements nickel and copper are avoided and replaced with chromium and molybdenum, there are further cost advantages for high-temperature sintering.

The dimensional accuracy and scattering of the dimensions were reported to be no greater in high-temperature sintering than in low-temperature sintering at 1120°C in the belt furnace. However, the investment costs for a roller hearth furnace are at least twice as high as for a belt furnace. Perhaps this is the most important reason for the still-low distribution of this type of furnace today.

Additive Manufacturing of hardmetals

Johannes Pötschke, Fraunhofer Institute IKTS, Dresden, reported on work on the Additive Manufacturing of tools and components made of hardmetal. He compared the various processes of Additive Manufacturing and found that with the processes that build parts on a powder bed with laser or electron beams (Laser and Electron Beam Powder Bed Fusion [PBF-LB and EB]), it has not yet been

possible to produce usable hardmetal parts. More successful were sinter-based AM processes where shaping by AM and consolidation by binder removal and subsequent sintering are separated from each other.

At IKTS, Binder Jetting (BJT) was used to produce prototypes made of WC-12Co and WC-17Co whose microstructure did not differ from pressed and sintered hardmetals (Fig. 8). Pötschke concluded that BJT combines high production speed with the ability to produce larger and more complex hardmetal parts than other AM processes.

Using Fused Filament Fabrication (FFF) technology, a form of Material Extrusion (MEX) AM, IKTS succeeded in producing hardmetal parts made of WC-8Co and WC-9Ni. FFF runs on small and inexpensive AM machines, but has significantly lower productivity than BJT.

Nano Particle Jetting (NPJ), a variant of BJT technology patented by the Israeli company XJet, was also tested at IKTS. In NPJ, a suspension loaded with extremely fine particles is jetted in the form of thousands of small drops, together with a support material, through miniature nozzles. Due to the temperatures prevailing in the build space, the volatile parts of the suspension evaporate, and a solid green part is formed. This method was used in a joint project between XJet and IKTS to produce hardmetal drills made of WC-9Co with green densities of 51% that were sintered to full density via SinterHIP (Fig. 9).

Finally, Pötschke presented another AM process that was developed at IKTS and is referred to as Multi Material Jetting (MMJ). Similar to XJet's NPJ, a wax-based suspension containing the finest hardmetal particles is jetted from a nozzle. By adjusting the nozzle diameter, viscosity and solids content, droplets of different sizes can be produced, which affects the resolution and the build speed. With this process, hardmetal parts were manufactured from WC with 6–12% Co (Fig. 10). The green parts produced in this way obtain material properties through debinding and sintering that

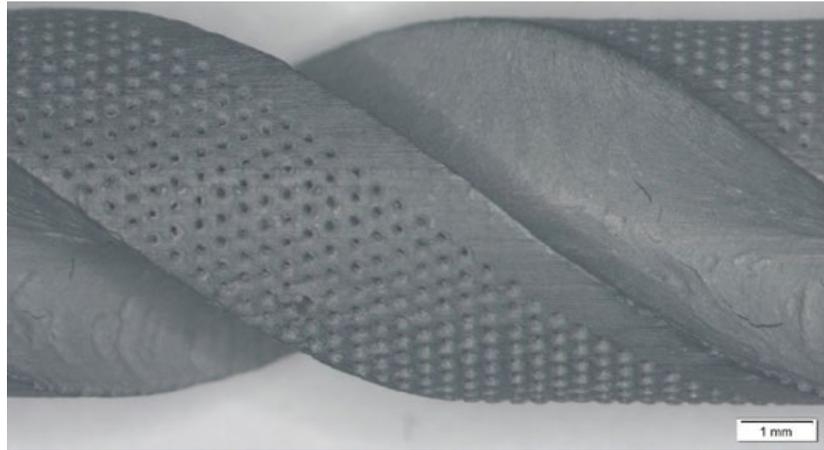


Fig. 9 Hardmetal drill with cooling structures made by Nano Particle Jetting. The cooling channels have diameters of approximately 140 μm . [Courtesy Fraunhofer IKTS]

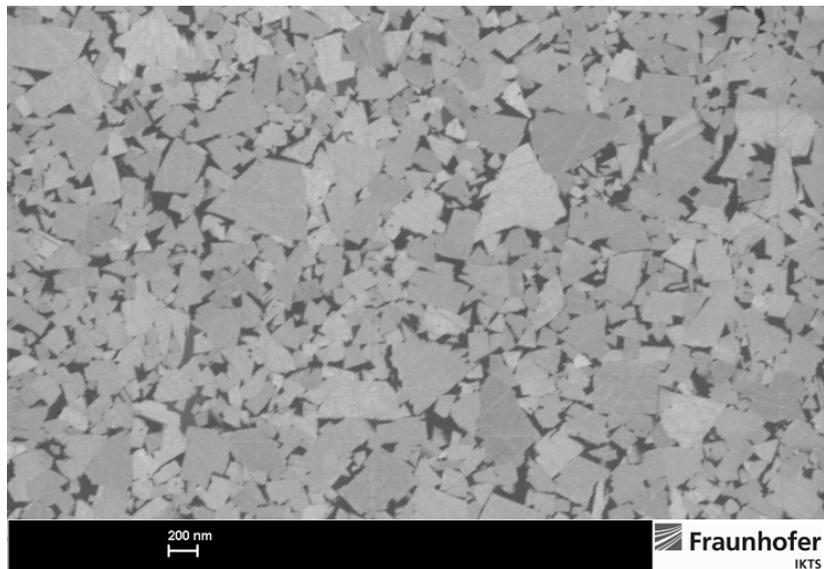


Fig. 10 Microstructure of the ultra-fine grained hardmetal generated by Fraunhofer IKTS's Multi Material Jetting process [Courtesy Fraunhofer IKTS]

are comparable to conventionally produced hardmetals. According to Pötschke, however, the surface quality of the parts is significantly better than that of BJT and FFF.

Energy-efficient machining with hardmetal tools

Ivan Iovkov, TU Dortmund, reported on studies that contribute to the fundamental understanding of machining processes with hardmetal tools and, thus, enable quality

improvements. Sustainability is also improved, because lower cutting forces and a longer tool life lead to shorter process times and shorter set-up times, as well as enabling the use of smaller machines that require less space and consume less energy.

The machining experiments were carried out with indexable inserts and drills made of hardmetal. The heat-resistant nickel-base alloy Inconel 718, which poses special challenges, was machined. The tests showed that an efficient supply of the cutting edge with cooling lubricant is essential

Discontinuous drilling with three interruptions

- Retraction movement Distance to bore hole bottom: $l_i = 2 \text{ mm}$
 ← Subsequent feed motion Time of interruption: $t_i = 2 \text{ s}$

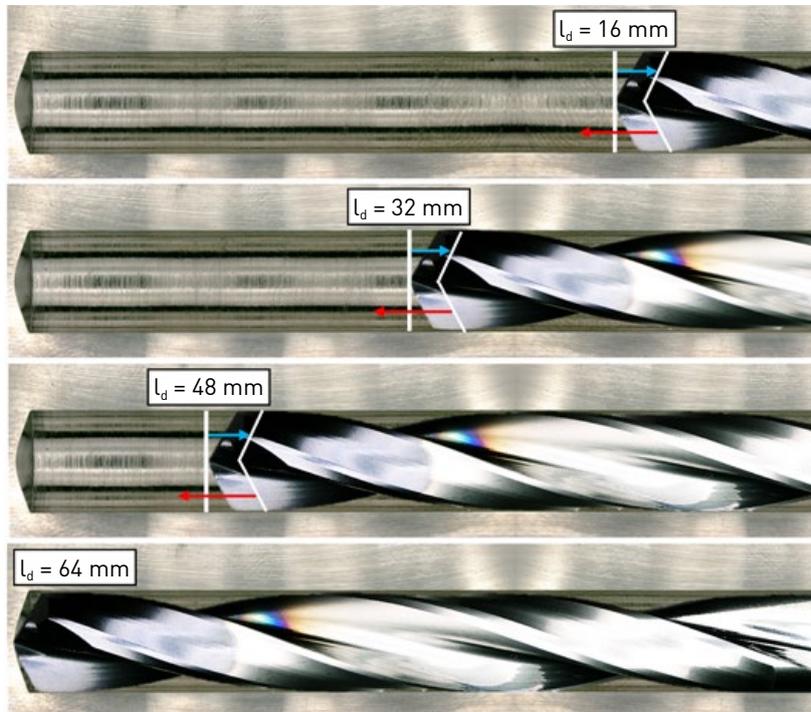


Fig. 11 Test execution during drilling with interruptions: the drilling process was interrupted at a depth of 16, 32 and 48 mm by 2 sec each and the drill was withdrawn by 2 mm. The total drilling depth was 64 mm (Courtesy TU Dortmund)

for good machining results for this alloy. Cut interruptions proved to be an effective method to improve the supply of cooling lubricant. Indexable inserts achieved better results with interrupted cutting than with continuous cutting.

The advantages of discontinuous machining continued to be researched in drilling tests. Fig. 11 shows the execution of the experiment. With an 8 mm drill with cooling channel, holes of 64 mm depth were drilled in Inconel 718. The drilling process was interrupted for 2 seconds at 16, 32 and 48 mm, respectively, and the drill was withdrawn by 2 mm each time. As a result, the drill cutting edges could be better supplied with cooling lubricant. In a further series of tests, drilling was carried out with seven interruptions after each

8 mm drilling path under otherwise identical conditions. The results were compared with those of continuous drilling without interruption. A total of forty holes were drilled with each drill, which corresponds to a total drilling path of 2560 mm.

The influence of the interruptions on the drilling torque and the feed force was hardly measurable. The wear development at the cutting edge of the drill was about 10% lower during drilling with interruptions than with continuous drilling. The examination of the bore quality (Fig. 12) showed that the surface roughness was similar in all tests. The roundness of the boreholes decreased measurably during drilling with interruptions. On the other hand, phase transformations on the bore wall were detected in the microstructure after continuous drilling, which,

according to Lovkov, are caused by a thermomechanical overload of the material. These phase transformations, considered by Lovkov to constitute serious damage to the material, did not occur during the discontinuous drilling.

Tool coatings reducing friction

Chemical Vapour Deposition (CVD) and Physical Vapour Deposition (PVD) are established coating processes for extending the service life of cutting and forming tools made of tool steel and hardmetal. In her lecture, Kirsten Bobzin of RWTH Aachen University covered a wide area of this topic, from the beginnings of CVD coatings in the 1970s to current developments in coatings that not only offer wear protection, but also reduce frictional forces.

Today, PVD-TiAlN and CVD-Al₂O₃ are of greatest economic importance. The highest growth rates have recently been shown by Si-containing PVD layers (e.g., TiAlSiN), whose performance increase is based on nanostructuring. The group of carbonaceous DLC coatings (Diamond-like Carbon) includes CVD diamond coatings. Since the late 1990s, friction-reducing DLC coatings via PVD have been available. They can be adapted to a wide variety of applications by varying the coating composition.

At the Institute of Surface Technology (IOT) at RWTH Aachen University, Bobzin and her co-workers developed innovative friction-reducing coatings that contain a solid lubricant in addition to a hard material. A tool for cold forging of the low-alloy steel 16MnCr5 was coated with a layer with the designation CrAlN+MoS₂, which, in addition to a high wear resistance due to the CrAlN layer, also has good tribological properties due to embedded molybdenum and sulfur. Significant improvements have been achieved with this coating in field trials.

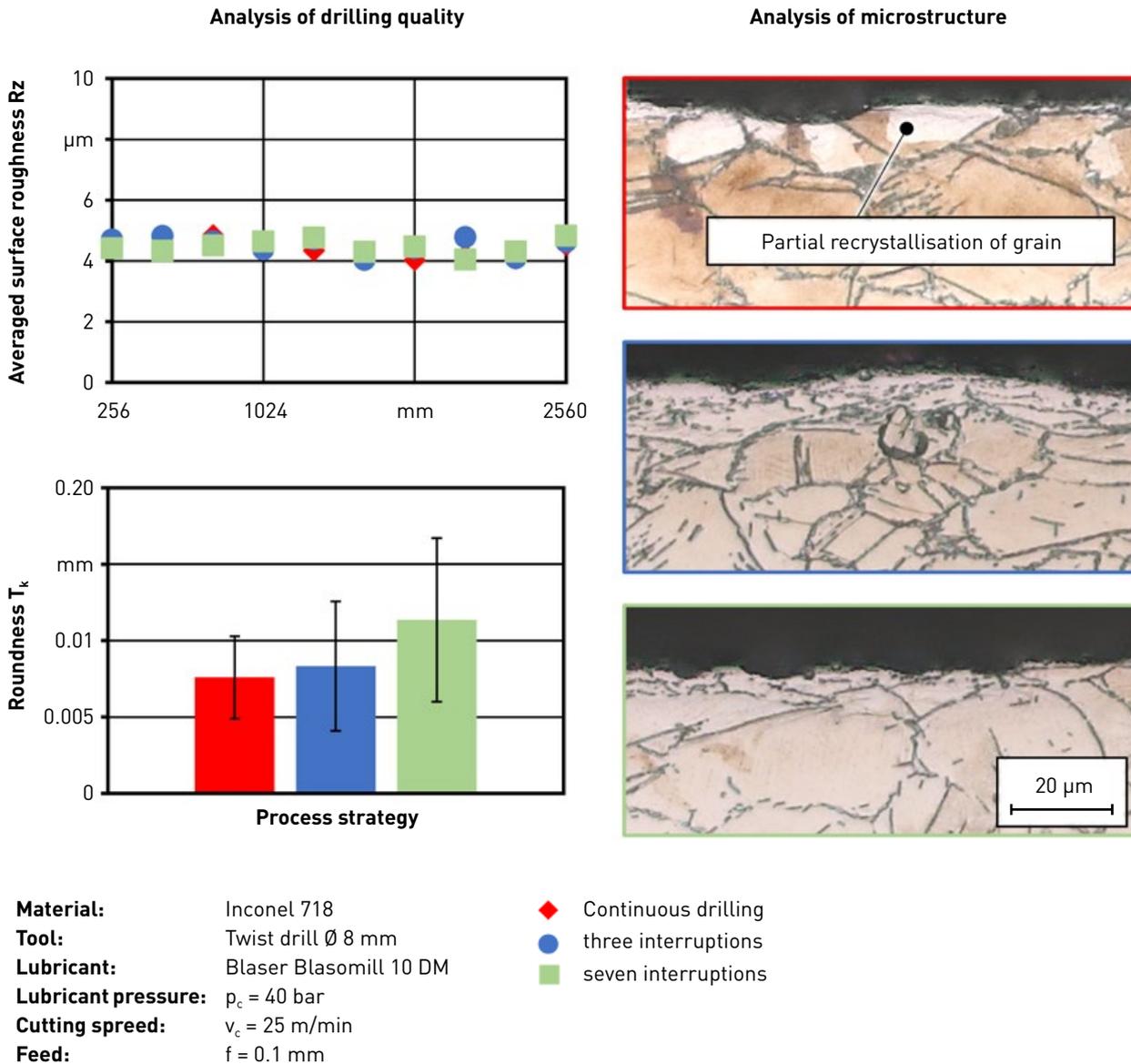


Fig. 12 Borehole quality after drilling tests (Courtesy TU Dortmund)

For the machining of titanium, tool coatings based on the ternary nitride CrAlN were developed, in which refractory metals vanadium, molybdenum or tungsten were embedded. These metals form friction-reducing oxides during machining. With such coatings, the tool life could be more than doubled. Finally, coatings with oxinitride CrAlON were also used for the machining of heat-treated tempered steel 42CrMo4. CrAlON has been shown to reduce both the tendency to adhesion and friction to the steel compared to a nitride coating.

Final remarks

It was clear from the Hagen Symposium which topics are important in research activities at universities, in research institutes and in industry. Unfortunately, apart from fundamentally new inventions, progress in terms of sustainability is usually made in small steps. It is usually small improvements in manufacturing processes that lead to a longer service life of the products, better work results and cost reductions. Nevertheless, this painstaking

work should not be underestimated, because it helps us to cope with the challenges of the future.

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Euro PM2021: A view to CO₂ reduction across the Powder Metallurgy workflow

Within the programme of the Euro PM2021 Virtual Congress, October 18–22, 2021, organised by the European Powder Metallurgy Association (EPMA), a double-session Special Interest Seminar (SIS) addressed the opportunities for the reduction of CO₂ emissions across the press and sinter PM workflow through developments in processes and equipment. Here, Dr David Whittaker provides a summary of each presentation given during the SIS, highlighting key points and findings.



Climate neutrality in powder production for PM

As the starting point of the PM process chain, a presentation from Hilmar Vidarsson (Höganäs AB, Sweden) described 'The road towards climate neutrality for the PM industry from a powder production perspective' [1]. Vidarsson explained that Höganäs has defined a climate roadmap, with the goal of becoming carbon neutral by 2045 at the latest. This roadmap is driven by the ambition to make PM a fully sustainable industry and poses challenges throughout the value chain, particularly in the sourcing of raw materials, energy and process gases. The ultimate goal is also to become part of the circular economy.

In terms of raw materials, a significant objective is to replace primary materials with secondary materials wherever possible. Emissions can be lowered considerably if recycled scrap can be used. As an

example, if recycled scrap is used in the production of 304 stainless steel powder, this can reduce CO₂ emissions per tonne by 3.7–4.7 tonnes. Where primary raw materials must be used, these should be sourced, where possible, from a process with a low CO₂ burden. In

this context, Fig. 1 demonstrates the often substantial contributions that the production of pure metals and ferroalloys can make to CO₂ emissions and the benefits that processing of ferrous materials in an electric arc furnace, rather than a blast furnace, can offer.

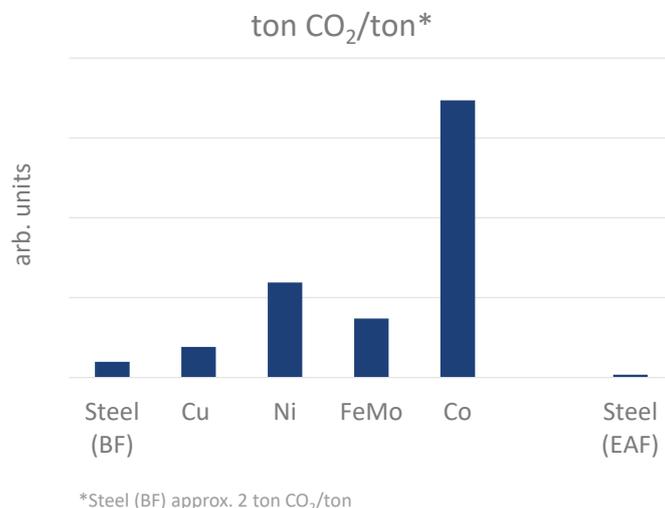


Fig.1 Embedded carbon levels in a range of primary metals and ferroalloys [1]

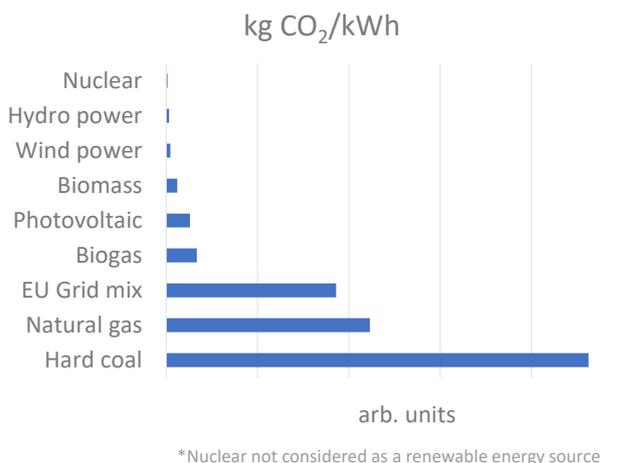


Fig. 2 CO₂ emission levels from various power generation technologies [1]

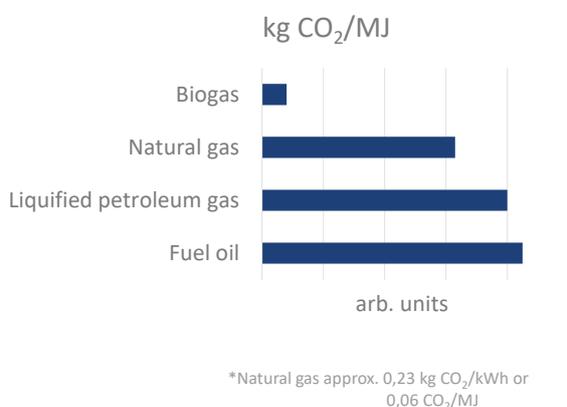


Fig. 3 CO₂ emissions from various fuels [1]

In relation to the electrical energy used in powder production, the guidance was to include more renewable energy in the generation mix. Fig. 2 gives a comparison of electricity from various sources in terms of kgs of CO₂ emissions per kWh of generated power. This figure demonstrates

that emissions in generation from hard coal are 2.5 x those from the EU grid mix and 103 x those from wind power. In Fig. 2, nuclear energy is not considered as a renewable source. The presentation also pointed to further energy efficiency gains throughout the value chain.



Fig. 4 Rising carbon tax levels in the EU [1]

In considering energy usage for heating purposes, the author advised an increased use of biogas, as the use of biogas rather than natural gas can deliver a 7.9 x reduction in kg CO₂ per MJ (Fig. 3).

Next, the presentation turned to the consideration of the process gases commonly used in PM. Endogas is normally produced from natural gas, hydrogen by steam reforming of natural gas and hydrogen/nitrogen by cracking of ammonia, which has around 20% higher carbon footprint due to contributions from the Haber-Bosch reaction and the cracking process. In order to lower the carbon footprint, natural gas can be replaced by biogas and/or CO₂ capture/storage/ utilisation, steam reforming by electrolysis using renewable energy and renewable energy/raw materials can be used in ammonia production.

Carbon has been used as a reducing agent for metals since the beginning of metallurgy (when oxidised 1 kg of pure carbon releases 3.6 kg of CO₂). In PM, carbon plays a part in iron powder manufacture (by direct reduction), in the manufacture of alloying additives and in lubricant/binder burn-off in sintering. Possible mitigating actions are to replace fossil carbon with bio-carbon or to use bio-based materials in lubricants and binders.

Copper is the most common metallic element used in press-sinter PM. However, copper additions have the effect of downgrading the scrap at component end of life, thus increasing the need for the use of primary steel raw material and therefore creating a higher CO₂ impact. In developing 'circular' PM alloying concepts, while Cu is therefore regarded as a nuisance in scrap, elements, such as Cr or Mn, can be more easily handled as these elements are required in many alloys. Such elements may therefore offer a route to more circular compositions for press-sinter PM, although there will clearly be a need to fulfil all processing requirements (pressing, sintering, etc.)

The general steel industry, in fact, shares the problem of increasing copper residual levels, because of the

Standard solution:

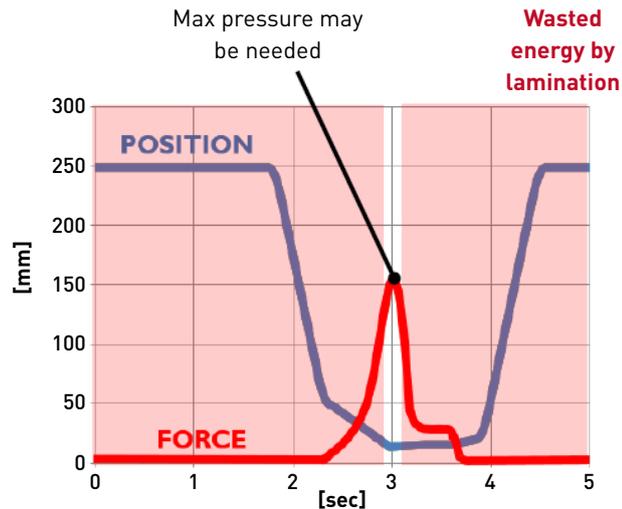
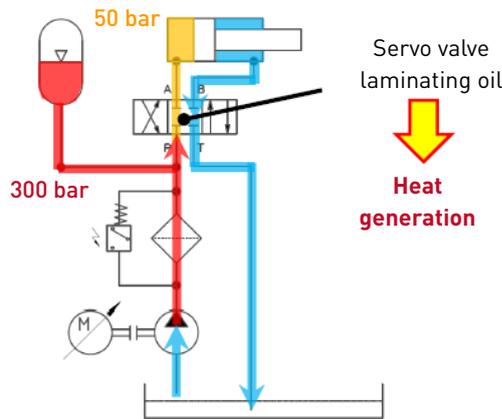


Fig. 5 The standard solution for line pressure control in a hydraulic press [2]

incorporation of electrical windings and cables in scrap. This issue, however, creates an opportunity for the increased usage of a particular PM material type, soft magnetic composites (SMCs). SMCs can ease the problem of separation of Cu windings from steel in electrical motors at the end-of-life.

This presentation concluded by questioning what is at stake on the ‘road to climate neutrality.’ In the short term, the current rises in carbon taxes (Fig. 4) will continue. In the medium/long term, end-users (e.g., the automotive industry) will demand increased use of secondary materials and lowering of CO₂ footprint, while society at large will increasingly seek climate neutrality.

In tackling the challenges identified in this presentation, the PM industry will ensure that it is ready to respond when customer demands heighten, but also new business opportunities will arise for more sustainable products.

Energy efficiency of compaction presses

Moving along the process chain, an overview of the energy efficiency of compaction presses and the latest trends in optimisation of energy consumption in presses was provided in a presentation by Pietro Albonetti (SACMI Imola S.C., Italy) [2].

The presentation began by identifying the advantages and disadvantages of the main press types available on the market – mechanical, hydraulic and electrical presses. Mechanical presses have the advantages of low investment costs, high stroke rate and low energy consumption, but disadvantages in reduced flexibility and a lack of precise regulation of the pressing force curve. Hydraulic presses can deliver high pressing forces, extreme flexibility (multiple axis capability), highly precise trajectory control, high power density in a compact layout and high stroke rate in any condition, but carry the disadvantages of higher energy consumption and the need to handle oil. Electrical presses offer a very compact layout, extremely high precision of movement (up to +/- 0.001 mm), very low energy consumption and almost total freedom from maintenance, but have force limitations and a higher investment cost per tonne than hydraulic presses.

Next, the main parameters affecting energy consumption in hydraulic presses were identified

as line pressure, oil flow and the efficiency of the press components. In terms of line pressure, a high nominal pressure in the hydraulic circuit negatively impacts energy consumption, but different solutions have been developed to reduce line pressure to minimum values. As for oil flow, the higher the flow needed to perform a certain pressing cycle, the higher will be oil consumption; hydraulic design and cycle optimisation are needed to reduce oil flow. Low performance components, such as pumps, valves, motors, and high hydraulic losses increase consumption, whereas improvements can come from high efficiency pumps, servomotor/inverter drives, reduced leakage servovalves and components and the use of CFD in piping and hydraulic block design.

The standard solution for line pressure control has limitations in relation to the lamination of oil in the servo valve generating heat in those phases where maximum pressure is not needed. This results in energy being wasted for most of the cycle (Fig. 5). One possible technical solution for energy consumption

“... the higher the flow needed to perform a certain pressing cycle, the higher will be oil consumption; hydraulic design and cycle optimisation are needed.”

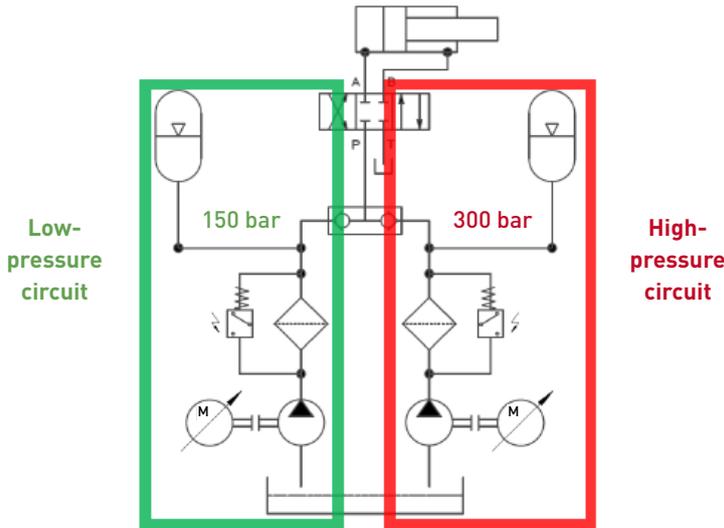


Fig. 6 The 'double line' solution for oil line pressure [2]

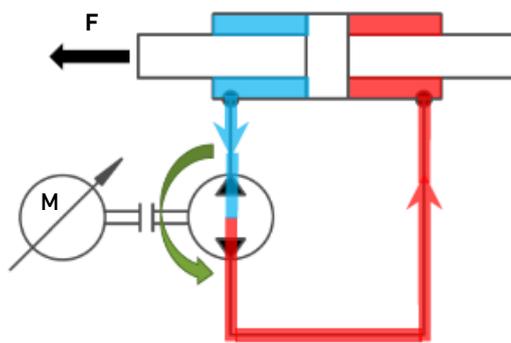


Fig. 7 Closed-loop hydraulic circuit [2]

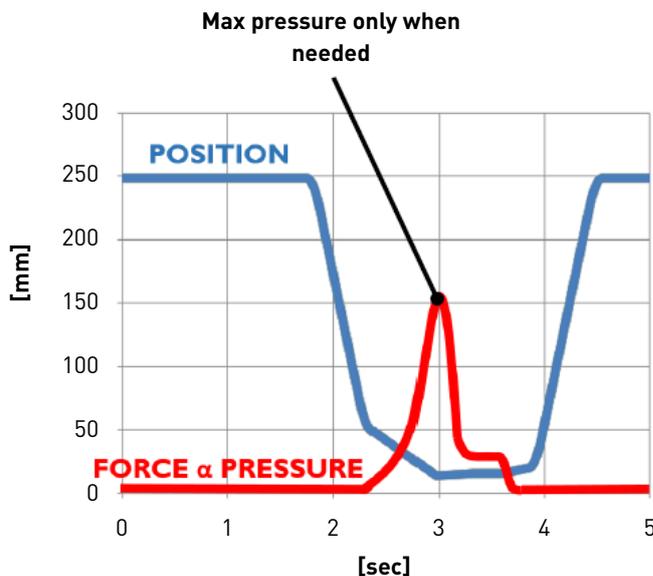


Fig. 8 Closed-loop circuit delivers maximum pressure only when needed [2]

optimisation is the use of a 'double line,' incorporating low and high pressure circuits (Fig. 6). A possible future trend was identified as a closed loop hydraulic circuit (Fig. 7), which creates instant pressure and needed force and delivers maximum pressure only when needed (Fig. 8).

Recommendations in relation to press component efficiencies include the use of high efficiency motors (e.g., class super premium IE4), HPU brushless motors or asynchronous motors with inverter, servovalves with reduced leakages, an optimised flow path for oil, to reduce hydraulic head losses, and diagnostics from HMI and preventative maintenance plans to maintain press efficiency.

An example of the benefits of the various energy efficiency solutions was quoted for the low tonnage MPH200² press. Here, the energy efficiency solutions were shown to reduce power consumption by up to 30%, equivalent to a reduction of 31 ton CO_{2eq}/year.

Where they can deliver adequate pressing force for the required product application, electrical presses have advantages. The principle of their operation is the translation of the rotating movement of a screw (fixed to the press frame) into a linear movement of a nut (fixed to the pressing beam) and this delivers a maximum torque only when needed. In terms of environmental advantages, these include reduced energy consumption (and thus CO₂ footprint), the elimination of oil disposal problems and the reduction in noise emissions.

CO₂ reduction in sintering furnaces

Next, Narayana Kaushik Karthik (Cremer Thermoprozessanlagen GmbH, Germany) discussed the opportunities for CO₂ reduction in sintering furnaces [3]. The sources of CO₂ associated with sintering can be either 'direct' or 'hidden.' Direct sources include the process gas, dewaxing atmospheres, burning of the heating gas in gas-fired furnaces,

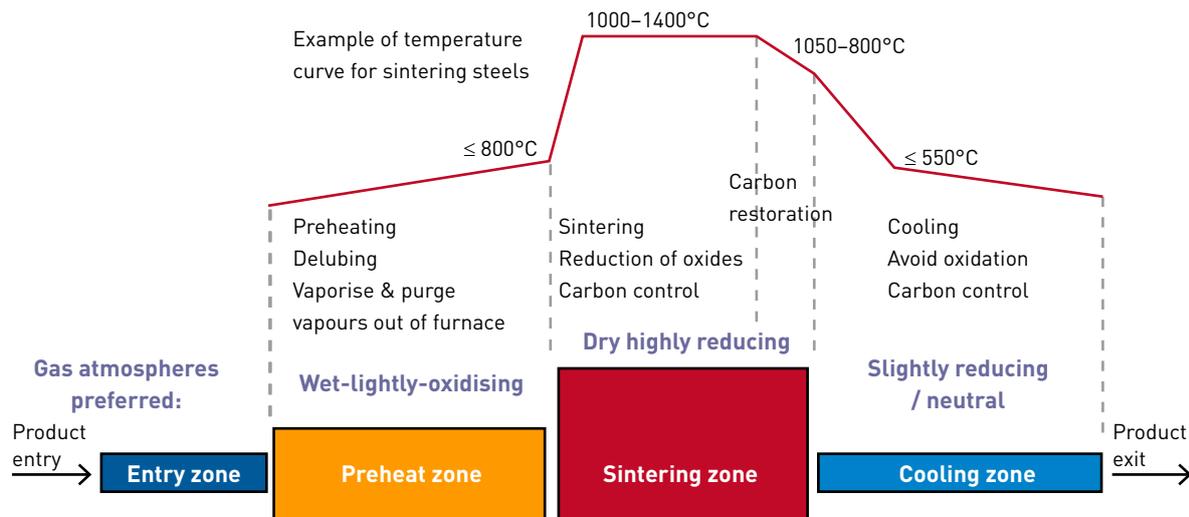


Fig. 9 Sintering furnace zones and atmosphere requirements [Source: Michael-Peter Graf, Torsten Holm, Akin Malas, Sören Wiberg (2012). Furnace atmospheres no. 6. Sintering of steels; Linde AG] [3]

inefficient furnace operation and thermal post-combustion. Hidden sources lie in the generation of electricity for electrically heated furnaces and the production of process gases.

The typical layout of a sintering furnace for steel alloy powders involves zones for dewaxing, sintering, carbon restoration, rapid cooling and final cooling. The temperature ranges and preferred atmospheres for each of these zones are described schematically in Fig. 9. There is a need to consider CO₂-minimising gas choices in each zone. In dewaxing, there are CO₂ reduction benefits in using a 'soft' Rapid -Burn-Off (RBO) unit with a mixed N₂-5 to 10%H₂-0.2%CH₄ atmosphere rather than a 'hard' RBO with an Endogas atmosphere, although this choice does involve some energy efficiency penalty. Further potential for CO₂ reduction can arise from adding H₂ into the existing natural gas network (Fig. 10). For example, CO₂ exhaust content can be decreased by around two-thirds by adding 30% H₂. This, in addition, enables more wet dewaxing atmospheres for better binder removal. Higher volume flow rates enhance convection and better dewaxing. Dilution of Endogas with H₂O is also an option if N₂-H₂ mixed gases are not readily available.

“Further potential for CO₂ reduction can arise from adding H₂ into the existing natural gas network. For example, CO₂ exhaust content can be decreased by around two-thirds by adding 30% H₂. This enables more wet dewaxing atmospheres for better binder removal.”

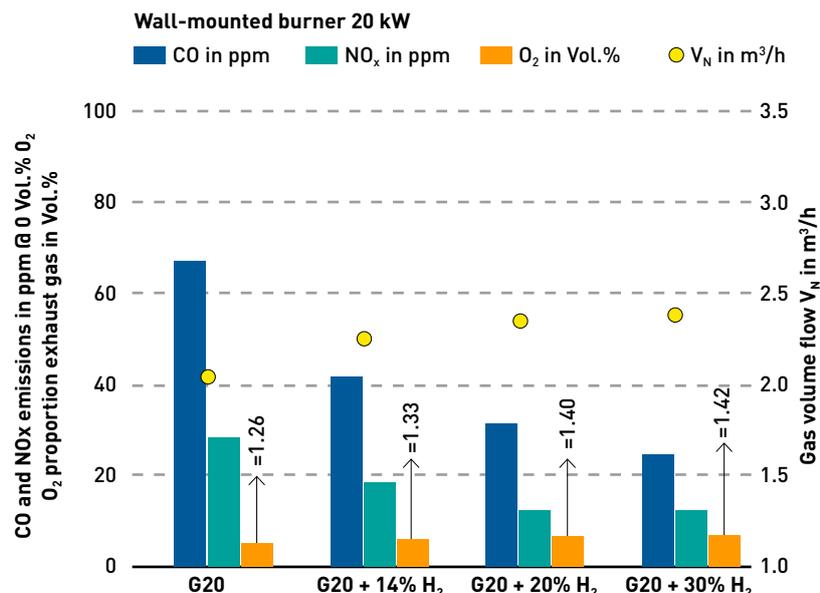


Fig. 10 Effect of adding H₂ into the natural gas network on CO₂ reduction [Source: Dörr, H Kröger, K Graf, F, Köppel, W, Bumeister, F, Senner, J, ... & Wessing, W (2016), Untersuchungen zur Einspeisung von Wasserstoff in Erdgasnetz. DVGW energie wasser praxis, 11, 50-9) [3]

Atmosphere	AGA class	Air-to-natural gas ratio	Dew point		Nominal composition (vol.%)						Key ratios		
			°C	°F	Nitrogen	Hydrogen	Water	Carbon monoxide	Carbon dioxide	Methane	Hydrogen to water	Carbon monoxide to carbon dioxide	Hydrogen to carbon monoxide
Lean exothermic	101	9.0	20 ^(a)	68 ^(b)	84.7	1.2	2.5	1.4	10.2	-	0.5	0.1	0.9
Rich exothermic	102	6.0	20 ^(a)	68 ^(b)	69.8	12.2	2.5	10.2	4.9	0.4	4.9	2.1	1.2
Endothermic	302	2.5	5	40	38.2	40.4	08	19.8	0.3	0.5	51	66	2.0
Dissociated methanol	-	-	15.5	60	-	65.6	1.7	32.4	0.4	-	39	81	2.0
Dissociated ammonia	601	-	-50	-60	25.0	75.0	0.004	-	-	-	19,000	-	-
Hydrogen	-	-	-60	-80	-	100	0.001	-	-	-	100,000	-	-
Nitrogen	-	-	-60	-80	-100	-	0.001	-	-	-	-	-	-

Table 1 Typical process gas compositions [Source: Dunkley, J J, & Atomization, I (1998). ASM Handbook. Vol. 7, Powder Metal Technologies and Applications] [3]

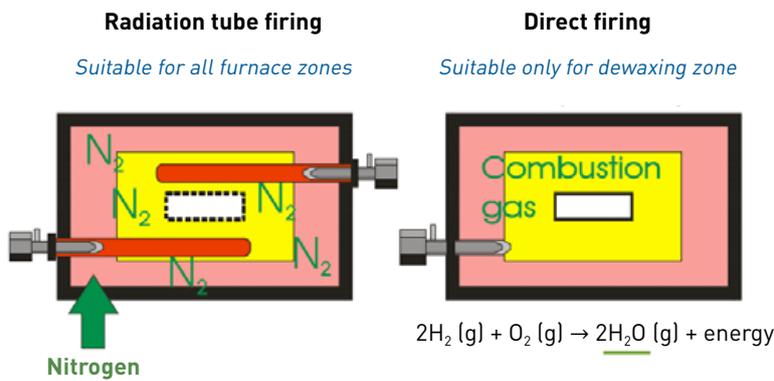


Fig. 11 Possible H₂ burner uses in sintering furnaces [3]

Typical sintering process gas compositions are shown in Table 1. It should be noted that CO will be automatically oxidised to CO₂ at the furnace exit. Replacement of Endogas (with the composition shown in Table 1) with a N₂ + 5-10% H₂ + 0.1-0.5% CH₄ atmosphere will reduce CO₂ by over 95% and also provide the benefits of precise carbon activity control, better control of gas wetness, elimination of health hazards and lower maintenance. On the other hand, there are no gas savings and, except where N₂ production is available on site, production costs are higher.

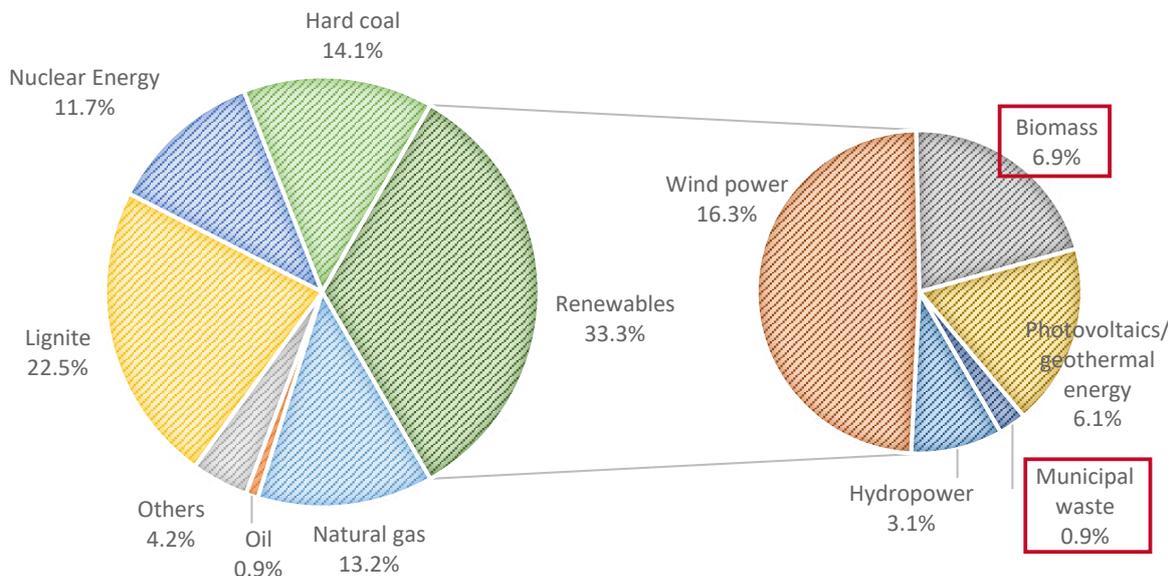


Fig. 12 Gross electricity generation in Germany in 2017 in TWh [3]

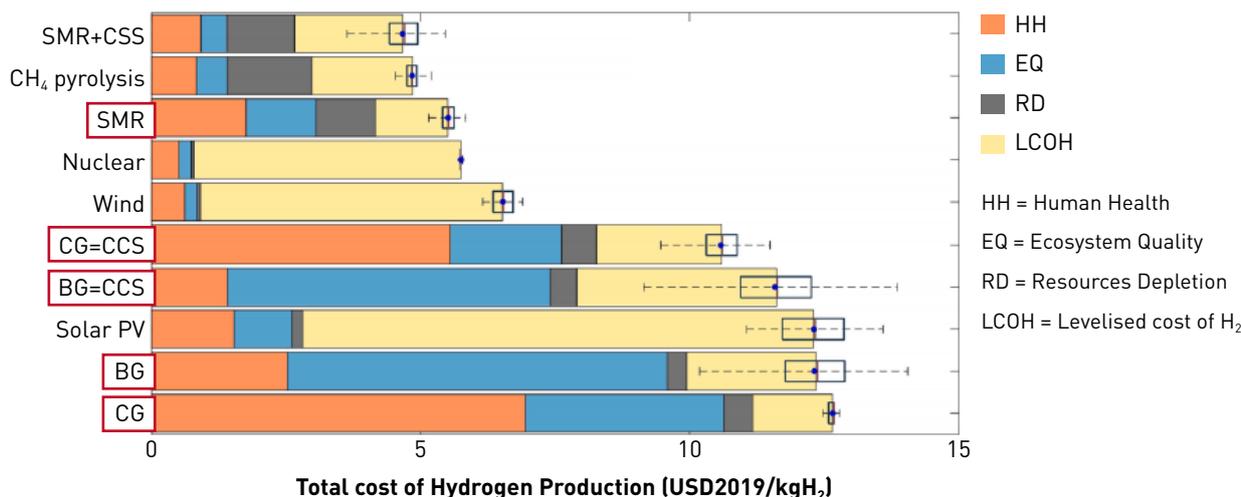


Fig. 13 H₂ gas production technologies in Germany. BG = Biomass Gasification; CG = Coal Gasification; SMR = Steam Methane Reforming; CCS = Carbon Capture and Storage; PV = Photovoltaics (Source: Al-Qahtani, A, Parkinson, B, Hellgardt, K, Shah, N, & Gullen-Gosalbez, G (2021). Uncovering the true costs of hydrogen production routes using life cycle monetisation. Applied Energy, 281, 115958) [3]

H₂-burners are already technically feasible for use in sintering furnaces, with radiation tube firing being suitable for all zones and direct firing being suitable only for the dewaxing zone (Fig. 11). In H₂-burners, higher flame speeds enhance stabilisation, but flashback needs to be avoided and therefore equivalence ratios up to 0.6 are recommended. Adiabatic H₂ flame temperatures are similar to those in natural gas burners and are suitable for high temperature sintering up to 1800°C. Steam diluted or stage combusted H₂ results in low NO_x emissions similar to natural gas, although more research on prompt/fuel NO_x routes is needed. Highly flexible control of reaction zone location (or flame front) is also possible to enable H₂ burners to be employed as flat flame burners. By using H₂ burners for thermal post-combustion, CO₂ reduction at exhaust gas burn-off is also possible. The crucial issue now, with H₂ burner deployment, is one of economic viability.

CO₂ reduction is also enabled through energy efficient furnace designs. Furnace energy efficiency improvement measures include suitable transporting devices, optimal thermal insulation and

optimisation of design of the RBO and Rapid Cool zones.

Finally, turning to hidden CO₂ sources, the author presented data on the generation mix in Germany for electricity production (Fig. 12). These data underline a clear need for an increase of the share of green renewables. Data on H₂ production in Germany (Fig. 13) show that the impact on external issues, such as human health, should also be taken into account in gas production cost analyses.

Sustainability and carbon footprint of high-temperature sintering

Continuing with the sintering theme, the benefits in sustainability and carbon footprint of high-temperature sintering (HTS) of PM structural parts were examined in a contribution presented by Alberto Molinari (University of Trento, Italy) and co-authored with Volker Arnhold (PM Solutions, Germany) and Vladislav Kruzhanov (PM

“Highly flexible control of reaction zone location... is possible to enable H₂ burners to be employed as flat flame burners. By using H₂ burners for thermal post-combustion, CO₂ reduction at exhaust gas burn-off is also possible. The crucial issue now... is one of economic viability.”

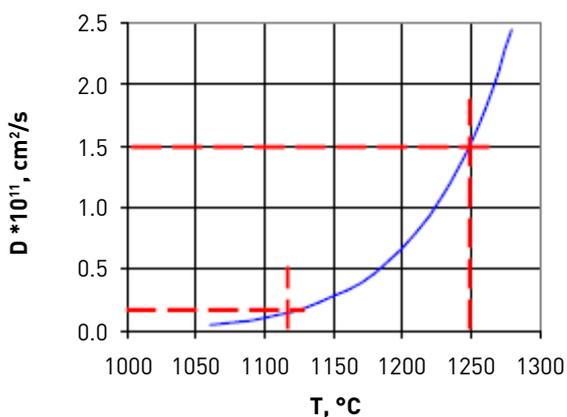


Fig. 14 Influence of sintering temperature on solid state diffusivity of iron [4]

Material	Nominal composition (wt.%)					
	Cr	Ni	Cu	Mo	Si	Graphite
A	-	4.1	1.5	0.5	-	0.49
B	3.0	-	-	0.5	-	0.45
C	1.1	-	-	0.8	0.7	0.60
D	1.3	0.4	-	0.8	-	0.65

Table 2 Material compositions studied in Project HTS2 [4]

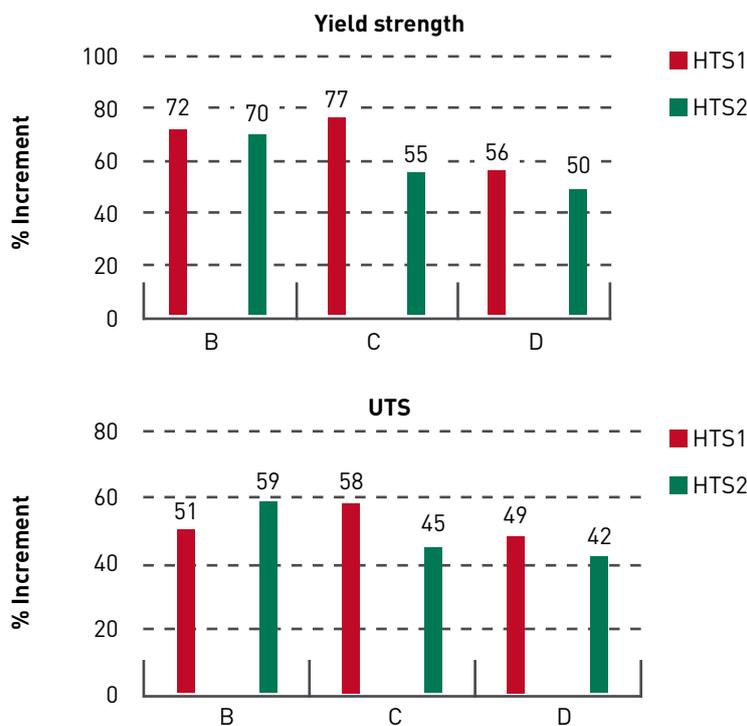


Fig. 15 Strength increments for the HTS materials as compared with the LTS of Material A (Ni-Cu diffusion bonded) [4]

Consulting, Germany) [4]. The data discussed largely arose from a two-stage EPMA Club Project (HTS1 and HTS2).

The main effect of increasing sintering temperature, from 1120-1150°C to 1250-1290°C, is an exponential growth in diffusivity. For example, the 10% increase in absolute temperature results in a 10-fold increase of solid state diffusion of iron (Fig. 14). This results in increased density, improved pore morphology and improved homogeneity, delivering either a reduction in process time for the same properties or better properties for the same process time.

Project HTS1 challenged the preconceived view that these benefits must be accompanied by a loss of dimensional stability and geometrical precision and demonstrated that, for simple ring geometry specimens and for five different material types, sintering temperature may be increased to 1250°C with no loss in dimensional or geometrical precision. Project HTS2 later confirmed this conclusion for parts with high geometrical complexity.

Project HTS2 also assessed the influence of HTS on achievable mechanical properties. Ni-free/low-Ni materials, specifically developed for HTS, were compared with a diffusion-bonded grade, traditionally used in LTS (low temperature sintering) for components with high property requirements (Table 2). It was demonstrated that, for the same dimensional/geometrical precision, HTS shows significant increments in strength (Fig. 15). This can allow component redesign to reduce size, with material usage and energy benefits.

The base iron powder in the examined materials was produced by water atomisation of molten iron produced from recycled steel scrap. There is a high potential for reduction of energy consumption, particularly in powder annealing (Fig. 16). The theoretical energy consumption in annealing, at 0.13 kWh/kg, is significantly lower than the currently achieved level of 0.3 kWh/kg.

The diffusion bonding process, for high strength grades processed by LTS, consumes considerable extra energy and hydrogen. HTS can allow the replacement of traditional alloying elements Ni and Cu with cheaper elements, such as Cr and Mn. The elimination of Ni is desirable because of its known carcinogenic problems in the inhalable fraction used in PM. Also, Cu additions can be a challenge in the recycling of PM steels.

The current price benefits of replacing Ni and Cu with Cr and Mn are shown in Table 3. Also, the trends towards e-mobility and renewable energy sources will mean future increases in Ni and Cu prices, because of high demand for these elements. Comparisons between the energy consumption in a mesh-belt furnace, used for LTS, and that in a roller furnace for HTS show that the roller furnace needs 10% more energy to heat parts up to sintering temperature. However, the mesh-belt furnace involves a large amount of redundant energy use in heating the belt and the energy lost in heating the protective gas atmosphere is not negligible. Also, the entry and exit locks on a roller furnace result in lower process gas consumption. The costs associated with these comparisons are quantified in Table 4. The data in this figure underline the gas and energy consumption benefits of the roller furnace.

The authors drew the conclusion that HTS can effectively contribute to the sustainability of press and sinter PM and to the improvement in its CO₂ footprint.

Achieving zero carbon in PM operations

The remaining presentation from Nick Painter and Richard Hodges (Ricardo, UK) came in two parts. Initially, Painter outlined Ricardo’s methodology for assisting client companies to achieve net zero carbon and then Hodges, in accord with the main focus of the

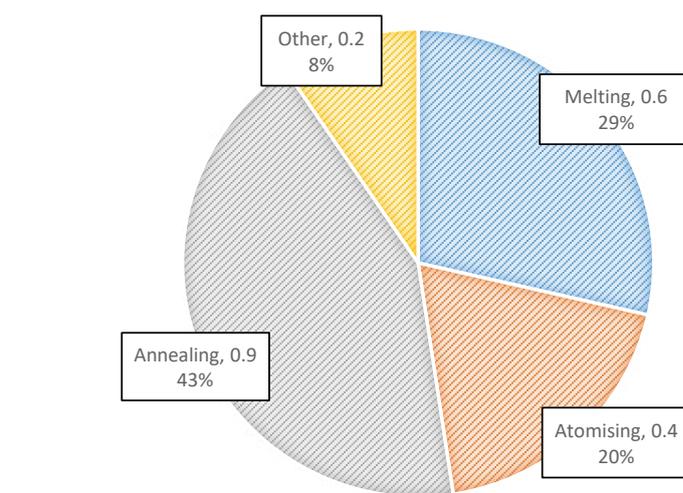


Fig. 16 Energy needs in powder production [4]

	wt. %	Fe	Cr	Ni	Cu	Mo	Si	€/kg
HAB – Distaloy AE		94.00	-	4.00	1.50	0.50	-	1.03
HAB – Astaloy CrM		96.50	3.00	-	-	0.50	-	0.46
GKN HC – Ancosteel 4300 mod		97.50	1.00	-	-	0.80	0.70	0.45
POM – Ecosint A		97.40	1.40	0.40	-	0.80	-	0.51
Metallpreise 2021 €/kg		0.25	4.00	14.00	9.00	19.00	2.00	-

Table 3 Material prices for the various alloys using current metal prices [4]

	Belt furnace - LTS	Roller furnace - HTS
Consumption of the process gas (N ₂ /H ₂)	50 m ³ /h	50 m ³ /h
Total electrical power to process the furnace at maximum loading*	100 kW	120 kW
Productivity	300 kg/h	460 kg/h
Gas consumption per kg of the sintered components	0.17 m ³ /kg	0.11 m³/kg
Energy consumption per kg of the sintered components	0.33 kWh/kg	0.26 kWh/kg
*measuring just the electrical power consumption in an optimised work load		

Table 4 Comparison of belt and roller furnaces [4]

seminar, addressed considerations for achieving zero carbon in Powder Metallurgy operations [5].

The Ricardo methodology (Fig. 17) comprised six stages, four in the planning phase (understanding

current emissions, analysing net zero pathways and defining targets, developing a net zero roadmap, building and maintaining governance) and two in the delivery phase (feasibility studies and design, implementing

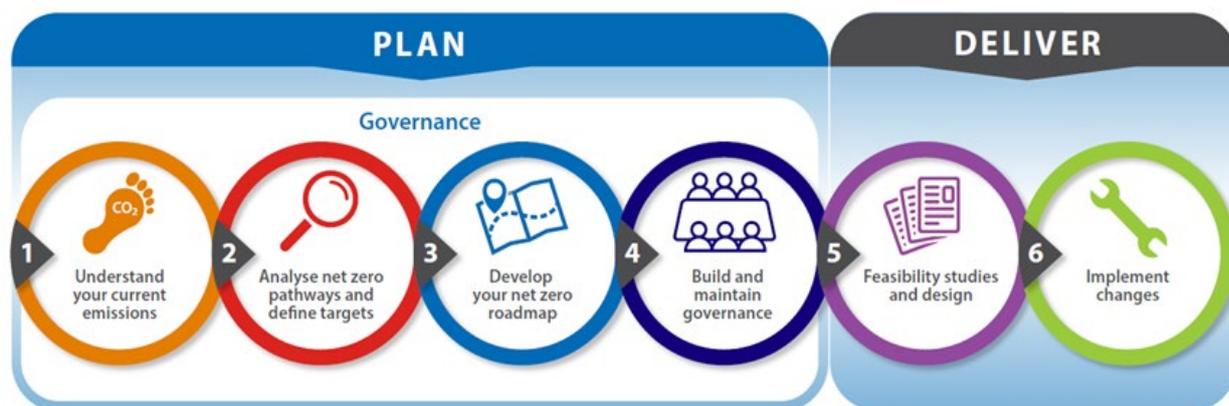


Fig. 17 Ricardo's six step approach for organisations to achieve net zero carbon [5]

changes). Ricardo can offer expertise and tools to assist clients in each of these stages.

Hodges opened by underlining PM's energy advantages over competing forming technologies (Fig. 18). Machining, casting and forging each have about 5 kWh/kg for input prior to the shaping process. PM has 2 kWh/kg for the production of iron powders using an electric arc furnace for melting and water atomisation.

Depending on the specifics of the plant under consideration, electricity is likely to make up the lion's share of energy consumption. The decarbonisation of Europe's electricity therefore provides a tailwind for PM decarbonisation. Actual CO₂ intensity of electricity in the UK in 2020 is estimated to be 196 g/kWh (including transmission and distribution losses) and will be

~100 g CO₂/kWh in 2025. This can be compared with a natural gas figure of 203 g CO₂/kWh. Therefore, low specific CO₂ emissions associated with PM components can be used as a marketing point (in addition to the other inherent advantages) as customers look to reduce the emissions associated with their supply chains.

In relation to powder production, the annealing stage is a major contributor to energy consumption, but with a large difference between actual and theoretically achievable levels (Table 5). This implies that attention paid to the annealing step in powder production is likely to pay dividends.

As regards PM component production, nearly 60% of energy is consumed in compaction and sintering (Table 6). Therefore, concentrating on the efficiencies of

these processes will typically pay the highest dividends.

In compaction, there is a need to maximise press utilisation levels to absorb fixed energy consumption over as many units of production as possible. Also, the author recommended consideration of the use of mechanical presses instead of hydraulic presses, where precision and complexity of the component allows this.

For the powder annealing and component sintering processes, improved furnace insulation should be sought to reduce radiative losses. Where gas is used to heat the furnace, the use of recuperative or regenerative burners to recover exhaust heat might be a viable measure. Depending on how much gas is used, savings can be significant and paybacks short. Recovery and reuse of heat from furnace cooling zones would also improve energy efficiency.

Moving beyond energy efficiency in seeking decarbonisation, a number of potentially valid measures were identified. Given the trajectory of decarbonising electricity grids, the technical feasibility of replacing any gas still used in annealing and sintering with electricity should be considered. Purchase of green electricity from suppliers would allow the reporting of zero CO₂ intensity in respect of this electricity while the overall grid intensity is still falling. Where the

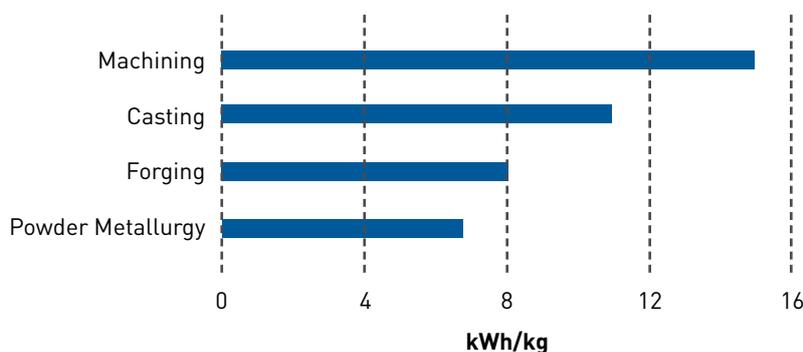


Fig. 18 Energy consumption comparisons between PM and competing processes [5]

consumption of gas from the grid is still necessary, the purchase of Green Gas Certificates should be considered. This may be the only near term option for dealing with emissions from unavoidable gas consumption for the generation of protective sintering atmospheres. Similarly, where the consumption of gas is still necessary, the direct supply of biogas from a local Anaerobic Digestion plant should be explored.

Finally, autogeneration may be an option worth considering. Generation of renewable electricity on site for internal consumption, using Photo Voltaic (PV) or wind turbines, could be valid. There will be a range of incentives available to improve the economics of pursuing this option, depending on the local jurisdiction.

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References

[1] The road towards climate neutrality for the PM industry from a powder production perspective, Hilmar Vidarsson. As presented at the Euro PM2021 Virtual Congress, October 18-22, 2021.

Process	Theoretical minimum (kWh/kg)	Typical actual measured values (kWh/kg)
Melting	0.3	0.6
Atomising	0.1	0.4
Annealing	0.25	0.9
Other	-	0.2
Total	0.65	0.21

Table 5 Energy usage in powder production (Source: Kruzhanov, Powder Metallurgy, Vol. 55 No. 1 p.14 (2012)) [5]

Process	Typical actual values (kWh/kg)
Compaction	1.0
Sintering	1.8
Heat treatment	0.2
Atmosphere	0.5
Sizing	0.3
Pneumatic	0.2
Other	1.0
Total	5.0

Table 6 Energy usage in PM component production (Source: Kruzhanov, Powder Metallurgy, Vol. 55 No. 1 p.14 (2012)) [5]

[2] An overview on energy efficiency of presses and latest trends for consumption optimisation, Pietro Albonetti. As presented at the Euro PM2021 Virtual Congress, October 18-22, 2021.

[3] Opportunities for CO₂ reduction in sintering furnaces, Narayana Kaushik Karthik. As presented at the Euro PM2021 Virtual Congress, October 18-22, 2021.

[4] Sustainability and carbon footprint: High Temperature Sintering (HTS) of structural parts, Alberto Molinari, Volker Arnhold and Vladislav Kruzhanov. As presented at the Euro PM2021 Virtual Congress, October 18-22, 2021.

[5] Innovation to drive net zero carbon operations in powder coated material manufacturing, Nick Painter, Richard Hodges. As presented at the Euro PM2021 Virtual Congress, October 18-22, 2021.

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How to make metal powders.

Part 2: Understanding water atomisation and water atomised powders

In the Winter 2021 issue of *PM Review*, we introduced the first instalment in our four-part series on metal powder atomisation, in which two masters of atomisation, Joe Strauss and John Dunkley, introduced the fundamental principles of atomising technology and atomised powders. Now, in the second instalment in the series, they explore one of the most widely used metal powder production methods – water atomisation. This long-established technology is used to produce a vast range of metal powders for many industrial applications, including press and sinter PM and MIM, and is now making inroads into metal AM.

General attributes of water atomisation

As outlined in our introduction 'How to make metal powders. Part 1: An introduction to atomisation, process fundamentals and powder characteristics,' published in the Winter 2021 issue of *PM Review*, materials in the form of powder constitute a substantial volume of many metals, ranging from ~0.1% to nearly 50% of global production of different alloys. Probably the majority of metal powders by mass are produced by water atomisation. This is a long-established process whose origins are unclear, but the preparation of iron and steel shot goes back over a century, and high-pressure water atomisation was perhaps originally developed for non-ferrous metals.

The great Dr W D Jones of FW Berk Chemical, later Powder Metallurgy Ltd, did pioneering work in the 1940s and 50s that led to the first stainless steel and self-fluxing nickel alloy powders. Since then, plants

have grown from the initial 100–200 kg for high alloys to 2–5 t units for pig iron in the 60s, then progressed to arc furnaces for 10 t, 20 t and 60 t ladles of steel, and now include units up to 110 t for iron powder serviced

by oxygen steelmaking vessels. A 5 t unit is shown in Fig. 1.

The water atomisation process utilises high-pressure (and hence high-velocity) water sprays to break up a stream of molten metal. There



Fig. 1 5 t capacity atomiser in operation. The molten metal from the tilt pouring melter (upper right) is poured into the tundish, which feeds the atomiser (Courtesy ASL)

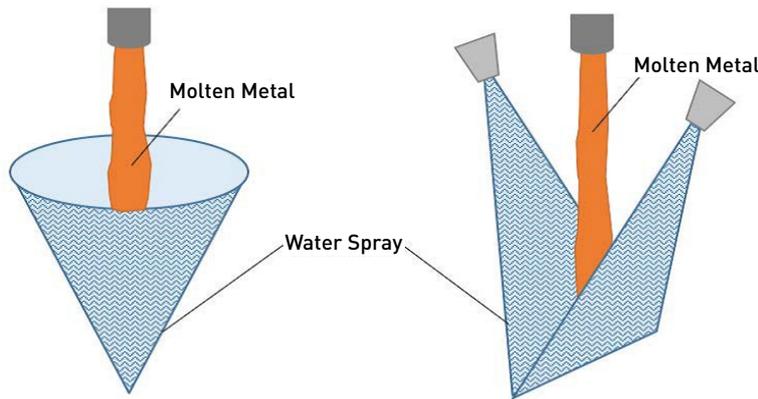


Fig. 2 Schematics of the two primary water jet configurations: conical (left) and V-jet (right) [Source: *Experimental and Computational Analysis of a Water Spray; Application to Molten Metal Atomization*, Ali Asgarian, presented at POWDERMET2018] [Courtesy MPIF]

are two basic types of jet configuration in use: the conical jet and the V-jet, as shown schematically in Fig. 2. In both cases, the melt stream falls vertically into the water jet array, which breaks it up into droplets. Due to the intense heat transfer to the water, the droplets freeze very rapidly into powder particles, which are contained in an atomisation vessel (Fig. 3). The process is often carried out with an inert atmosphere in the vessel, but also with air-swept units.

The water pressures range from as little as 20 bar (2 MPa) to 200 bar (20 MPa) for most applications, but can reach up to almost 500 bar (50 MPa) with modest design modifications, beyond which totally different designs are needed due to the fact that the water velocity reaches sonic speeds. These very special Ultra-High-Pressure (UHP) water atomisers can use pressures of 1000–2000 bar (100–200 MPa) to produce ferrous, silver, and copper powders with median sizes finer than 10 µm.

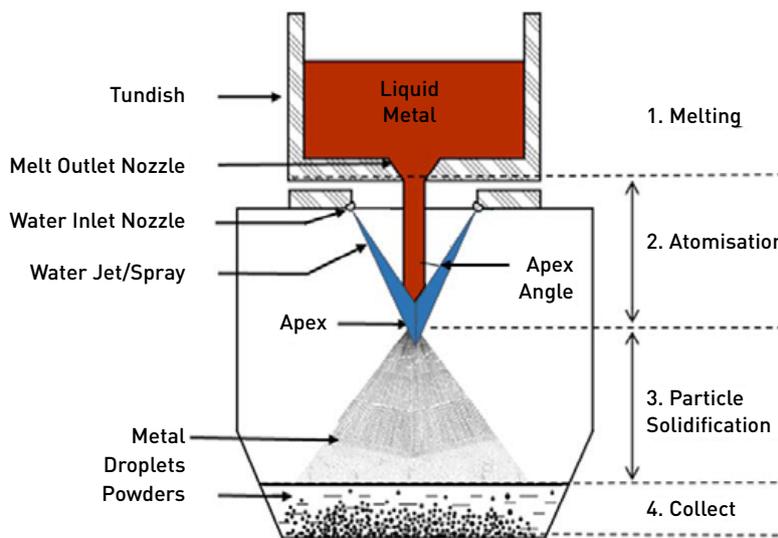


Fig. 3 A schematic of the fundamental water atomisation system layout [Source: *Jiao, Z, Asgarian, D L A, Chatterjee, S, Girard, B, Paserin, V, Lavalley, F, and Chattopadhyay, K. (2016) 'Influence of Apex Angle and Nozzle Design on Energy and Momentum Transfer during the Water Atomisation Process*, presented at POWDERMET 2017] [Courtesy MPIF]

As the process is used for a vast range of metals and alloys, from zinc to platinum and Fe, Co, Ni, Cu, Au & Ag, the scale of operation can vary from 1 kg units for gold to 100 t systems for iron operating at 30 t/h. Zinc is produced continuously for many days at 3 t/h, while batch operation is more common for most metals and alloys, which may be required in a huge variety of compositions, sizes and shapes.

The very largest water atomisation systems are those for blast furnace slag, which can operate at 5 t/min, so the productivity of this process sets it apart from all other technologies, except perhaps centrifugal atomisation, which is also highly scalable. For small quantities (e.g., of precious metals and their alloys), atomisation at ~1–10 kg/min is typical, with batches from 5–250 kg. For copper alloys and high-alloy materials such as Ni and Co alloys, melt sizes of 100–1000 kg are common, atomising at 20–70 kg/min. High-alloy steels such as stainless steel are typically made using furnaces from 500 kg–5 t, and atomisers operating at from 50–200 kg/min. Iron powder is produced at 200–500, or even approaching 1000 kg/min.

The unit cost for water atomisation is among the lowest of all atomisation processes. Although a water pump, which can represent a significant cost for larger systems, is required. Water is typically inexpensive and reusable. Conversely, gas atomisation systems use compressed gas, which requires relatively elaborate storage and handling hardware or a compressor system and the gas may not be able to be reused. Thus, PM processes seek to use water atomised powder as their first choice due to its lower cost. For example, Metal Injection Moulding (MIM) and Additive Manufacturing (AM) processes were developed around gas atomised powder, but new applications are being developed which aim to use water atomised powder to provide a cost advantage.

Characteristics of powder made by water atomisation

The disintegration of the melt stream by high-pressure water produces a myriad of powder particle shapes, from spherical to highly irregular, depending on several factors, including the atomisation water pressure, configuration of the water jets, the water to melt mass ratio, melt superheat, and the way in which the alloy interacts with the water (i.e., oxidation). Fig. 4 shows some of the powder particle morphologies attained via water atomisation. The majority of water atomised powder is used for its surface area (as a precipitant for hydrometallurgical refining or for leaching) or for the ability to deform and interlock when die compacted for the production of discrete parts via press and sinter Powder Metallurgy.

In these cases, the water atomisation process is conducted to provide the highest cooling rate so that solidification of the newly formed metal droplets formed by the disintegration of the melt stream solidify prior to being able to spheroidise. This is achieved by high water to melt ratios, low melt superheat, a large engagement zone between the water jets and the melt stream, and a high water level in the collection vessel. Conversely, more spherical powder is produced using lower water to melt ratios, etc., and these powders are finding use in MIM and Additive Manufacturing. Particle size is mostly a function of the atomisation water pressure.

Types of water atomisers

There are a huge variety of designs of water atomiser, but they can be classified into either batch or continuously operating types. Batch atomisers are by far the most common. The high atomising rates, which are readily achieved in water atomisation, and the ability to change over alloys, mean that batch systems can have a high productivity and alloy

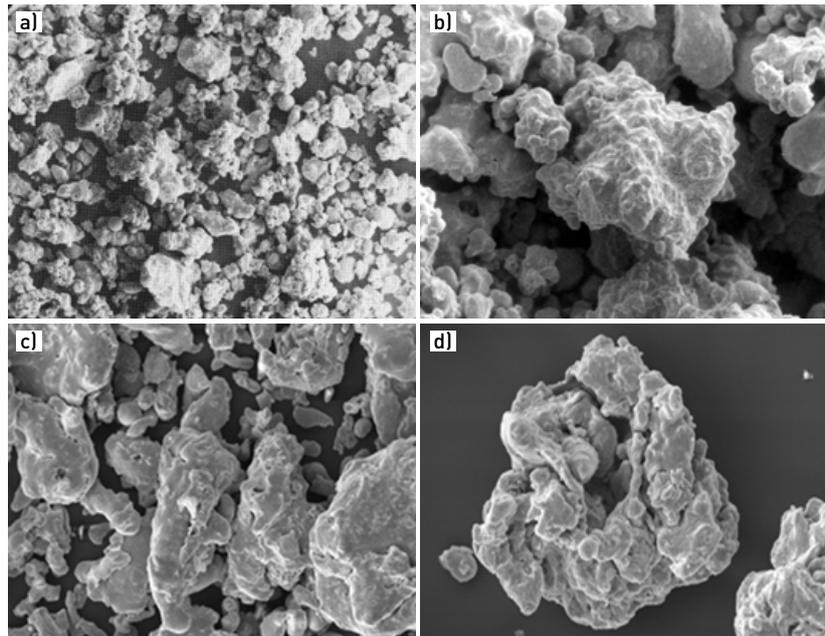


Fig. 4 a) Water atomised iron, 100X magnification, b) Water atomised steel, 300X, c) Water atomised 316 stainless steel, 300X, d) Water atomised bronze, 630X (Source: 'International Atlas of Powder Metallurgical Microstructures', MPIF 2002)

versatility. Batch atomisers cover a large range of sizes. The smallest systems, for example producing 1–10 kg batches of precious metals, will be very compact and large enough to contain the water and powder from one batch run in one vessel, which is important to minimise losses.

The same arrangement is sometimes used for medium-sized alloy powder plants, from 100–500 kg capacity, but in these cases, the vessel does not have the capacity to hold all of the water from the entire run so the system must be continually emptied. This is achieved with the use of slurry pumping from the atomiser to a separate dewatering system, which may be batch settling, or a continuous type of unit like a vacuum filter, hydrocyclones, or

magnetic dewatering device. Once batch sizes exceed 500 kg, up to 100 t, it is increasingly necessary to use separate – and sometimes multi-stage – dewatering and drying systems, so system design is very varied, depending on such factors as flexibility of alloy, value of alloy, particle size to be made, and the properties (e.g., ferromagnetism) of the alloy. There are large systems (such as that shown in Fig. 1) which are ladle-fed from smelters where the objective is to convert the molten alloy into a powder for subsequent leaching or dissolution for hydrometallurgical refining. These must be designed so that the cadence of the tapping of the smelter matches that of the downstream dissolution process.

“... Once batch sizes exceed 500 kg, up to 100 t, it is increasingly necessary to use separate – and sometimes multi-stage – dewatering and drying systems, so system design is very varied.”

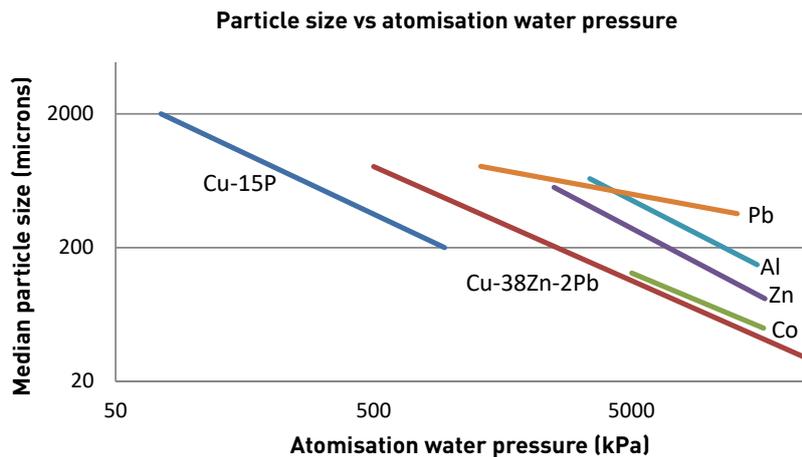


Fig. 5 Log-log plot of median particle size vs atomisation water pressure (Source: J J Dunkley, 'The Production of Powders by Water Atomization,' Powder Metallurgy International, Vol. 10 (no. 1) 1978, 38-41, used with permission from ASL)

Operating pressures

It is a special feature of water atomisation that the median particle size of the powder is almost inversely related to the operating pressure, as shown in Fig. 5. The illustrated plot relationship between the median particle size and water atomisation pressure applies over all alloys and over a wide range of atomisation pressure. This means that water atomisation can be used for making everything from millimetre shot to $10\ \mu\text{m}$ powders, a range of about 100:1 in size. Obviously, the system design will be hugely affected by the choice of pressure, in turn dictated by the desired particle size distribution.

Low pressure atomisation is carried out below ~50 bar (5 MPa) and operating pressures as low as 1 bar (0.1 MPa) are used in shotting.

Median particle sizes (for steels) around 200 μm only need ~20 bar (2 MPa). Medium pressure is used for typical PM grades ($200\ \mu\text{m}$, median ~50 $\mu\text{m}</math>, made at 100–150 bar (10–15 MPa).$

High pressures from 200–500 bar are used to make powders with median sizes as small as 20–30 μm . Ultra-High pressures of 1000–2000 bar can be used in very special designs to make powder with median sizes below 10 μm .

As the pressure increases, the kW of the HP water pumps rises pro-rata. Thus, a 60 kg/min atomiser running at 150 bar and using a 6:1 water/metal ratio (sufficient, for a steel, to limit the slurry temperature to ~50°C above the head tank temperature) needs a 360 l/min pump which absorbs 90 kW. However, at 1500 bar (150

MPa) it would need 900 kW. It is also notable that a steel flow with ~1300 kJ/kg at 60 kg/min (so 1 kg/s) is a heat input of 1300 kW. The energy of pumping water at 1000 bar (100 MPa) is thus approaching the energy in the melt and the temperature rise of the water in atomising will rapidly approach 100°C and boiling will occur – not an easy matter to design for. Thus, ultra high pressure (UHP) atomisation tends to be run at lower water (and metal) flow rates to reduce pump costs and operating problems.

Generally speaking, the water/metal ratio should be selected to avoid boiling of the water, so the minimum depends on the heat content of the melt, which can range from as little as 250 kJ/kg for Au to 1340 kJ/kg for Fe (and 3060 for Si!). However, it is not mandatory to supply all the water at high pressure; secondary, low-pressure water can be used to absorb the heat. Thus, atomisation water flow rates as little as one litre of water/kg of metal are possible. However, this can certainly affect both particle size and shape, and must be carefully considered.

Major system parts

Melters

Melting is a fundamental component to all methods of atomisation. For batch systems under about 20 kg, the primary melting may be done in the tundish feeding the atomiser by using a stopper rod to control the initiation of the melt flow. Above that size, a primary melter is used, which feeds the tundish usually by tilt pouring. In this configuration, the tundish is heated to mitigate heat losses, rather than heating to the atomisation temperature.

Primary melters

For water atomisation, various methods are used for the primary melting. Coreless induction melting dominates all plants below 10 t batch size, above which arc furnaces, Oxygen steelmaking, or smelting units take over. That said, induction

“It is a special feature of water atomisation that the median particle size of the powder is almost inversely related to the operating pressure... This means that water atomisation can be used for making everything from millimetre shot to $10\ \mu\text{m}$ powders...”

melting is now carried out at a scale of 50 t. As even a large atomiser will take over an hour to process such a batch, feeding atomisers above about 5 t is often done using well-insulated ladles fed by a large primary melt source, to allow the furnace to melt at high utilisation.

Tundish

The primary melter pours into the tundish, which acts as an intermediate reservoir that feeds the atomiser. The melt rate is controlled by a combination of the orifice size of a hole or nozzle insert in the bottom of the tundish and the metallostatic head pressure above this orifice. Another objective of the tundish design is to mitigate heat loss of the melt while in the tundish. The tundish must be well insulated and it may also be heated. For smaller or slow feed systems, the tundish may be heated to above the melting point of the alloy to prevent the melt from freezing. Induction or fuel-fired melters can be used, depending on the melting point of the alloy. For systems that pour at high enough rates so that heat loss through the tundish is minimal, there may be no tundish heater, although flame or resistance pre-heating is usually employed to prevent immediate freezing of the alloy.

Atomising head

The atomising head is primarily made up of the assembly of water jets but may also contain functions for delivering additional water and secondary gases. The atomisation head is typically either separately housed or inside the atomisation vessel and can be inert gas purged, which reduces oxidation of the powder and is also a safety feature to avoid hydrogen explosion problems. There are many designs of atomising heads, but they basically split into those using multiple discrete V-jets and conical spray designs as shown earlier in Fig. 3. The conical spray designs are generally only used for large-scaled iron powder plants, as they lack somewhat in flexibility, but are very robust.

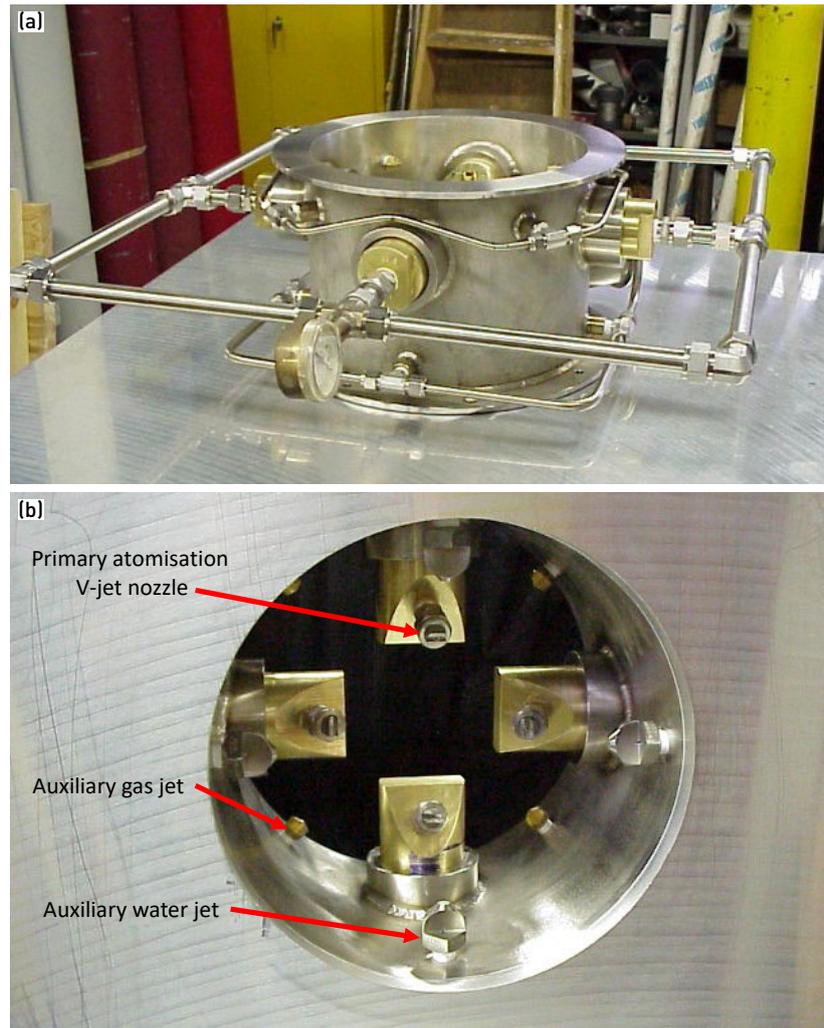


Fig. 6 (a) Small or research atomisation head assembly and (b) atomisation head from the bottom (Courtesy HJE Company, Inc. R&D Division)

Fig. 6 (a) and (b) shows an elementary atomisation head typical of small- to medium-sized systems (5–30 kg/min). In this example, there are four fan-jet nozzles housed in a radially symmetric array. The apex angle can be adjusted by indexing the nozzle holder. Also shown are additional fan-jet nozzles above and below the atomisation nozzles. The ones above provide process gas (inert or air) and the ones below provide additional low-pressure cooling water, if required. The use of fan-jets in this type of atomisation head allows a lot of flexibility in water energy density, apex angle configurations, and operating pressure and flow, which makes them popular for research or multi-alloy operations.

For low- to high-pressure systems, standard off-the-shelf fan-jet type nozzles can be used, which allow the systems to match pump flow and pressure capacity to melt flow rate and ultimately particle size and distribution. For UHP systems, where the water jet velocity can be super-sonic, custom nozzles are required.

High-pressure

High-pressure pumps can vary in design. For lower pressures (up to ~20 bar [2 MPa]) multi-stage centrifugal pumps are possible, and they are used for huge iron powder plants at up to 150 bar (15 MPa), but efficiency is low (~60%) and flexibility is poor. Positive displacement plunger pumps are a



Fig. 7 A small heat being poured into a 5 kg rated atomiser (Courtesy ASL)

more popular choice for pressures above 20–50 bar (2–5 MPa) as their efficiency is over 90% and they allow great flexibility in operating pressures. Recent advances have seen the development of UHP pumps, for concrete cutting and even water-jet cutting of steel, that can reach pressures of over 2000 bar (200 MPa), although, as noted above, power requirements are, inevitably, high, and special nozzle jets will be required.

Atomising vessels

Atomising vessels vary greatly in design. One common feature is a conical base to collect the powder or as an exit from where the slurry is pumped. Tiny units, used for gold,

etc, can collect all of the process-generated slurry inside and use water flow rates of only 30–50 l/min. 250 kg high-alloy atomisers which collect slurry need to have a vessel volume of over 2 m³ and begin to resemble gas atomisers. If slurry pumping is done, the vessel can be very compact and have a volume as small as 100–200 l. The internal design is very important, as absorbing the energy of the water jets without disturbing the entering stream of melt is critical. This leads to the use of relatively large units for iron powder; typically ladle-fed systems, with internal volumes of 1–3 m³ or larger.

Dewatering

Dewatering of the slurry can occur in the atomiser for really small units, up to 50–100 kg, but generally the slurry is pumped away to be dewatered for larger units. A huge range of methods is available: hydrocyclones, vacuum filters (rotary and flat bed) magnetic separators, spiral classifiers, rake classifiers, continuous and batch centrifuges, to name a few. Selection requires consideration of flexibility, speed, corrosion of the powder, efficiency, energy consumption, etc. Often, two-stage dewatering is used, such as hydrocyclone thickening the feed from 10% solids to 80% to a vacuum filter which reduces moisture to 3–5% in the cake.

Drying

Drying is another process that presents a huge range of options including rotary, flash (pneumatic), tray (both vacuum and air), double cone and other jacketed mixer driers. Again, a number of factors must be considered in selection, including powder oxidation/corrosion, PSD, density, mechanical damage to particles, explosivity of the powders.

Collection/transport

Collection/transport of the powder, whether dried or damp, presents many options. For flexibility and cleanability, handling in IBC (Intermediate Bulk Containers) or mobile hoppers is excellent, but clearly more laborious than conveying, which obviously is not applicable if grades/alloys are frequently changed. Screw, belt, and both lean- and dense-phase conveyors are used in single-product (alloy) plants.

Oxide reduction/annealing

Oxide reduction/annealing is necessary for PM grade iron and steel powders, and is done in continuous belt furnaces ranging up to 6 t/h capacity. Some special powders, like high speed tool steel, are vacuum annealed to reduce the oxygen content from ~0.2% to ~0.08%. The costs of these operations, both

capex and opex (especially energy/CO₂ emission costs) can exceed the costs of the melting and atomisation stages, so they are only used when essential.

Particle size separation (sieving and classification)

Particle size separation (sieving and classification) is almost universal for powder for PM, AM, and thermal spray applications (it is not needed for leaching applications, neither are dewatering and drying). For simple scalping (e.g., removing 5% > 250 µm), simple vibratory or huge gyratory sieves are suitable with capacities of many t/h. For complex cuts, such as demanded by AM, thermal spray, and filter markets, a wide range of systems are used, often working at very low speeds (< 100 kg/h). Separation rates fall rapidly with mesh size and many types of sieves are unsuited to use below 100 µm, although the use of ultrasonic anti-blinding devices has helped operations down to 45 µm. Recent developments have seen sieves capable of cuts as low as 10-20 µm, but productivity is very low, the sieve cloth for fine micron separation is expensive, and its life is limited. Sieving is, sadly, a 'dark art' and poorly understood. There are many different types of machines, and reliable advice is hard to come by. Presently, air (or inert gas) classification is most often used for cuts below 50 µm, even down to a few microns, to make MIM powders (typically D90 of ~20-25 µm) and AM powders (typically -53+20 µm).

Explosion issues

There are two concerns relating to explosions in water atomising (in addition to the – probably much greater – risk of serious accidents in induction melting, due to bridging and lining failure). One is dust explosions, the other hydrogen explosions.

Dust explosions are possible if a metal is sufficiently reactive to burn and the powder is sufficiently fine to allow an explosible/combustible



Fig. 8 Metal powder samples await chemical analysis at Atomising Systems Ltd (Courtesy ASL)

concentration of dust to build up. These incidents are very rare in water atomisation plants, but need to be considered in designing plants handling MIM powders, such as UHP systems. The major incidents, some incurring fatalities, that have occurred have been related to iron powder reduction, where the newly reduced fines can be explosible and great care over housekeeping is essential and mandatory.

Hydrogen is generated when many metals are water atomised, due to the formation of metal oxide: $M + H_2O = MO + H_2$. It is easy to calculate that an atomiser processing X kg/min of a powder with Y% oxygen content will release 14XY litres/min of Hydrogen. So, while processing

FeSi15 at 50 kg/min with oxygen content of 0.1% produces ~70 l/min of hydrogen, atomising 50 kg/min of FeMn with oxygen content 1% produces 700 l/min. Thus, the plant has to be carefully designed to purge away this hydrogen and avoid any risk of an explosible mixture of air and hydrogen forming inside the atomiser. This can be done by flooding with an inert gas or with enough air to dilute the gas within the atomiser vessel below the explosibility limit. Generally, it is found that the spray jets inhibit propagation of explosions and that keeping the atomiser volume to a minimum much reduces the risk. If large vessels are used, of several cubic metres, then explosion relief doors or panels may be needed.

“The internal design [of atomising vessels] is very important, as absorbing the energy of the water jets without disturbing the entering stream of melt is critical.”

Water recycling

It has been many years since it was acceptable to pump hot and dirty water from an atomiser into the drains (although one client found he was losing several tons/year of nickel in this way). A properly designed water atomiser should have a closed water recycling system to filter and cool the process water and put it into a tank with sufficient head to feed the HP pumps without cavitation issues. It is generally recommended that batch operating plants have sufficient water in their head tank for operation for at least 50% longer than the design run-time. This will account for start-up delays, shut-down delays, and potential slow running of the melt.

Filtration demands, especially for UHP plants where sub-micron particles occur, are quite challenging and magnetic filters, cartridge filters, pre-coat filters, as well as hydrocyclones and centrifuges are used, often in multiple stages. High efficiency is achievable; a 25 kg batch atomiser making pure silver at ~50 t/yr (but at 10 kg/min) recycled all water except that evaporated in drying, and only found ~1 kg of powder in their head tank after a

year – indicating a 99.998% metal recovery. While the atomiser may need to use 6 m³ of water per ton of powder, with good practice the water can be filtered and reused with losses generally less than 1%.

Conclusion

Water atomisation is, for the most part, a very robust process. In the simplest sense it is just the union of two relatively straightforward processes: pouring molten metal and operating a high-pressure water pump. Both of these unit operations are commodities that are well-understood and have a wide knowledge base. There are many sources for the equipment involved and these operations are highly professional. However, it is necessary to integrate equipment properly so that the atomisation process is reliable as well.

Water atomisation equipment is typified by having a relatively small foot print for the actual atomiser. However, post processing (water slurry transport, separation, drying, reduction/anneal, waste water treatment) is involved and greatly increases the foot print and complexity of the entire operation.

This somewhat limits the scale of the operation to larger production applications. Operating at small scales is limited to more costly alloys and applications.

Most applications of water atomised powder take advantage of its irregular morphology for die compaction, uses requiring high specific surface area, and low cost. However, the water atomisation process can be tuned to produce more spherical particle morphologies, which are usable in MIM and are also making inroads into metal Additive Manufacturing.

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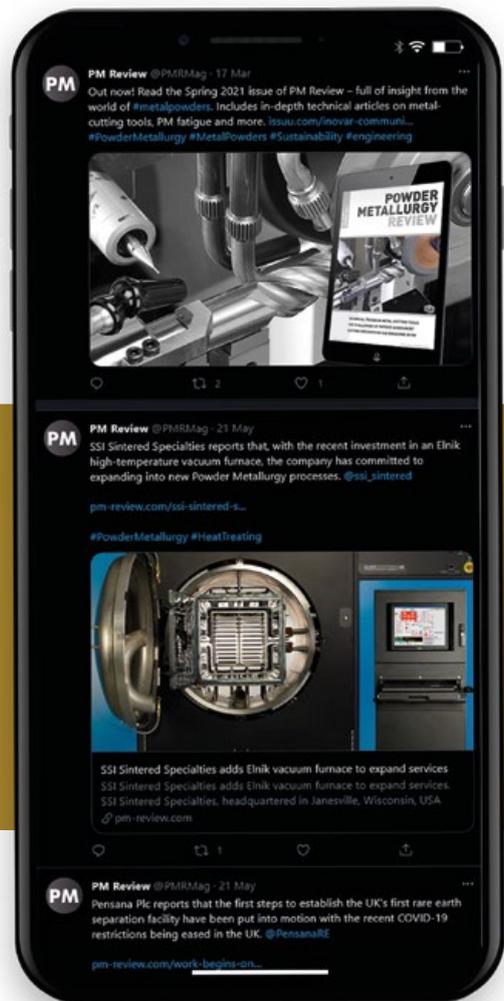


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Gasbarre Products, Inc: Three generations of press and furnace expertise in the heartland of North America's PM industry

West-central Pennsylvania, USA, boasts the largest concentration in the world of PM parts manufacturers. As a result, it is also home to many of the largest material, equipment and solution providers that serve them. Among the best known of these is Gasbarre Products, Inc., manufacturer of a range of presses and furnaces that have served as the workhorses of this industry for decades. Bernard North visited the company and spoke to Alex Gasbarre (CEO), Mark Thomason (International Sales Manager), Heath Jenkins (president – Press and Automation), and Mark Saline (president – Sinterite and C.I. Hayes), about Gasbarre's history, present, and plans for the future.

George Gasbarre began his career in the PM parts and associated press and furnace manufacturing industries and, after several years in the field, he came to believe that there was a need for a press manufacturer focused specifically on the needs of PM parts manufacturers. In 1973, he launched his own company, specifically the Gasbarre Press Division, from the back of a gas station in Falls Creek, Pennsylvania. Sons Tom and Bill (both still very active in the business) recall pumping gas to help cash flow during the fledgling company's early days.

Initially, the company brought in press frames from an external supplier to use as the basis for mechanical compaction and sizing presses, but progressed to integrated press manufacturing, and, in 1980, moved a few miles to their current DuBois headquarters and press manufacturing site (Fig. 1).

The company grew organically in the following years, and made

strategic purchases of other press companies, as well as acquisitions in the synergistic press tooling and furnace areas. Table 1 shows the company's acquisitions by calendar year.

These acquisitions were carried out mindfully, with great attention to continuity of business to minimise any customer disruption, and, in some cases, with an extended period of manufacturing at the acquired



Fig. 1 Gasbarre HQ in DuBois, Pennsylvania, USA [Courtesy Gasbarre Products, Inc.]



Fig. 2 Founder George Gasbarre, pictured with a Gasbarre press in the company's early days (Courtesy Gasbarre Products Inc.)

“West-central Pennsylvania is a very stable, family- and community-oriented area – mostly quite rural but with a strong manufacturing base, which, in turn, allows job openings to be filled quite readily with reliable people.”

Year	Company	Location	Business type
1989	Sinterite	St. Mary's, Pennsylvania	Custom sintering furnaces
1997	McKee Carbide Tool	Olanta, Pennsylvania	Precision tooling
1999	PTX Pentronix	Plymouth, Michigan	High speed mechanical compacting presses
2000	Best Hydraulic Press	Castle Hayne, North Carolina	Hydraulic compacting and sizing presses
2002	SIMAC Ltd	Rugby, UK	Dry bag cold isostatic presses
2003	C.I. Hayes	Cranston, Rhode Island	Conveyer, pusher, and vacuum furnaces
2011	J.L. Becker	Plymouth, Michigan	Heat treatment furnaces
2012	Major Powdered Metal Technologies	Livonia, Michigan	Press tooling

Table 1 Gasbarre's acquisitions by year

company's site before relocation. Two of the acquired business sites, and most of the brand names, have been retained to this day.

Gasbarre in the present day

Over time, the acquired businesses' manufacturing has been consolidated in three Pennsylvania locations, in and around the state's key PM manufacturing locations of St. Mary's, Brockway, Ridgway, Emporium, and DuBois. The company's press manufacturing and headquarters are located in DuBois, its furnace making is located in St. Mary's, and its press tooling production is situated in Olanta. Together, its facilities boast a total manufacturing floor area of 14,000 m² (150,000 ft²). In addition, there are engineering, sales, and service centres in Livonia, Michigan, and Cranston, Rhode Island. The Livonia site also has two test furnaces to enable the demonstration and proving out of heat treatment cycles. The company maintains several authorised distributors internationally; in Asia, its authorised distributors provide most of the service and support, but elsewhere customer support is offered directly from central locations.

Group sales are currently approximately \$45 million per annum (and growing) and, as of mid-December 2021, the staffing level was 175, plus eleven recruitment openings. Geographically, the company's sales are currently made up of approximately 85% North America and 15% overseas. By product type, the sales split is 50% furnaces, 40% presses/tooling, and 10% contract manufacturing, fabrication, and assembly. Approximately 50% of sales are for new capital purchases by customers, with the rest consisting of 'aftermarket' service, equipment upgrades and tooling. By market area, the mix varies, but for the eighteen-month period prior to December 2021 it was, per Fig. 3, approximately 26%

automotive, 22% general industrial, 10% lawn and garden, and 7% each for aerospace, electronics, medical, and military, with the remaining 14% spread across multiple industries.

The keys to Gasbarre’s success

The author spoke to the company’s leadership about what they felt were the reasons for Gasbarre’s success. The factors they mentioned run the gamut from its employees to its business practices, further detailed below.

People and community

West central Pennsylvania is a very stable, family- and community-oriented area – mostly quite rural but with a strong manufacturing base, which, in turn, allows job openings to be filled quite readily with reliable people. The company conducts extensive training of its workforce and participates in external education through JEFF TECH (Jefferson County – Dubois Area Technical School), Penn State Continuing Education, Triangle Tech, and local high schools. Gasbarre practices an active Solutions Program, where employee proposals of improvement ideas are strongly encouraged and reinforced (Fig. 4).

Alex Gasbarre spoke highly of the company management’s experience and ability to empathise with its customer’s needs, as well as the quality of the wider workforce. “Our leaders are very experienced, including at companies typical of those who purchase Gasbarre products – they have ‘walked in the customer’s shoes’ and know what is important,” he explained. “The workforce has an excellent work ethic, and is very experienced and loyal, with an average service level of thirteen years – twenty-one of them with over thirty years.”

Service offering

The company management explained that the press and furnace businesses maintain dedicated instal-

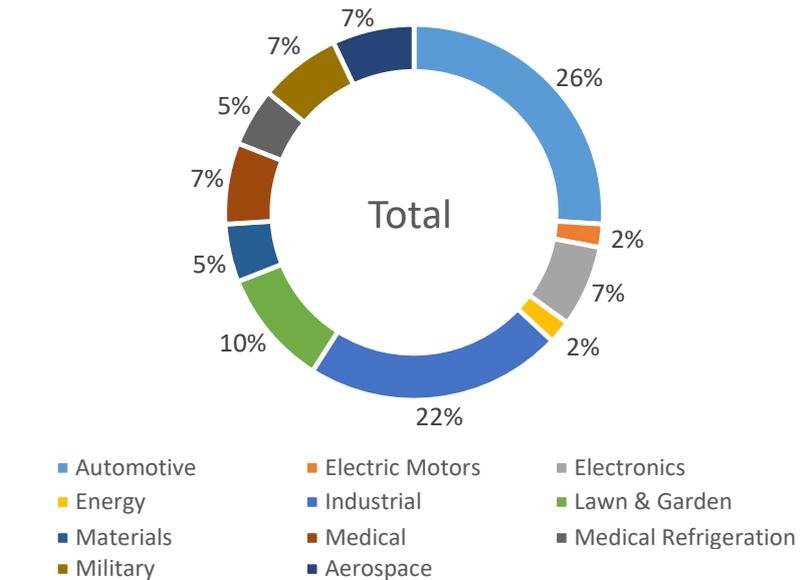


Fig. 3 Market segmentation of Gasbarre’s business

lation, scheduled maintenance, calibration, service, training, and support teams. These specialised teams endeavour to resolve customer issues quickly and comprehensively, and maintain detailed lead-time metrics to heighten visibility. Approximately one third of unplanned ‘press down’

situations (in which a press is unable to run) involving Gasbarre presses, including those requiring replacement parts, are resolved in less than five business days, and 50% within eight business days.

Fig. 5 illustrates the time-to-resolution for all service calls from August 2016 to November 2021.



Fig. 4 Heath Jenkins (president - Press and Automation) with Solutions Program Awardee of the Month Jeff Ogden

Gasbarre time to resolution (2016-2021)

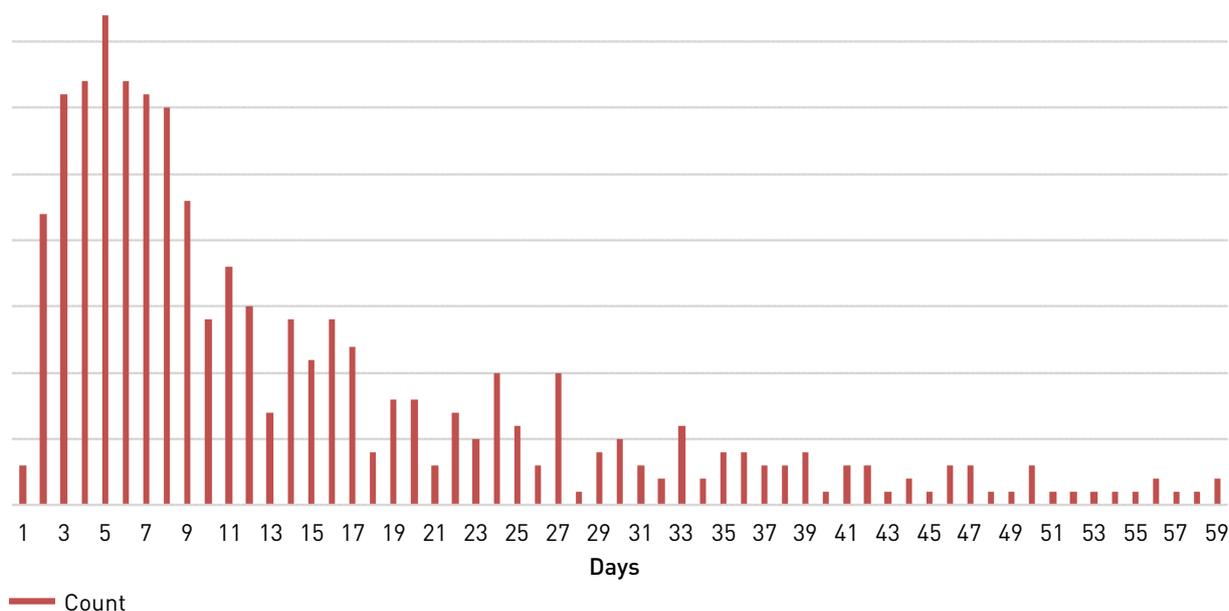


Fig. 5 Time to resolution for all service calls by Gasbarre over a five-year period

While always very important, service speed and quality have become increasingly vital in recent years, as some customers have lost critical internal skills as a result of early retirements or hiring difficulties, especially since the outbreak of COVID-19 in 2020.

Vertical integration

As much as possible, the management explained, Gasbarre keeps design, parts manufacturing and assembly in-house. Where external suppliers are employed, they are mostly US-based. This helps to control the quality, cost and lead times of its offerings.

Lead time / work-in-process visibility

During the DuBois plant tour, Heath Jenkins pointed out highly visible, real-time monitor displays showing the status and schedule details of different jobs, a key aspect of the company’s flow management system. Along with vertical integration, established vendor relationships and other factors, this contributes to a short lead time averaging about six months for a complex and highly customised offering of presses and furnaces. In

both product areas, the first three months of lead time are predominantly for design, design review, and component manufacturing or sourcing, while the second three months is primarily for assembly, wiring, testing, finishing, shipment and installation.

A versatile product range

Through a combination of acquisitions and organic developments, Gasbarre’s management explained, the company offers a very large range of products, which allows it to specify the proper machine for the technical application, and also assists the company in an economy of scale sense, both internally and in its share of customers’ business. Most products are customised to some degree, reflecting the individual needs and preferences of customers, but generally from standard modules and sub-assemblies, avoiding unnecessary complexity and the need to ‘reinvent the wheel.’

Product performance, capability, and automation

It is clear that Gasbarre’s presses, tooling, and furnaces are modern products, fully competitive in their

respective markets. In today’s world, this is a prerequisite for doing business. Indeed, a large and growing proportion of customer purchases are of presses and furnaces with materials handling automation packages included. Most customers prefer to do ‘one-stop shopping’ and avoid the need to integrate an automation package from a third party themselves, and/or the inconvenience of going through additional capital authorisation processes.

Market diversification

While readers of *PM Review* will mostly be involved with the Powder Metallurgy side of the business, and it is a critical part of Gasbarre’s business (accounting for approximately 35% of sales), their press business also serves the engineering and electrical ceramics industries, while the furnace business serves a broad range of heat treatment processes besides sintering. Further diversification comes from the broad range of end-user industries served, as shown by Fig. 3. Additional revenue comes from contract manufacturing, which, to some degree, can be modulated to reflect changes in the workload in the press and furnace businesses.



Fig. 6 A group of five Pentronix high-speed mechanical presses in DuBois press assembly and test shop



Fig. 7 Mechanical presses with robotic automation in production

The impact of COVID-19 on Gasbarre

As previously reported in a *PM Review* article from PowderMet 2021, COVID-19 had mercifully little effect on the PM capital equipment area, with a strong order book entering the pandemic counterbalancing a temporary downturn in new orders. This is not to say that the pandemic did not affect and, at the very least, inconvenience PM supplier businesses such as Gasbarre.

In the initial phase of the pandemic in early spring 2020, when US companies were instructed by government order to close, Gasbarre received an early waiver as a critical business, but experienced some complications with installation, maintenance, and servicing at times due to travel restrictions. On the positive side, Mark Thomason explained, "The company has supplied presses for manufacturing of insulating panels for refrigerated packaging of vaccines."

As aforementioned, the already-apparent trend of customers losing in-house skills was exacerbated by the pandemic, and this has made Gasbarre's servicing, training, and support functions even more important than before.

Trade show attendance has, of course, been impacted by the pandemic. In typical years, the company would exhibit at between six and eight shows for presses and three or four for furnaces, but since 2020 this has been much reduced. At the time of writing this, however, there are positive signs of things returning to normal – Gasbarre exhibited at Powdermet 2021 – but there remains some uncertainty. Gasbarre has been quite resilient against supply chain issues (which dominated the news in the latter half of 2021) due to its high degree of vertical integration and use of mostly domestic external suppliers, but, more recently, the company has been encountering some problems with electronic components sourced from overseas. The leadership mentioned, however, that "several of [their] customers were being severely impacted by rationing of hydrogen gas supplies, in some cases having to shut down production for a week per month."

Press offering and technical trends

Presses are manufactured at the DuBois location (see Figs. 6 and 7). Machining, grinding, and sheet metal bending and cutting operations, as

well as parts storage, are contained in the rear of the headquarters building, while assembly, testing, and painting is carried out in a newer building a short distance away. According to Mark Thomason, "The company, including those it has acquired, has shipped about 4,000 presses in total, most of which are still in operation, encompassing about seventy-five countries and over 3,000 customers."

Reflecting Gasbarre's organic developments as well as acquisitions, the product range offered is very broad overall range in terms of both size (between 2 and 1,200 tons) and type – mechanical, hydraulic, and electric uniaxial presses, as well as dry bag isostatic presses. Applications are also broad – PM parts, engineering and electrical ceramics, cemented carbides, heavy metal, magnets, chemicals, and according to application and press type either simple or complex, multi-level tooling may be used. Some presses are used for sizing rather than parts compaction.

Key technical trends include a shift towards electric presses, individual servos on mechanical or hydraulic presses, user-friendly, in-house developed HMIs (Human Machine Interfaces) aiding setup, monitoring, and adjustments, greater precision and repeatability

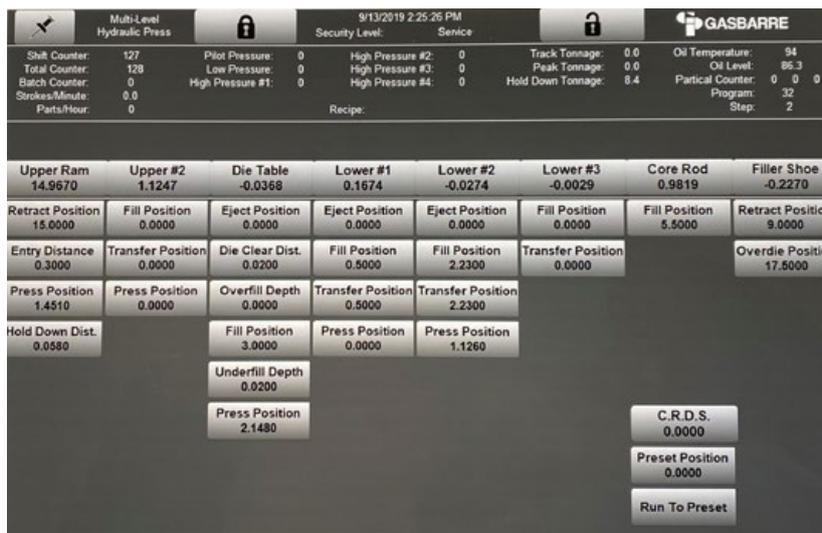


Fig. 8 HMI (Human Machine Interface) on a dry bag isostatic press

(position tolerance +/- 8 μm (0.0003 in); accuracy +/- 1 μm (0.00005 in)), and flexibility of use. Gasbarre’s in-house capabilities, combined with a network of key providers including Rockwell, Siemens, and Bosch-Rexroth, allows the company to stay at the vanguard of modern developments (Fig. 8). In a typical month, Gasbarre ships three new presses and one which has been rebuilt. As an example, at the time

of the author’s visit, the assembly area held eight new and one rebuild press in various stages of completion, six destined for the PM industry and three for ceramics. The majority of presses are custom built to order; however, a small inventory of finished presses can exist at any given time – at the time of the author’s visit, a PTX Pentronix high-speed mechanical press and a SIMAC dry bag isostatic press were in inventory.



Fig. 9 PM press tooling manufactured by Gasbarre at its Olanta, Pennsylvania plant

Press tooling

Press tooling, made from both tool steels and cemented carbides, is manufactured at the 2,800 m² (30,000 ft²) Olanta plant, with a staff of about thirty-five (although some are resident at customers’ facilities). Press tooling is designed and built for a range of loads from 2 to 800 tons. The plant came from the acquisition of McKee Carbide Tool in 1997, and it also incorporates equipment and products from Major Gauge & Tool from its 2012 acquisition, with the move completed in 2019. The tooling is used by customers on both Gasbarre and other companies’ presses (Fig. 9).

The plant operates conventional machining and grinding, as well as high-speed milling, plunge EDM, and fine polishing processes. Besides press tooling, the plant manufactures components for the DuBois and St. Mary’s plants.

Furnace product range

Furnace manufacturing is conducted in a single building at the former Sinterite facility in St. Mary’s, and a large range of furnace types are made in the plant, reflecting the three key furnace company acquisitions and subsequent organic developments. Reflecting on the company’s success as a furnace maker, Mark Saline stated, “Gasbarre, including the companies which it has purchased, has shipped over 8,000 furnaces, and most of them are still running. The oldest one I know of is a Hayes vacuum furnace from the 1930s, where the customer recently asked for some spare parts.” Typically, three or four furnaces are shipped to customers every month. Most are new; about 10% are rebuilds, while most replacement of worn-out components (for example, muffles) is done at the customer’s site. By brand and furnace types:



Fig. 10 PM parts entering a mesh belt sintering furnace

Sinterite continuous belt furnaces (mesh belt for PM parts, metal sheet for powders)

Used for sintering and a variety of other heat treatment processes at up to approx. 1500°C (2700°F). They range in size from small lab units (one has an approx. 8 cm (3 in) wide belt) to very large production units (examples including a 34 m (110 ft) long mesh belt PM sintering furnace with a 1 m (39 in) wide belt, and a 30 m (100 ft) long sheet belt powder processing furnace with a 1.3 m (50 in) wide belt). Sinterite-branded furnaces also include pusher and other types (Fig. 10).

C.I.Hayes vacuum furnaces

Capable of heat treatments at up to approx. 1650°C (3000°F), available in both single- and multi-chamber batch and continuous types, again for a wide variety of thermal processes. A batch furnace for tungsten parts sintering was on the floor at the time of my visit.

J.L. Becker

Now rebranded Industrial Furnace Systems, atmosphere heat treatment batch furnaces of various types, for a wide variety of thermal processes, primarily for non-PM applications.

At least two physically very large units were under construction at the time of the author's visit, one being a tip-up type that one could, quite literally, drive a full-size pick-up truck into!

The St. Mary's plant also manufactures ancillary equipment including washers, dryers, rapid quench units, ammonia dissociators, endothermic and exothermic gas generators, steam treaters and oil impregnators, consistent with the company's policy of providing full process systems, not just individual pieces of equipment, to its customers. As with the DuBois plant, the St. Mary's facility has its own booth for painting equipment after it has been tested and partially disassembled.

Trends apparent in the furnace business include a shift towards more vacuum furnaces (especially associated with titanium, including powder for Additive Manufacturing), user-friendly HMI's for programming and monitoring, sophisticated sensors and monitoring for data trending and tracking. As with the presses, most furnaces are custom-built to order, but standard units are sometimes held in stock. At the time of the visit, a small nitriding furnace was in inventory.

Automation

Besides the specific technical trends noted individually for presses and furnaces, a clear trend towards materials handling automation is very apparent for both equipment families, and Gasbarre frequently provides equipment capable of robotically handling load, unload, part inspection, palletising etc. According to Alex Gasbarre, "About 40% of presses and 10% of furnaces have automation packages included up-front. About 75% of such automation packages are included with new equipment, while about 25% are retrofits to existing equipment. We expect automation to continue to increase for both new and retrofit applications."

Contract manufacturing

Design, modelling, machining, grinding, metal bending and cutting, welding and other internal capabilities, as well as established vendor and customer relationships, allows Gasbarre to maintain a significant contract manufacturing business which, besides its importance in its own right, helps the company through any lean periods in its

primary presses and furnaces businesses. At the time of the author's visit, large, welded metal chutes were being manufactured for a graphite electrode manufacturer.

Quality control, health and safety and sustainability

Each of Gasbarre's businesses is separately certified to the ISO 9001 – 2015 quality standard (with the company first being certified to ISO 9001 in 1996). In addition, the St. Mary's plant is certified to the ISO 17025 calibration and testing standard (first having been certified to ISO 17025 in 2013), and designs equipment to meet the CQI 9 automotive heat treatment, and AMS 2750 pyrometry, industry standards.

The company takes employee health and safety very seriously, with lockout/tagout and rigging training being highly emphasised; in 2021, there were just three minor lost-time accidents, and all three Pennsylvania locations received PMEA safety awards for 2020. Recent examples of power consumption reduction (and lighting and noise improvements) in manufacturing include the replacement of fluorescent lighting with LED tubes and upgrading of air compressors. A metal plasma cutting unit used by Gasbarre will soon be replaced with a laser cutter, giving much more precise cuts and thus obviating some machining operations.

On the product side, the general shift to electric presses, as well as localised servo hydraulic actuators on presses, and servos for die and top ram motions on mechanical presses, all reduce the customers' energy needs as well as cutting footprint and noise. For furnaces, examples include replacing pilot lights on gas furnaces with glow plugs. The provision of comprehensive gas flow and temperature monitoring equipment allows fine-tuning of cycles, which minimises energy usage.

Involvement in industry associations

Gasbarre has a long history of involvement with the Metal Powder Industries Federation (MPIF) and American Powder Metallurgy Institute (APMI), with many past and present staff taking key responsibilities within the associations over a long period of time and receiving awards for their service to the PM industry. The 2019 Members Directory lists twenty-one Gasbarre staff as APMI members, and several leadership staff are currently active on committees and/or with training and technical conferences. For example, Bill Gasbarre is chair of the MPIF Conference Committee and MPIF Technical Board, as well as serving on the MPIF Technical Program Committee, APMI International Fellow Award Committee, and APMI International PMT Certification Commission.

The largest local chapter of APMI is the West Pennsylvania chapter, and Gasbarre is very active in sponsoring meetings and providing financial support to special events. (A note to *PM Review's* readers – if you should ever get the chance, try to attend the West Penn APMI Chapter Annual Seafood Picnic held in September each year – as many crab legs and shrimp as you can possibly eat, and a plethora of raffle prizes, all in the excellent company of about 450 good-humoured colleagues from the Powder Metallurgy community!)

Conclusion

From its roots at a Pennsylvania gas station, Gasbarre has grown to become a major player in presses, furnaces and other industrial equipment used in the PM and associated metallurgical and ceramics industries. It has done so by not losing sight of its community and the people therein. By leveraging their knowledge and experience, it is able to provide equipment which reflects industry trends while maintaining the

high-quality technical performance and capabilities for which Gasbarre products are known, at short lead times, as well as providing high-level customer service. The company has grown through three generations of leadership from the Gasbarre family, and anticipates a fruitful future.

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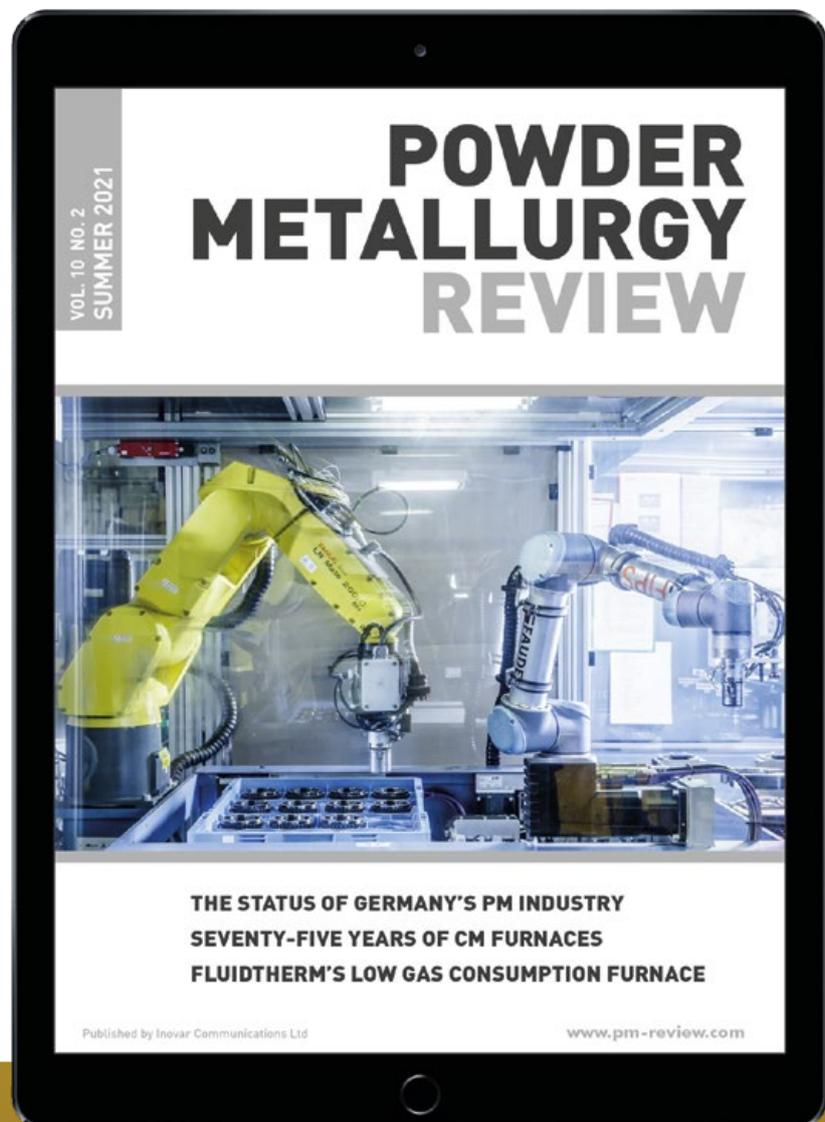
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www.powdermet2022.org / www.amprm2022.org

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www.summerschool.epma.com

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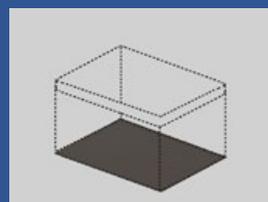
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