POWDER METALLURGY’S DATA CHALLENGE
SPECIAL ATOMISATION METHODS
PRESS DEVELOPMENTS FROM CERAMITEC 2022
In the world of metal powders, Höganäs is always at the forefront of innovation. From more sustainable production processes to new and patented powder compositions, we are dedicated to offering you the optimal solutions while reducing environmental impact. With our range of metal powders designed for efficient press and sinter processes, we can offer powders designed for any application.

Combining optimal powder performance with improved sustainability is a priority for Höganäs, as we are on a journey to becoming the first green metal powder producer. In addition to our material innovations, we have also committed to Science Based Targets and are founding members of the Additive Manufacturing Green Trade Association, demonstrating our ongoing commitment to leading sustainable transformation in our industry.

www.hoganas.com
Knowledge is power

As the much-awaited return of the PM World Congress draws near, the technical programme offers a glimpse into a highly active Powder Metallurgy research base, populated by an engaged community of global companies, research institutions and academia.

We come to this event in a period when the PM industry, like much of the manufacturing sector, is under unprecedented strain, due to rising energy prices, recruitment and staff retention challenges, and supply chain disruptions, as well as the ever-encroaching threat of vehicle electrification and its impact on the entire PM supply chain.

While attending PowderMet in Portland this June, I was interested to hear the term ‘brains trust’ used to describe the PM community. The term was traditionally associated with a small group of political advisers but has since come to depict any collection of experts whose knowledge makes them capable advisers to industry or academia, and while I had heard it used in other spheres before June, it was surprising to realise that this was the first time I had heard it used in the context of our highly-specialised, expert-led industry.

In fact, the collective ‘brains trust’ of PM experts might be the most valuable tool in our industry’s arsenal in these trying times. While World PM2022 may struggle to draw a truly international audience in this post-COVID world, the event nevertheless promises to provide a rich source of knowledge for all in attendance, and the technical programme, complete with a series of Special Interest Seminars on selected topics of key importance to the industry, demonstrates the depth and breadth of research and collaboration currently ongoing.

See you there!

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

Cover image
Centrifugal atomisation on a spinning cup (Courtesy Atomising Systems Ltd)
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
Powder Metallurgy’s challenge: How does automotive’s reliance on model-based decision making impact our industry?

With the automotive industry’s adoption of a model-based engineering approach dependent on access to reliable information, the limited data available for PM materials is putting the industry in a vulnerable position compared to wrought or cast materials.

As Ian Donaldson, Director Advanced Engineering Applications at GKN Sinter Metals, explains, in order to compete for its place in the rapidly changing automotive supply chain, it is imperative that the PM industry moves away from a primarily document-centric approach that relies on engineering specification sheets and limited material databases and toward developing more comprehensive databases.

How to make metal powders. Part 4: Centrifugal and other special atomisation methods

In the Winter 2021 issue of PM Review, we began our four-part series on metal powder atomisation. Over the course of this series, two atomisation experts, Joe Strauss and John Dunkley, have offered our readers a valuable overview of the principles of atomising technology, atomised powders and their applications.

In this final instalment in the series, Strauss and Dunkley present those special atomisation methods such as centrifugal, ultrasonic, pressure (single-fluid) atomisation, and two-fluid atomisation with unconventional media. While perhaps not as widely known as gas or water atomisation, each of these specialist methods of metal powder atomisation has its own unique applications – some industrially significant and some highly niche.
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Precision and energy efficiency in PM press technology: Insights from Ceramitec 2022

After a four-year interruption due to the COVID-19 pandemic, Ceramitec, the leading trade fair for the ceramics industry, reopened its doors at the Munich Exhibition Centre this June.

Although the focus of Ceramitec is on ceramic production technologies, many exhibitors also offer and showcase products for the Powder Metallurgy industry - in particular, powder compaction technology for press and sinter PM.

Dr Georg Schlieper visited the trade fair on behalf of PM Review, and spoke to a number of suppliers of powder compaction technology about the latest developments and trends in the industry. >>>

Historic traditions and new innovations: refractory metals and hard materials at the 20th Plansee Seminar

After a five-year hiatus, delegates from twenty-seven countries gathered once more to attend the Plansee Seminar in Reutte, Austria, this June.

Here, the most knowledgeable minds from the refractory metals and hard materials world, both industrial and academic, gathered to discuss the present and future of this important sector of Powder Metallurgy (and maybe enjoy some in-person networking).

Here, Bernard North provides his knowledgeable impression of the conference as a whole and outlines its opening sessions and technical programme. >>>

Understanding the compaction and sintering effects of four commonly used lubricants in Powder Metallurgy

Lubricants are a necessary addition to the Powder Metallurgy compaction process, reducing ejection forces from the tool, maintaining product quality, and increasing tool life. Depending on the application, different amounts and types of lubricant are needed to address issues related to green density and product geometry.

In this article, researchers from Penn State University, North American Höganäs and Abbott Furnaces review the compaction and sintering effects of three commonly used lubricants – Acrawax® C, Intralube® E, and Intralube® HD – to shed light on the best application for different types of lubricant, and the effects these choices can have on final part quality. >>>

Tailoring a speciality alloy for Additive Manufacturing: From powder production to parameter optimisation

Ultra-high temperature materials, such as niobium-base alloys, have been limited to simple geometric designs due to their high working temperatures and related production costs.

Now, thanks to the development of commercially available Nb-base alloy powders, it is possible to additively manufacture complex-shaped, high-performance components from this material. To do so, it is important to understand the full workflow, from powder production and characterisation, to determining the optimal process parameters for these speciality materials.

In this article, Taniobis GmbH and Alloved Ltd detail the process of preparing, characterising, and processing two such alloy powders. >>>
TMA: OPTIMIZED SOLUTION FOR DEMANDING POWDER METALLURGY

- TMA is a family of metal atomizers designed for a wide range of metallic powders production such as Titanium, Stainless Steels, Chrome-Cobalt, Nickel based alloys, Precious and Non-Ferrous metals and for a variety of different fields of application, such as: Industrial, Chemical, Electronics and Part Manufacturing using AM techniques (like SLM and EBM).

- In order to cover this range, different plant architectures are involved such as: Gas-Atomizers (VIGA / EIGA) and Water Atomizers.

- Topcast TMA Atomizers are designed to easily control all the process variables, such as Gas/Water pressure and flow rate, metal temperature and flow through the nozzle. Therefore, shape and particle size distribution of the produced powder can be adjusted and tuned according to the customer needs.

- For additional details please visit our website: https://www.topcast.it/en/products/metal-atomizers

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GKN Powder Metallurgy to begin production of permanent magnets for electric vehicles

GKN Powder Metallurgy has announced it will begin manufacturing permanent magnets specifically for the electric vehicle market, with significant investment planned to establish capacity for up to 4,000 tonnes per year by 2024.

As a leading manufacturer of metal powders and Powder Metallurgy parts, and a Tier 1 supplier to the automotive industry, GKN believes it is well positioned to meet the increasing demand for a stable, local supply of permanent magnets.

Significant progress in product development has been made and the business is now entering the phase of industrialisation planning. A dedicated Magnets project team, bringing together multidisciplinary experts, operates out of the company’s Innovation Centres for metal powders in Cinnaminson, USA, and for Powder Metallurgy manufacturing in Radevormwald, Germany.

“The key driver behind this strategic decision is our understanding of the challenges facing the automotive industry today and tomorrow,” stated Diego Laurent, CEO at GKN PM. “The stability in manufacturing is an ongoing concern, but with our expertise, scale, and reputation, we can provide a robust solution.”

“As a trusted provider of metal powders and components for the industry, we already have a scalable production footprint,” Laurent continued. “We will leverage our well-established processes and capabilities to align these with the requirements of permanent magnet production.”

According to the company, the move into permanent magnets for the EV market is part of GKN PM’s business-wide commitment to sustainability. With ambitious environmental targets in place, including achieving net zero greenhouse gas emissions in all operations worldwide by 2050, the company is contributing to a more responsible and sustainable future.

“Automakers are looking for a reliable, local supply. We aim to have in place the capacity for up to 4,000 tonnes of permanent magnets by 2024, which will see us become a key player in driving the future of the electric mobility market,” concluded Laurent.

www.gknpm.com
Nippon Piston Ring and Riken Corporation plan merger to form NPR-Riken Corporation

Nippon Piston Ring Co., Ltd., Tokyo, Japan, and Riken Corporation, Tokyo, Japan, have announced a Memorandum of Understanding (MoU) to establish a joint holding company formed by mutual stock transfer, and to consolidate the two companies on equal terms. The MoU has been resolved by the board of directors of the two companies and the trading name of the new joint company will be NPR-Riken Corporation.

Founded in 1934, NPR is recognised for its high-performance, high-quality Powder Metallurgy piston rings, valve seat inserts, camshafts, and other parts primarily for use in internal combustion engines. In addition to press and sinter PM, the company also uses Metal Injection Moulding to manufacture a wide range of components.

Riken was established in 1927 to commercialise the research out of the Institute of Physical and Chemical Research and has contributed to the development of the global automotive industry for over ninety years through its study of surface treatment, processing and materials technologies for piston rings and other components.

The automotive industry is undergoing a remarkable transformation, and the market for internal combustion engine parts is becoming more restricted. To address this, while the internal combustion engine remains the primary form of powertrain, the companies are dedicated to developing components that enable more environmentally friendly engines. The companies also believe it is necessary to increase investment in new business areas that address global Sustainable Development Goals (SDGs) and Environment Social Governance (ESG), reducing carbon dioxide emissions and protecting the environment. Additionally, NPR and Riken will work to accelerate efforts in the fields of marine, hydrogen, new energy projects, thermal engineering, electromagnetic compatibility (EMC), medical equipment, axial motors, MIM and other non-automotive engine parts.

Through the formation of NPR-Riken Corporation, the two companies plan to integrate and utilise the management resources of both companies. It will enable the reduction of costs through shared use of infrastructure and other resources, further reducing manufacturing costs by improving production efficiency through shared product integration.

Once the formation of NPR-Riken Corporation is approved at each of the company’s shareholder meetings, and subject to the necessary approval of relevant authorities, the two companies plan to engage in a joint share transfer in April 2023. It is reported that the president of Riken will assume the position of CEO of NPR-Riken Corporation and the president of NPR will assume the position of COO of NPR-Riken Corporation.

Elkem uses its experience and know-how in surface treatment, processing and materials technologies for piston rings and other components.

Elkem focuses on refractories growth with KeyVest acquisition

Advanced materials supplier Elkem SA, Oslo, Norway, reports that it has acquired KeyVest Belgium S.A, based in Grâce-Hollogne, Belgium. The company specialises in the sourcing of materials and production of metal powders for the refractory industry and other segments including advanced ceramics.

KeyVest will be acquired from a subsidiary of Holta Invest AS, a privately held investment company headquartered in Oslo, Norway. The transaction closed on June 20, 2022, and the new name of the entity will be Elkem Processing Services Belgium.

Refractories are designed to withstand very high temperatures and are therefore suitable for use in furnace linings for the steel, cement, and aluminium industries. Elkem offers a wide portfolio of high-quality products for the production of advanced refractory and ceramic products globally. The KeyVest acquisition will further support and expand this offering.

KeyVest was established in 2007 as an independent processing and milling company of silicon carbide and silicon metal powders. It also distributes related products that include ferrosilicon nitride, fused silica, boron carbide, and aluminium powder. The company focuses on building long-term relationships with its customers and produces around 140 tailor-made products, with annual revenues of around €10 million.

"The acquisition of KeyVest fits well into Elkem’s offerings to the refractory market," commented Inge A Grubben-Strømnes, Elkem’s senior vice president for Silicon Products.

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www.elkem.com
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Metal Powder Works to begin powder manufacturing in Neighborhood 91

Metal Powder Works (MPW), Sewickley, Pennsylvania, USA, has announced that it will join Neighborhood 91, the Additive Manufacturing production campus located at Pittsburgh International Airport. The new facility will function as the company’s main powder production site, expanding capacity by a factor of eight and signalling a shift to an operational focus as the company winds down fundamental development.

Founded in 2017 by John Barnes and Chris Aldridge, MPW aims to bring a step change in metal powder production yield, cost and quality with its proprietary DirectPowder™ powder production technology. The process converts feedstock into fine powder particles via software-driven, patent-pending technology, which reportedly converts nearly 100% of input material into suitable powder without the need for melting. Direct-Powder is said to allow for specific particle size distributions and enables non-equiaxed morphologies.

MPW will market and sell primarily aluminium and copper powders from the Neighborhood 91 location. Tom Bockius, MPW’s Technical Director, will oversee the construction and installation of equipment at Neighborhood 91, with the company planning to be fully operational by the end of October 2022.

“The concept of Neighborhood 91 was always to bring an Additive Manufacturing supply chain to one centralised location,” stated Barnes, MPW’s CEO. “We’re excited to be a part of Pittsburgh’s advanced manufacturing scene.”

www.metalpowderworks.com
www.neighborhood91.com

Sandvik acquires precision tools manufacturer Sphinx Tools and tap manufacturer Balax

Sandvik AB, headquartered in Stockholm, Sweden, has signed an agreement to acquire 100% of the equity in Sphinx Tools Ltd, headquartered in Derendingen, Switzerland, and its wholly owned subsidiary P Rieger Werkzeugfabrik AG. In a further press release, the company also announced it has acquired Balax, Inc., North Lake, Wisconsin, USA, a supplier of carbide and HSS cut taps and roll forming taps for the general engineering and automotive sectors.

Sphinx Tools

With three production sites in Switzerland and a global distribution network, Sphinx Tools produces precision solid round tools (micro tools) and surgical cutting tools, serving customers in the automotive, aerospace and medical segments. The company will be reported within Sandvik Coromant, a division within Sandvik Manufacturing and Machining Solutions.

Sphinx Tools was founded in 1994 and has around 150 employees. In 2021, the company generated revenues of approximately 292 MSEK.

Balax acquisition

Founded in 1958, Balax pioneered a design for cold forming taps featuring ‘Lead Form Geometry Correction,’ a process which reduces tapping torque by creating lead threads on pitch. The taps, called Thredfloers, were said to be ‘BALanced AXially,’ leading to the company’s name of Balax. The company went on to add other metalworking tools to its product line, including Thredsaver cutting taps, and thread gauges.

Balax conducts all manufacturing processes in house, including blank making, heat treating, shank and square grinding, fluting, thread grinding and surface treatments. It also maintains a fully equipped tapping laboratory to test new design concepts for tapping torque, tapping speed, tool geometry, coolant or lubrication performance, pretap hole sizing, and material compatibility. The company employs sixty-six staff and, in 2021, saw revenues of $10 million.

www.sphinx-tools.ch
www.balax.com
www.sandvik.coromant.com
www.home.sandvik
PERMANENT MOMENTUM for EV manufacturing

As the EV market grows exponentially, GKN Powder Metallurgy is bringing certainty to automakers with a permanent solution for permanent magnets.

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> Discover more at gknpm.com/magnets
Kennametal reports strong financial results in its 2022 fiscal year

Kennametal Inc, Pittsburgh, Pennsylvania, USA, has announced its fourth quarter and fiscal 2022 results, with FY22 sales increasing 9% to $2 billion from FY21, up 11% on an organic basis. Fourth quarter sales saw an increase of 3% year over year to $530 million, up 7% on an organic basis.

“We posted solid results this year with strong full-year operating leverage delivering over 300 basis points of year-over-year adjusted operating margin improvement,” stated Christopher Rossi, president and CEO. “These results demonstrate continued success in executing our operational and commercial excellence initiatives, including timely pricing actions to cover inflationary pressures.”

Sales of $2,012 million increased from $1,841 million in the previous year. Operating income was $218 million, or 10.8% margin, compared with $102 million, or 5.5% margin, in the prior year. The increase in operating income was said to be primarily due to organic sales growth, restructuring and related charges of $4 million compared to $40 million in the prior year, favourable pricing, lower incentive compensation costs, favourable product mix and approximately $14 million of incremental simplification/modernisation benefits, partially offset by higher raw material costs of approximately $49 million, certain manufacturing inefficiencies including higher depreciation and approximately $25 million due to the restoration of salaries and other cost-control measures that were taken in the prior year. Adjusted operating income was $224 million, compared with $143 million in the prior year.

Net cash flow provided by operating activities in fiscal 2022 was $181 million compared to $236 million in the prior year. The change in net cash flow provided by operating activities was driven primarily by working capital adjustments, in part, due to increased safety stock for potential supply chain disruptions and higher raw material costs, partially offset by higher net income. Free operating cash flow (FOCF) was $85 million compared to $113 million in the prior year. The change in FOCF was driven primarily by working capital adjustments in part due to increased safety stock for potential supply chain disruptions and higher raw material costs, partially offset by higher net income and lower capital expenditures.

“Given our demonstrated ability to operate successfully in an uncertain macroeconomic environment, while maintaining a strong balance sheet, returning cash to shareholders and investing in the business, I am confident our strategic initiatives will continue to drive growth and improved profitability over the long-term,” Rossi concluded.

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www.globaltungsten.com
Alleima begins trading on Nasdaq Stockholm

Sandvik AB, Stockholm, Sweden, has announced that the shares of Alleima, formerly Sandvik Materials Technology (SMT), have commenced trading on Nasdaq Stockholm. This marks the launch of Alleima as a fully independent company after being part of Sandvik.

The name Alleima is said to combine two core aspects of the company – alloys and materials – with ‘alei’, an antiquated version of ‘alloy’.

“This is a historic day for our company and an important step to build for the future,” commented Göran Björkman, president and CEO of Alleima. “We are the result of nearly 160 years of collective minds, working together with our customers. Today, Alleima is a world leader in its fields and a strong performer in its industry. As a standalone company, Alleima will have the right prerequisites to realise its full potential and the best possible conditions for growth and value creation.”

“I want to thank all our employees for the great work and the quality we deliver and our customers for their trust and the advancements we achieve together,” Björkman continued. “Even though our name is new, we will not forget our origins. We will continue to offer the same advanced high-quality products and services with the same expertise and solutions that our customers are used to.”

The Annual General Meeting of Sandvik AB decided on April 27, 2022, to distribute all shares of Alleima AB to the shareholders of Sandvik AB. Shareholders of Sandvik AB as per the record date August 29, 2022, have received one share in Alleima for every five shares held in Sandvik. The total number of outstanding shares in Alleima AB is 250,877,184. Alleima is listed on Nasdaq Stockholm under the ticker ‘ALLEI’.

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Alleima is now trading on Nasdaq Stockholm (Courtesy Alleima AB)

Alleima begins trading on Nasdaq Stockholm

9 - 13 October 2022, Lyon Convention Centre, Lyon

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www.alleima.com
voestalpine joins the Science Based Targets initiative

The voestalpine Group has announced that it is setting goals to reduce emissions in Scope 2 (energy-related) and Scope 3 (raw materials, transport, etc). These reductions will be stylistically evaluated within the framework of the independent Science Based Targets initiative (SBTi) to ensure the Group’s targets are compatible with the Paris agreement goals and validated correspondingly.

“We have decided to subject ourselves to examination by the Science Based Targets initiative to offer our stakeholders the greatest possible levels of transparency and comparability when it comes to our climate action measures,” stated Herbert Eibensteiner, CEO. “The complex process of monitoring and goal setting along the entire process chain highlights our commitment to achieving climate neutrality over the long term.”

The objectives apply not only to the steel-producing sites in Linz and Donawitz, Austria, but the entire voestalpine Group. Specifically, and taking the year 2019 as its reference, the company plans a 30% reduction in Scope 1 (direct greenhouse gas emissions from production) and 2 emissions and a 25% reduction in Scope 3 emissions by 2029.

The Science Based Targets initiative is a partnership between the Climate Disclosure Project (CDP), UN Global Compact, World Resources Institute, and World Wildlife Fund for Nature (WWF). It helps companies align their business activities with the Paris Climate Goals, and provides scientific proof of this achievement.

Globally, around 3,000 companies from a wide range of sectors including the steel industry are involved in the SBTi.

greentec steel is voestalpine’s phased plan for green steel production: in a first intermediate step, partial replacement of the existing blast furnace route with a hybrid-electric steel pathway could reduce carbon emissions by around 30% from 2027, corresponding to around 3 to 4 million tons of CO₂ annually. In 2027, voestalpine will begin operating one electric arc furnace at each of the Linz and Donawitz sites; the necessary preparations are already underway. voestalpine’s mission is carbon-neutral steel production using green hydrogen by 2050, for which the Group is already undertaking research into promising breakthrough technologies.

www.voestalpine.com

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Höganäs Environment Solutions to close as focus moves to core metal powder business

Sweden’s Höganäs AB has announced that it will exit its water treatment business and close Höganäs Environment Solutions, LLC, based on a strategic decision to consolidate and focus on the group’s core business. The company stated it will focus on the continuing development of the competitive and sustainability advantages within Powder Metallurgy, electrification, surface coating and Additive Manufacturing.

Höganäs Environment Solutions was founded in 2017 in Cary, North Carolina, USA, as the company’s business platform for research & development, commercialisation and support of environmentally focused products and solutions. The company offered the Cleanit advanced metals-based drinking water, industrial wastewater and environmental remediation products.

A contributing factor to the exit decision was last year’s imposed force majeure situation at Höganäs’ Niagara Falls plant, which ended in the closure of the site. “This has been a hard decision to make, and we have worked thoroughly to explore options and investigate alternative routes forward,” stated Fredrik Emilson, CEO, Höganäs. “However, given the current market traction, we need to refocus our efforts on our core business and continued sustainable business transformation journey. Our priority will be on helping the affected employees and we are committed to supporting them moving forward.”

This decision will impact around thirty of Höganäs’ employees and the closing of Höganäs Environment Solutions, LLC operations in North Carolina as well as Environmental Solutions’ activities in Brazil, China and India.

www.hoganas.com

Stellantis to invest $99M in engine production across three North American plants

Stellantis has announced plans to invest a total of $99 million in three North American plants for the production of a new four-cylinder turbocharged engine. In line with the company’s Dare Forward 2030 plan, investments will be made at the US Dundee Engine Complex in Michigan and the Kokomo Casting Plant in Indiana, as well as the Etobicoke Casting Plant in Toronto, Ontario, Canada. The new engine is a 1.6-litre, I-4 turbocharged unit with direct fuel injection and flexibility for hybrid-electric vehicle (HEV) applications. Based on a current Stellantis production engine in Europe, this engine, the first to be produced by Stellantis in the region, will power two future North American HEV models. Production is expected to begin in early 2025.

With an investment of nearly $83 million, Dundee Engine will be retooled and become the final assembly location for the new engine. The Michigan plant will continue production of the 3.6-litre Pentastar Upgrade for the Jeep® Grand Cherokee and Jeep Grand Cherokee L. The Tigershark 2.4-litre I-4 engine will build out in the first quarter of 2023.

Engine blocks will be cast at the Kokomo Casting Plant, reputedly one of the largest facilities of its kind in the world. More than $14 million will be invested to convert existing die cast machines and cells for the new engine. Etobicoke Casting will produce the oil pan for the new engine.

The company will invest nearly $2 million to support the development and installation of new tooling and equipment upgrades.

www.stellantis.com

Sintex celebrates twenty-five years of Powder Metallurgy

Powder Metallurgy parts maker Sintex a/s, headquartered in Hobro, Denmark, recently celebrated its twenty-fifth anniversary. As part of its celebration, the company welcomed the families of its employees into the facility and announced a DKK 25,000 donation to provide direct emergency relief to Ukraine.

A Grundfos Group business, Sintex manufactures and supplies a range of Powder Metallurgy components, including stainless steel parts, sintered stainless steel filters, Metal Injection Moulding, metal spraying, soft magnetic composites and permanent magnetic systems such as magnetic couplings and magnetic rotors.

The company supplies to a wide variety of industries across the world.

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Volkswagen publishes industry-first Responsible Raw Materials Report

The Volkswagen Group has published its first Responsible Raw Materials Report, detailing the group’s methodology and activities within a newly implemented due diligence framework. The report takes a first look back on achievements and offers an outlook on the challenges ahead.

The Responsible Raw Materials Report is said to be a first for the automotive industry, as it is specifically dedicated to address mitigation measures against human rights and environmental risks in particularly exposed supply chains. The report covers sixteen high-risk raw materials, including battery materials such as lithium and cobalt.

Often, the highest risks for human rights and the environment occur in the upstream supply chain, which is at a level where the car manufacturer itself does not have direct contractual relationships. This makes transparency and the implementation of standards particularly demanding. In this report, Volkswagen discloses – for the first time – the list of smelters in its tin, tantalum, tungsten and gold supply chains as well as the countries of origin. Furthermore, the carmaker prepared more binding sustainability requirements for its suppliers, targeting leather and natural rubber, among others.

In 2021, Volkswagen Group joined the pledge for a moratorium on deep sea mining, which poses potentially severe environmental risks. Furthermore, the company joined the Global Platform for Sustainable Natural Rubber (GPSNR) and supported the development of Reporting Requirements for companies in rubber supply chains.

A key priority for Volkswagen Group in 2022 is said to be engaging with suppliers in the battery supply chain – from mine to cell – to promote responsible sourcing and mining through credible certification schemes. As a step towards this goal, Volkswagen joined the Initiative for Responsible Mining Assurance (IRMA) in March 2022 and pledged to gradually implement the IRMA standards in its own battery supply chains.

Volkswagen Group’s Board Member for Purchasing, Murat Aksel, expressed confidence about the progress made since the introduction of the first Responsible Raw Material Report and thanked Volkswagen Group’s suppliers for their cooperation. “On the one hand, we are setting a good example: In order to identify, assess and mitigate human rights risk and ensure responsible sourcing of raw materials we have implemented dedicated management systems. On the other hand, we have high expectations towards our business partners and suppliers in terms of sustainability. The non-negotiable fundament of our business relations are – for example – our Code of Conduct for Business Partners, the Sustainability Rating as well as a grievance mechanism. We can only overcome global challenges and succeed in protecting the environment as well as human rights, if we work together with all relevant stakeholders and our business partners along the supply chain.”

www.volkswagenag.com 

The Responsible Raw Materials Report is a first for the automotive industry (Courtesy Volkswagen Group)

Tekna signs titanium powder supply agreement with Marle Tangible

Tekna Holding ASA, Sherbrooke, Quebec, Canada, has signed a long-term titanium powder supply agreement with US-based medical device manufacturer Marle Tangible, formerly Tangible Solutions which was acquired by the Marle Group earlier this year. The agreement will see Tekna supply and deliver titanium powder to be used for Marle Tangible’s additively manufactured and specialised orthopaedic implants.

“We are excited to have been selected by Marle Tangible as their preferred partner for titanium powders,” commented Luc Dionne, Chief Executive Officer at Tekna Canada. “With the Marle Group being a leading player in orthopaedic implants, we consider this agreement a testimonial to the high quality of our products. We are delighted to add Marle Tangible to our growing list of major medical customers and look forward to a long-lasting relationship.”

Tekna added that the agreement follows a longstanding partnership between itself and Marle Tangible and positions Tekna as a preferred supplier of metal powders in the field of medical implants and devices.

Chris Collins, Chief Operations Officer at Marle Tangible, stated, “We are delighted to have signed this agreement with Tekna. Their high-quality titanium powders are impressive, consistent, and always delivered in a timely manner. We are very pleased to have secured long-term supply.”

www.tangiblesolutions3d.com
www.tekna.com
IperionX and ORNL collaborate for low-cost titanium alloys

IperionX Limited, Charlotte, North Carolina, USA, and Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, USA, are collaborating to develop low-cost titanium alloys for Additive Manufacturing using IperionX’s titanium metal powders. Under a US Department of Energy (DOE) approved User Agreement, the companies will work at the DOE’s Manufacturing Demonstration Facility (MDF) at ORNL, a 10,200 m² facility that is reputedly the nation’s only large-scale, open-access user facility for rapidly demonstrating R&D manufacturing technologies and optimising critical processes. Key objectives of the User Agreement include:

- Evaluation and characterisation of spherical titanium powders produced through IperionX’s technologies for use in Additive Manufacturing, including opportunities to use titanium powders to manufacture parts which currently rely on other metals, including stainless steel and aluminium.
- Demonstration that press and sinter Powder Metallurgy parts produced using IperionX’s titanium powders have equivalent or better characteristics to parts produced using industry standard titanium powders.

As a focus of the collaboration, initially, press and sinter Powder Metallurgy parts will be produced and tested at the MDF with the aim of validating that the components fabricated with commercially pure titanium or a Ti6Al4V alloy produced by IperionX meet the characteristics for lightweighting for the transportation sector, including heavy trucks, aircraft components and other transportation applications where titanium has an advantage over currently used metals such as steel and aluminium.

The user agreement is expected to complement IperionX’s ongoing project to qualify and demonstrate the performance of its titanium powder for additively manufactured aerospace parts, supporting a project with the US Navy to test titanium flight critical metal replacement components for the US Department of Defense.

“We are extremely pleased to be working with ORNL. The laboratory is an ideal partner for IperionX, with expertise in Additive Manufacturing, along with a strong interest in identifying new powder feedstocks that lower costs and increase energy efficiency, particularly in transportation,” stated Anastasios (Taso) Arima, IperionX’s Managing Director and CEO.

He continued, “ORNL brings a knowledge base from numerous collaborations with advanced manufacturing companies, such as partnering in Volkswagen’s first US innovation hub in Tennessee to develop lighter vehicle components from composite materials and electric vehicles, its recent work with NASA which resulted in a 3D printed thermal protection shield traveling to the International Space Station, or its 3D printing work with Boeing’s 777x.”

“Both organisations share Tennessee roots, and we look forward to progressing the User Agreement and establishing a strong relationship between IperionX and ORNL,” Arima concluded.

www.iperionx.com
www.ornl.gov

Micromeritics expands operations in Asia

Micromeritics Instrument Corporation, a supplier of high-performance systems used to characterise particles, powders and porous materials based in Norcross, Georgia, USA, has established direct sales, service and support operations in South Korea through the acquisition of Protech Korea, its long-time distributor.

The new Micromeritics Korea facility is headquartered in Daejeon, a centre for academic and industrial innovation. The entire Protech sales, service, and applications teams are now part of Micromeritics Korea.

Additionally, to further enhance its regional customer support, the company opened an expanded sales, service, and training headquarters in Shanghai, China. The new facility is located near Shanghai Hongqiao International Airport, a hub for regional travel said to be central to the growing businesses related to advanced batteries and the net-zero economy.

Ruby Hooi will lead the company’s sales operations in partnership with its network of distributors in Southeast Asia. Based in Singapore, Hooi has spent more than a decade providing technical support and building effective relationships with customers in analytical laboratories.

John Jordan, vice president of Worldwide Sales & Service, commented, “Asia has been a tremendous growth driver for our company; the demand from innovative companies and institutions in Korea, China, and Southeast Asia continues to grow. Our investments in Asia are a demonstration of our unwavering commitment to collaborate, provide superior technology, and deliver expert support to our customers in Asia.”

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Porite India expands production with hydraulic CNC powder press from Dorst

Porite India Pvt Ltd, Pune, India, has added a new TPA 800/4 hydraulic CNC powder press from Dorst Technologies GmbH, Kochel am See, Germany. The 8000 kN multi-platen press is now installed and operational at its Powder Metallurgy production facility in Pune.

The TPA 800/4 reputedly offers high productivity and reproducibility while maintaining tight tolerances. The modular design, offering up to four upper and four lower tool levels, is equipped with an interchangeable die set system for efficient setup and fast product changeover.

Porite India began commercial parts production at its 25,000 m² facility in 2017, manufacturing components for vehicles and power tools, as well as oil-less bearings for sectors such as electronics, aviation, green energy, and industrial production. The company has a range of compacting presses, including advanced CNC hydraulic systems, conventional and high-temperature sintering furnaces, sinter hardening and automatic sizing machines.

www.dorst.de | www.porite.co.in

TIJO offers nickel alloy IN625

Changsha Tijo Metal Material Co., Ltd, (TIJO), Changsha City, Hunan, China, is now offering nickel alloy IN625 metal powder, a non-magnetic, corrosion and oxidation resistant, nickel-base superalloy for Additive Manufacturing.

IN625 provides high fatigue strength and toughness, with resistance to corrosion in temperatures up to 1093°C. The alloy is said to have good weldability in Laser or Electron Beam Powder Bed Fusion (PBF-LB and PBF-EB) Additive Manufacturing processes.

Parts built from IN625 can be heat treated and material properties can be varied within a specified range. Parts can be finished by various conventional means, including machining, EDM, hot-peening, grit-blast, vibratory polishing, and coatings in both as-built and in heat-treated conditions. Suitable applications include heat shields, furnace hardware, combustion liners and spray bars, gas turbine engine ducting and chemical plant hardware, as well as special marine applications.

TIJO’s IN625 AM alloy powder is reported to contain low amounts of oxygen, up to 0.03%, typically ranging at 0.015~0.020%. The powder morphology is typically spherical, with a smooth surface and a low level of powder satellites.

www.tijo-metalpowder.com
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Thanks to the competences available within the Group, SACMI also supplies state-of-art furnaces for the Powder Metal Industry and versatile solutions for automation aiming at increasing output rates while ensuring maximum simplicity of operation.
Plansee reports record sales of over €2 billion

The Plansee Group, headquartered in Reutte, Austria, has reported record sales of €2.02 billion in the fiscal year 2021/22, up 56% from the previous year. Excluding the effect of fully consolidating the Ceratizit subsidiary for the first time, the increase in sales would have been 15%, the company added.

General conditions for the year were said to be anything but favourable, with disrupted supply chains, significant increases in raw material costs and long delivery times presenting the Plansee Group with major challenges. However, the strong economy, internal improvement measures and the full consolidation of the hard metal subsidiary Ceratizit led the Tyrolean group to a new sales record.

"First the pandemic, then supply chain problems, now the Ukraine war. These challenges were and are a major effort for our employees and managers. A major effort that we are successfully mastering," stated Kartheinz Wex, spokesman of the Plansee Group Executive Board, at a press event in Reutte.

Looking ahead to the current fiscal year, Wex was optimistic about the first half of the year. The Plansee Group is on solid economic footing and the order books are well filled. At the same time, however, Wex also pointed to the risks: the unpredictable consequences of the Ukraine war, uncertain gas supplies, rising inflation, increasing trade barriers between countries and regions, and excessive stockpiling in some supply chains. “This is causing us problems and will have an impact on our economic development in the second half of the year,” commented Wex.

With the acquisition of Ceratizit, the Plansee Group is reported to have reorganised its tungsten powder production to be more competitive. It is increasingly based on recycling, and to meet its ambitious recycling targets, Ceratizit has launched an initiative to recover and recycle as much tungsten scrap as possible. The recycled tungsten is used in the Plansee Group to manufacture new products. Modern recycling technologies ensure that products made from recycled tungsten have identical properties to products made from virgin tungsten.

Outlook

The Plansee Group expects difficult external conditions to continue in the current fiscal year. Rising electricity and gas prices, rising inflation, logistics and supply problems in the procurement markets and a lack of skilled workers in several professions are among the challenges, the company stated.

www.plansee.com
www.ceratizit.com

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Mimete adds nitrogen atomisation option

Mimete Srl, a division of the Fomas Group, Osnago, Italy, reports that its manufacturing facility can now offer nitrogen as well as argon for the atomisation of metal powders. The company states that due to the increased demand for custom metal powders, and the potential technical advantages nitrogen offers, the decision was made to expand the manufacturing facility’s capacity.

According to Mimete, a number of new alloys specifically developed in partnership with its customers have revealed that manufacturing based on argon gas does not fulfil all the customer’s technical requirements when compared with nitrogen gas.

Additionally, nitrogen gas is mandatory for some specific technologies and applications, as it provides the perfect chemical composition for the desired mechanical properties during the final stage. The manufacturing plant’s lean design ensures, through a simple switch, a fully automatic changeover of the system, resulting in an elevated degree of efficiency and avoiding contamination.

In order to maintain the highest atomising performance, the vacuum inert gas atomisation (VIGA) system automatically manages the different physical properties between the two gases. Mimete atomisation recipes are custom-made in order to deliver the distinctive properties of each gas (for instance, nitrogen bears lower specific weight and higher cooling capacity) and to achieve the best metal powder characteristics.

As both gases are inert, they are able to reach very low levels of oxidation in the molten and powder forms. Therefore, they can be employed to equal effect in metal powder manufacturing. The company explains that argon is the gas of choice for manufacturing processes where high purity is required, such as nickel superalloys. Nitrogen is preferred in steel manufacturing dedicated to Hot Isostatic Pressing consolidation as it is soluble in metal.

Andrea Tarabiono, Manufacturing Director of Mimete, commented, "The addition of nitrogen, as an alternative to argon, integrates our starting plant set up, giving us the opportunity to fulfil the specifications of new customers and introduce brand-new alloys that were not feasible before. With a lean process, switching from one gas to the other is simple and straightforward. Moreover, it results in zero contamination between the two gases and enhances our market response."

www.mimete.com

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Japan’s Powder Metallurgy industry begins road to recovery

The Japan Powder Metallurgy Association (JPMA) has published statistics showing the production volumes of Powder Metallurgy structural parts and bearings in Japan in 2021, along with figures highlighting the production of metal powders in the country.

Structural parts and bearings
The trade association stated that in 2021, the volume of structural parts produced was 78,145 tons, a 13.5% increase from the previous year. The volume of PM bearings produced was 5,445 tons, a 16% increase from the previous year. Unsurprisingly, the automotive industry remained the largest consumer of PM structural parts and bearings by volume, with structural parts production for vehicles identified as 72,946 tons, a 12.2% increase from the previous year, and bearings production for vehicles at 3,721 tons, up 15%.

Of the other powder categories, the volume of friction materials was reported to be 881 tons – a 50.9% increase from the previous year. Electrical contacts volume was at 91 tons, a 33.8% increase from the previous year. Despite the ongoing issues with COVID-19, demand for MIM parts for medical appliances was said to be good.

Production of metal powders for PM applications
The increase in demand for structural parts and bearings resulted in an increase in the production of metal powders. An increase in demand from overseas was notable, with a 31.6% rise in iron powder exports from the previous year accounting for 42,197 tons.

Figures for MIM powders in 2021 are not yet available, but the JPMA believes that, following a decrease in 2020, MIM powder shipments will recover to the level of 2018.

www.jpma.gr.jp
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Porite Taiwan installs fourth Dorst 1600 powder press

Porite Taiwan Co Ltd, Miaoli, Taiwan, has further expanded its manufacturing capacity with a fourth TPA1600/3 Powder Metallurgy press from Dorst Technologies GmbH, Kochel am See, Germany. The 16,000 kN hydraulic CNC powder press is now installed and operational at Porite’s Powder Metallurgy production facility.

The TPA1600/3 high-performance press, in a height-reduced design, is reported to enable efficient press forming of thin, single-level plates, with and without surface structure, as well as substrates and wafers for electronic applications, batteries and fuel cell elements.

With an integrated, special die carrier, the press is designed for maximum rigidity and strength. It can be programmed through an intuitive, state-of-the-art visualisation system supported by Dorst’s Intelligent IPG program generator for the powder pressing process.

Porite Taiwan has a range of compacting presses from 0.5 tons to 1600 tons, including advanced CNC hydraulic systems and automatic sizing machines. It has in-house tooling capability, with advanced wire cutting and electric discharge machines used to manufacture high-quality tooling. In addition to press and sinter Powder Metallurgy, the company also offers Metal Injection Moulding production.

The company’s Powder Metallurgy products are used in a wide range of industries including the automotive sector, consumer electronic products, electrical instruments, industrial products, office equipment, electric home appliances, aerospace and green energy. Established in 1952, Porite Taiwan contributes 45% of the total production of the Porite Group.

Read more about the Porite Group in Powder Metallurgy Review magazine, Autumn 2018.

www.dorst.de
www.porite.com.tw

Porite Taiwan has added a fourth TPA1600/3 Powder Metallurgy press from Dorst (Courtesy Porite Taiwan)
Tekna announces two orders for its research-scale TEK15 plasma system

Tekna Holding ASA, Sherbrooke, Quebec, Canada, has signed contracts for the sale of two TEK15 research scale plasma atomisation systems which enable the development of highly spherical metallic or ceramic powders. The two systems will be used to produce spherical powder of various materials to be applied in Additive Manufacturing processes such as Binder Jetting, as well as Metal Injection Moulding.

The orders amount to a total value of $1.45 million and will be delivered to customers in early 2023. The systems will be used in a government research centre in Asia and by a private company in the USA for commercial R&D purposes.

“Our TEK15 system fosters innovation by enabling our customers to experiment with many different materials,” stated Romain Vert, Director of System Sales at Tekna. “The system has been developed to allow users to explore different plasma environments and conditions and make swift adjustments to produce different variations of materials. These agreements take the number of units sold up to fifty-seven and correspond with the increased demand Tekna is experiencing for its advanced materials.”

Sandvik completes acquisition of Peterson Tool Company

Sandvik AB, headquartered in Stockholm, Sweden, has announced that it has completed its acquisition of Peterson Tool Company, Inc., (PTC), Nashville, Tennessee, USA, a leading supplier of machine-specific custom insert tooling solutions. The company will be reported in the GWS Tool business unit in Walter, a division within the business area of Sandvik Manufacturing and Machining Solutions.

PTC’s product offering includes custom carbide form inserts for high-production turning and grooving applications, primarily within the general engineering and automotive segments. The company has a department dedicated to designing and manufacturing HSS, carbide tipped, and solid carbide tools.

PTC is reported to be a recognised worldwide leader in special cutting tool solutions, primarily for the automatic screw machine market, whether it be multi-spindle or single spindle. In 2021, the company reported revenues of $9 million.

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Electric vehicle boost in Southeast Asia as local production begins

The electric vehicle market is taking off in Southeast Asia as automakers plan to start production in at least three countries this year, reports Nikkei Asia. Many of these companies are based in China and South Korea, while Japanese automakers, which now account for more than 90% of new-car sales in Southeast Asia, are said to be falling behind.

Hyundai Motor began full-scale production at its new electric vehicle factory in Indonesia earlier this year and China’s SAIC-GM-Wuling Auto-mobile unveiled a new mini EV slated to start production in the Southeast Asian country by the end of the year.

Wuling is reportedly a driving force in China’s growing EV market, selling 420,000 Hongguang Minis, which start at just 32,800 yuan (US $4,885). The company has yet to announce the price of its new model in Indonesia, however it is expected this could ignite the EV market in that country, where the majority of models now cost over $35,000 and only around 700 new EVs were sold in Indonesia last year.

Thailand is reported to be aiming for EVs to reach 30% of its auto production by 2030. It has begun offering tax incentives and subsidies for those looking to purchase. China’s Great Wall Motor has received orders for over 4,700 Ora vehicles since they went on sale in Thailand during November, more than double the country’s entire EV sales in 2021. Great Wall looks to reduce prices further by starting Thai production as early as 2023.

Nikkei Asia added that Toyota Motor and SAIC Motor also are taking advantage of the Thai incentives. Toyota is expected to start selling Japanese-built EVs in Thailand later this year, with plans to switch to local production as early as 2024.

The Mercedes-Benz Group plans to start assembling vehicles in Thailand this year, while Thai state energy group PTT aims to begin EV production in 2024 with Hon Hai Precision Industry, the Taiwanese manufacturer also known as Foxconn.

Volvo Cars announced in March that it had begun assembling vehicles in Malaysia. The Fieldman Group, a Malaysian producer of palm oil and other commodities, said in January that it would build a joint EV assembly plant with China’s Changan Automobile.

VinFast, the automaking arm of Vietnamese conglomerate Vingroup, began selling locally made EVs in December. It plans to manufacture and sell vehicles in the US as well.

In the Philippines, a law to bolster the EV sector took effect in May. It requires logistics providers and public transportation operators to electrify at least 5% of their fleets by a date to be decided later. The government is weighing new incentives for the import and manufacturing of such vehicles.

Honda Motor’s joint venture in China with Guangzhou Automobile Group has begun building an electric vehicle factory in Guangdong with an initial investment of 3.49 billion yuan ($522 million), reported Reuters. The Japanese automaker is aiming to start the factory’s operation in 2024, it said in a statement. The new factory has an annual production capacity of 120,000 units.

Honda said another EV plant in China, in a joint venture with Dongfeng Motor Group, is also expected to start operations in 2024.

Honda’s joint venture with Guangzhou Automobile Group in China has begun building an electric vehicle factory in Guangdong with an annual production capacity of 120,000 EVs (Courtesy Reuters/Honda)

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Carpenter Technology eyes accelerated growth in fiscal year 2023

Carpenter Technology Corporation, headquartered in Philadelphia, Pennsylvania, USA, has announced financial results for its fiscal fourth quarter and year ended June 30, 2022. Net sales for the fourth quarter of 2022 were $563.8 million, compared with $421.6 million in the fourth quarter of 2021. This resulted in a net income of $2.6 million, up from a $57.1 million loss in Q4 2021. Overall, full year 2022 net sales were $1,836.3 million, up from $1,475.6 million in FY2021, with a net loss for the year reported at $49.1 million, an improvement on the $229.6 million loss reported for FY2021.

“Our fourth quarter results marked a successful end to the year and place us on strong ground to deliver accelerated growth in fiscal year 2023,” stated Tony Thene, Carpenter Technology’s president and CEO. “The quarter saw us return to a positive EPS as both the Specialty Alloy Operations (SAO) and Performance Engineered Products (PEP) segments outperformed our expectations. We also continued to expand our backlog across our end-use markets and secured another price increase on our transactional business as overall demand conditions across our end-use markets remain strong.”

Operating income for the fourth quarter of 2022 was $24.6 million compared to an operating loss of $70.7 million in the prior year period. Adjusted to exclude special items, operating income was $14.9 million in the recent fourth quarter compared to adjusted operating loss of $12.5 million in the same period a year ago. The improvement in operating income is reported to be the result of increased shipments as activity levels continued to ramp to meet improving market conditions in key end-use markets compared to the previous year.

“In the fourth quarter, our backlog grew by 29% on a sequential basis and 191% year-over-year. We also generated positive free cash flow of $65 million and finished the fiscal year with total liquidity of $448 million. The fourth quarter’s operating income results were driven by double digit sequential revenue growth in the aerospace and defense and medical end-use markets.”

GF acquires machine tool service provider Vam Control

GF Machining Solutions, a division of GF, Schaffhausen, Switzerland, has announced that it has acquired 100% of Vam Control S.r.l., a machine tool service provider based in Onore, Italy. The acquisition closed on July 15, 2022, and is said to be a further step in line with the company’s Strategy 2025, which aims to strengthen its milling and automation capabilities and expand its service offering in Europe.

Founded in 1997, Vam Control specialises in services for machine tools and currently has thirty employees. The company reported sales of €4 million in 2021. GF Machining Solutions is one of the three divisions of GF and provides solutions for precision components, tools manufacturers and the mould-making industry. Founded in 1802, the corporation operates in thirty-four countries with 139 companies, sixty-one being production facilities. GF employs over 15,000 staff and generated sales of CHF 3,722 million in 2021.

GF Machining Solutions explains that customer service has expanded in recent years and is now one of the strategic segments for the company’s future growth. With the acquisition, the company anticipates that it will be able to strengthen its in-house milling and Field Service Engineers (FSE) capabilities and enhance the service and solutions offered to its customers. The acquisition will reportedly enable it to develop additional services for the European market, such as machine refurbishments and rebuilding key components and devices.

“Fiscal year 2022 proved to be a challenging but successful year,” Thene continued. “We navigated through an unforeseen outage of our Reading Press, continued COVID-19 isolations, a difficult hiring environment, and other supply chain challenges. But in addressing each of them, I believe we are emerging from it stronger and well-positioned for growth.”

“Looking ahead, we expect to see continued growth across our end-use markets, especially in aerospace, defense and medical applications, where customers are still ramping to pre-pandemic levels. To capitalise on the demand in our core business, we are focused on achieving additional productivity and capacity gains through the Carpenter Operating Model. Further, our strong position in our core business is supported by our capabilities in key emerging areas including electrification and additive manufacturing that further support our long-term growth profile. We believe the continued execution of our strategy will drive sustainable long-term value creation for our customers and shareholders,” he concluded.

www.carpentertechnology.com

GF Machining Solutions has acquired machine tool service company Vam Control S.r.l. ( Courtesy GF Machining Solutions)

Engineers (FSE) capabilities and enhance the service and solutions offered to its customers. The acquisition will reportedly enable it to develop additional services for the European market, such as machine refurbishments and rebuilding key components and devices.

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S&P study finds copper supply may pose challenge in achieving net-zero goals

Analytics company S&P Global, headquartered in New York, USA, has published a study entitled ‘The Future of Copper: Will the looming supply gap short-circuit the energy transition’. This study comes as a response to concerns raised by authorities – including the US government, the International Monetary Fund and the International Energy Agency – about the availability and reliability of minerals needed to reach climate goals.

The study projects that copper demand will nearly double in the next decade – from 25 to 50 million metric tonnes – in order to deploy the technologies necessary to achieve net-zero goals by 2050. This demand is expected to grow to 53 million metric tonnes in 2050: more than all of the copper consumed in the world between 1900 and 2021.

The study utilises a detailed bottom-up approach, technology by technology, to quantify the amount of additional copper that will be required by increased electrification and the energy transition – most specifically, the rapid move to electric vehicles and renewable electricity and the need for increased electricity infrastructure. It then examines the ability of copper supply to meet that demand on the basis of current trends, or with an unprecedented acceleration of supply from mining and recycling. It also identifies the key operational risks that can constrain future supplies.

"Copper is the metal of electrification and absolutely essential to the energy transition," stated Daniel Yergin, vice chairman, S&P Global. "Given the global consensus for Net-Zero Emissions by 2050, it is critical to understand the physical materials required for achieving that ambition. The world has never produced so much copper in such a short timeframe as would be required. On current trends, the doubling of

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global copper demand by 2035 would result in significant shortfalls.”

Notably, the study posits, growth in new copper supply capacity – from new mines or expansions of existing projects – would unlikely be able to keep pace with the surge in demand. The International Energy Agency has estimated that it currently takes sixteen years, on average, to develop a new mine, meaning that a new mine seeking permission today would not become productive in time to accommodate the demand spike.

That leaves increases in capacity utilisation (output as a percentage of an existing mine’s total capacity) and recycling as the main sources of additional supply, according to the study. Under current trends — whereby both capacity utilisation and recycling rates remain at their current ten-year global average — the study’s Rocky Road Scenario projects annual supply shortfalls that reach nearly 10 million metric tonnes in 2035. That is equivalent to 20% of the demand projected to be required for a 2050 net-zero world.

“This comprehensive analysis demonstrates that, even at the outer edge of what could happen in copper mining and refining operations, there would not be enough supply to meet the demands of a Net-Zero Emissions by 2050 world,” added Mohsen Bonakdarpour, executive director, economics and country risk, S&P Global Market Intelligence. “Even strong price signals and incentivising policy initiatives, aggressive capacity utilization rates and all-time high recycling rates would not be enough to close the gap.”

Such a supply gap would have broader consequences across the global economy, disrupting supply chains for both energy transition and non-energy transition industries, the study says. Given copper’s use in a wide range of end markets, it would also exert tremendous upward pressure on the cost of goods for global manufacturers as well as energy costs for consumers.

The study also finds that the burgeoning supply gap would exacerbate the growing reliance on copper imports in the United States, in particular. Imports made up nearly 44% of US copper usage in 2021 — up from just 10% in 1995. Under the study’s scenarios, that share would swell to between 57 and 67% by 2035. An intensifying competition for critical metals is very likely to have geopolitical implications, the study says.

“The challenge for all active participants in the energy transition will be to manage often competing and seemingly contradictory priorities in this New Era of Copper Demand,” said John Mothersole, director, non-ferrous metals, S&P Global Market Intelligence. “Technology and innovation will both be critical in meeting this challenge, as will partnership between governments, producers and end-users. ‘Dr Copper’, as the metal is called, may well currently be, as it has been in the past, a leading indicator of a slowdown in economic growth or recession, but the overall supply outlook for the years ahead is extremely tight.”

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Johnson Electric reports strong sales of PM parts in Europe

Johnson Electric Holdings Limited, headquartered in Hong Kong, has reported its business operations and finances for the three months ending June 30, 2022. The group, which includes Powder Metallurgy parts maker Stackpole International, reported that sales were down 4% from the same quarter in 2021, at $840 million.

Foreign exchange rate movements had a negative effect of $37 million on the group’s sales for the quarter. This was mainly due to the impact of weaker average exchange rates, especially for the Euro, but also for the RMB and Canadian Dollar against the US Dollar, compared to the same quarter in 2021.

The Automotive Products Group (APG) reported sales for the quarter ended 30 June, 2022 decreased by $20 million, or 3%, compared to the same quarter in 2021. Excluding currency effects and the acquisition of E. Zimmermann GmbH, APG’s sales increased by $9 million, or 1%, in the quarter. This increase in underlying sales compared to a 4% decrease in global light vehicle industry production volumes in the quarter.

On a regional basis, APG’s sales also fared better than automotive industry production volumes, which were constrained by shortages of semiconductors, in all regions during the quarter. The sales changes by region, excluding currency effects and the acquisition of Zimmermann, were decreases of 15% in the Americas; 7%, in Asia; and 2%, in Europe.

COVID-related factory lockdowns in China adversely affected sales of powertrain cooling and Powder Metallurgy products, although other areas – such as closure and water pumps – increased. In Europe, oil & water pumps, coolant valves and Powder Metallurgy parts were said to be strong, although sales of other products decreased due to a reduction in light vehicle production in the region. In the Americas, there was strength reported across many product lines.

The Industry Product Group’s sales for the quarter decreased by $17 million, or 8%, compared to the same quarter in 2021. Excluding currency effects, IPG’s sales decreased by $12 million, or 6%, in the quarter, with Asia reporting a decrease of 33%; Europe, of 7%; and the Americas, 16%.

Asia sales, which primarily represent goods invoiced to Asia-based OEMs and contract manufacturers whose end products are mostly destined to export markets, were said to have declined owing to the combination of supply chain disruptions caused by COVID lockdowns in China, ongoing shortages of semiconductor chips and other components, and a decline in demand for some ‘home-centric’ products that had experienced an exceptional surge in sales during the pandemic. In Europe, sales grew in the beverage and lawn segments and, in the Americas, in the medical, ventilation and white goods segments, due to increased demand.

“Despite external challenges, our business units continue to work collaboratively with customers to adjust prices to offset the surge in cost input increases experienced in the past year,” stated Dr Patrick Shui-Chung Wang, chairman and Chief Executive. “Our global operating footprint and geographically diverse sales mix also provides Johnson Electric with strong foundations to navigate further potential volatility in the macro economy.”

www.johnson-electric.com

Climatic chamber for conditioning metal powders installed at TWI

TWI, Cambridge, Cambridgeshire, UK, has acquired a climatic chamber from Weiss Technik, Germany, for the conditioning of metal powders for Additive Manufacturing. The new climatic chamber will be used to assess the influence of storage conditions, such as the effect of humidity and temperature, on AM metal powders as part of IUK funded Scalable AM Rule Creation & Dissemination (SAMRCD) project.

The climatic chamber is capable of simulating various environmental conditions, due to its extended temperature and humidity ranges. Additionally, the climatic chamber allows for rigorous checking and regulation of testing parameters to ensure simulation conditions meet the necessary requirements.

The SAMRCD project operates through a consortium led by Authentise Ltd, London, UK, having been awarded a competitive grant by the UK Research and Innovation’s (UKRI) Transforming Foundation Industries challenge, delivered by Innovate UK. The consortium includes ICD, Materials Processing Institute, TWI and Photocentrics.

TWI will also use the new climatic chamber to help customers simulate a particular environment for metal powders, simulate storage or operating conditions. It will help assess corrosion resistance, evaluate thermal stress and distortions, and understand coating thermal shock response.

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VDM Metals receives Gold status from EcoVadis

VDM Metals International GmbH, Werdohl, Germany, a leading supplier of nickel alloys and high alloyed special stainless steels and part of the Acerinox Group, has been awarded Gold status by EcoVadis for the first time. Gold status puts VDM Metals among the top 5% of companies evaluated by EcoVadis.

Sustainability oriented processes and structures are said to play a prominent role within the Acerinox Group, which has also been a member of the UN Global Compact since 2013. The first performance evaluation of the company took place in 2018, with further evaluations taking place at the end of 2019 and in summer 2021.

“We are very proud of this award, as we were able to improve our rating for the fourth time in a row,” stated Dr. Niclas Müller, CEO. “This development proves that we are on the right track. At the same time, the Gold status is an encouragement to further improve our sustainability performance.”

EcoVadis provides a platform through which companies can have their sustainability performance independently assessed. Customers can access this evaluation and then take it into account in their purchasing decisions. In recent years, the EcoVadis platform has developed into an international standard, and more and more VDM Metals customers are requesting access to the company’s assessment results.

The evaluation takes place in several steps. The main element of data collection is a questionnaire covering the topics of environmental activities, labour & human rights, sustainable procurement and ethics/compliance. All information must be provided with suitable evidence and, in a further step, the data is evaluated by EcoVadis. The analysis of each topic is based on three key indicators: policies & guidelines, measures and results.

After analysing the responses and related documents, EcoVadis summarises the results into an overall and a topic-based score and provides an overview of strengths and weaknesses.

www.vdm-metals.com
www.ecovadis.com

VDM Metals has been awarded Gold status by EcoVadis (Courtesy VDM Metals International)
ASM International announces key changes to its leadership structure

ASM International has announced two key changes to the Society’s leadership structure, with the promotion of Ryan Milosh to Chief Operating Officer and the addition of Kelvin Scott as Chief Information Officer. ASM International is the world’s largest professional technical society serving the needs of scientists, engineers, and technicians who develop, test, select, and apply advanced materials, including metals, composites, polymers, and ceramics.

As Chief Operating Officer, Milosh will be responsible for oversight of all ASM International operations, except the Data Ecosystem and Information Technologies groups. In his most recent position, Milosh has served the organisation as Chief Sales and Marketing Officer. He has a wealth of experience in understanding industry requirements, building partnerships and collaborations, and launching new products and services.

Sandy Robert, Executive Director, will continue to work with Milosh on capabilities planning for the rest of the organisation with an eye to aligning the society with its lines of business and strategic priorities, as well as maximising its value to members and customers.

Scott is joining as a full-time staff member after five years in an IT counsel role with ASM International. His background includes more than twenty-two years of running international consulting businesses, providing IT strategy, enterprise architecture, and programme management. As Chief Information Officer, Scott will work across the organisation to develop and deploy ASM’s digital strategies and information technology systems, both internal and customer-facing.

www.asminternational.org

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Lynas awarded $120M contract to build commercial heavy rare earth facility

Lynas Rare Earths Ltd, headquartered in East Perth, Australia, has announced that its wholly owned subsidiary, Lynas USA LLC, has signed a follow-on contract for approximately US $120 million with the US Department of Defense (DoD) to establish a commercial heavy rare earths (HRE) separation facility in the United States, said to be the first of its kind.

The contract supports Lynas in establishing an operating footprint in the United States, including the production of separated heavy rare earth products to complement its light rare earth product suite. As a result, the US industry is hoping to secure access to domestically produced HREs which cannot be sourced today, yet which are essential to the development of a robust supply chain for future-facing industries including electric vehicles, wind turbines and electronics.

Phase 1 of the US-based HRE facility was announced in July 2020 and, since, Lynas has worked closely with the DoD to reach this point. Construction costs for the HRE capacity as submitted in June 2021 are fully covered by this DoD contract, which is sponsored and funded by the US DoD Industrial Base Analysis and Sustainment (IBAS) programme.

Lynas has expressed its intention to co-locate the heavy rare earths separation facility with the proposed light rare earth separation facility (announced on 22 January 2021) which is sponsored and half funded by the US DoD Title III, Defense Production Act office.

Following a detailed site selection process, the facility is expected to be located within an existing industrial area on the Gulf Coast of the State of Texas and is targeted to be operational in the financial year 2025. Feedstock for the facility will be a mixed rare earths carbonate produced from material sourced at the Lynas mine in Mt Weld, Western Australia. Lynas will also work with potential third-party providers to source other suitable feedstocks as they become available.

"The development of a US heavy rare earths separation facility is an important part of our accelerated growth plan and we look forward to not only meeting the rare earth needs of the US Government but also reinvigorating the local Rare Earths market," stated Amanda Lacaze, CEO and Managing Director, Lynas Rare Earths. "This includes working to develop the Rare Earths supply chain and value-added activities."

"The US government’s selection of Lynas for this strategic contract reflects our proven track record in Rare Earths production," she continued. "The DoD's decision to fully fund the construction of the heavy rare earths facility demonstrates the priority that the U.S. Government is placing on ensuring that supply chains for these critical materials are resilient and environmentally responsible, and as importantly, their confidence in Lynas' ability to execute, including access to quality feedstock and processing expertise."

Lacaze concluded, "This contract is an excellent example of Indo-Pacific cooperation to meet supply chain challenges, and Lynas looks forward to collaborating with the DoD, the State of Texas and US manufacturers as we progress our plans for the facility."

www.lynasrareearths.com ●●●
Pensana breaks ground at rare earths processing facility

Rare earth metals company Pensana Plc, headquartered in London, UK, reports that it has broken ground at its rare earth processing facility at Saltend Chemicals Park, located in the Humber Local Enterprise Partnership in Yorkshire, where it plans to create what it states is the world’s first rare earth processing facility powered by offshore wind, producing key components for electric vehicle and offshore wind original equipment manufacturers with low-embedded carbon.

Following a twelve-month construction period, the $195 million state-of-the-art plant aims to start production in late 2023, before ramping up to full capacity in 2024. Pensana hopes to produce 12,500 tonnes of separated rare earths, including 4,500 tonnes of the critically important magnet metal rare earths, which represent over 5% of the world’s supply. Saltend will employ over 450 people during the twelve-month construction phase and expects to create 125 jobs.

The company states that it has secured funding under the UK Government’s £1 billion Automotive Transformation Fund (ATF) to support the development of the Saltend rare earths processing facility. The ATF is a funding programme developed to promote the creation of a high-value end-to-end electrified automotive supply chain in the UK. It is an important mechanism to reach targets set out in the UK Government’s ten-point plan for a green industrial revolution and its recent Transport Decarbonisation Plan.

During the ground-breaking ceremony, the Rt Hon Kwasi Kwarteng MP attended and announced the UK Government’s Critical Minerals Strategy, which details the Government’s approach to securing technology-critical minerals and metals and is an important step towards securing a resilient, long-term supply chain to deliver a green industrial revolution for the UK.

“It is a great privilege to have broken ground on the world’s first independent and sustainable rare earths separation plant,” commented Paul Atherley, Pensana chairman. “This is a huge milestone for both Pensana, the Humber region and the UK, as part of our ambition to establish a critical magnet metals supply chain to secure the green energy transition.”

“Securing ATF funding is a key development, demonstrating the UK Government’s support for this important project in line with the newly launched Critical Minerals Strategy,” he continued. “Pensana is set to play a vital role in transforming the UK’s electric vehicle and offshore wind industries, by producing low embedded carbon magnet metals and creating high-value local jobs.”

Kwasi Kwarteng MP, Secretary of State at the Department of Business, Energy and Industrial Strategy, stated, “Pensana breaking ground today has been made possible in part through government support and shows how our plans to secure an internationally competitive electric vehicle supply chain in the UK continues to gain momentum. This incredible facility will be the only of its kind in Europe and will help secure the resilience of Britain’s supplies into the future.”

www.pensana.co.uk
NETL aims for critical materials supply chain research centres

The National Energy Technology Laboratory (NETL), a US-based national laboratory under the country’s Department of Energy Office of Fossil Energy, is working to develop critical mineral supply chains with an approach which is intended to help disadvantaged communities become critical contributors in the nation’s low-carbon energy future.

NETL is currently focused on developing the technology to unlock unconventional sources of critical minerals, including overlooked resources such as waste rock, coal ash and acid mine waters.

The lab has coordinated regional teams of researchers across the country through the Carbon Ore, Rare Earth, and Critical Minerals (CORE-CM) Initiative for US Basins, which is intended to take a step toward comprehensive resource assessment technologies and providing a beachhead for the local development of supply chains near unconventional mineral resources.

“We hope to unite complementary approaches and research capabilities with the long-term goal to create dedicated supply chain research centres that will continue to prove out domestic production techniques for CMs,” stated Burt Thomas, technical portfolio lead for critical minerals at NETL. “These domestic sources will provide jobs that can’t be off-shored in American communities that need investment. Many of these jobs will be in the nation’s historic mining and power communities and will incentivise new cleanup initiatives at legacy mining sites.”

The research in NETL’s portfolio are multi-year efforts intended to catalyse regional economic growth and accelerate the development of upstream and midstream critical mineral supply chain technologies. These efforts are finding unconventional mineral resources in the country and impacting the down-stream manufacturing of high-value, non-fuel, carbon-based products.

In addition to finding economic value in US resources, these projects will promote the environmental and justice initiatives that are a foundation for long-term social license to operate. CORE-CM Initiatives and the NETL team are committed to ensuring best practices for environmental health and safety associated with any proposed work.

“This challenge is something the US is up for. Research facilities like the proposed research centres at NETL will help scientists, engineers, and commercial partners in these communities understand the pathways to commercialise their resources,” Thomas continued. “If we succeed, the same communities that kept the lights on for all of us by mining coal may yet be responsible for keeping the lights on by supplying the nation’s magnets, batteries, and electronic components.”

www.netl.doe.gov

EPMA re-elects president and treasurer during 35th General Assembly

The 35th General Assembly of the European Powder Metallurgy Association (EPMA) marked the first time in two years that members could meet at an in-person event, with the meeting taking place both online and in-person in Brussels, Belgium, on April 28, 2022. During the assembly, it was confirmed that EPMA President, Ralf Carlström of Hoganas AB and EPMA treasurer, Christoph Laumen, Linde GmbH, were re-elected to their positions for a further three-year term.

The EPMA team presented an overview of past and ongoing work. The current situation with the World PM2022 Congress was presented by Sabine Hazoume, while Romain Rayez gave an update on the Communication & Marketing activities. EPMA Technical Managers, Bruno Vicenzi and Kenan Boz, presented the various ongoing European projects and working groups, as well as an overview of the different Sectoral Groups activities over 2021/2022.

More detailed information was then reported by the chairmen of the various EPMA groups: Cesar Molins from Press & Sinter, Georg Breitenmoser from Metal Injection Moulding, Peter Kjeldsteen from Functional Materials, Steven Moseley from Hard Materials, Adeline Riou from Additive Manufacturing and Jim Shipley from Hot Isostatic Pressing.

Keynote speeches, presented towards the end of the assembly, saw Elena Vyboldina of Eurometaux discuss the Russia-Ukraine crisis and its impact on EU non-ferrous metals sector. Chris Heron presented ‘Euro-mettaux on Legal Affairs’ and Melina Hervet-Henry of AddUp Solutions gave a talk on ‘Patents applications: a strategic value for the company.’

A look at sustainability in the steel industry was also presented by Clare Broadbent, World Steel Association.

www.epma.com
PowderMet2022: State of the North American PM industry

The PowderMet2022: International Conference on Powder Metallurgy & Particulate Materials, and the co-located AMPM2022: Additive Manufacturing with Powder Metallurgy Conference, was held in Portland, Oregon, USA, from June 12-15, 2022. Organised by the Metal Powder Industries Federation (MPIF), the event included three days of presentations accompanied by an exhibition and a range of social and networking events.

The Opening General Session included a presentation by MPIF President Rodney Brennen, who gave delegates a detailed overview of the state of the North American Powder Metallurgy industry.

"The North American Powder Metallurgy industry has not been immune from the unprecedented challenges facing the global supply-chain. We continue to feel the negative effects of the COVID-19 pandemic," began Brennen.

The semiconductor microchip processor shortages also had a major impact on the PM sector, and continues to cause delays in automotive production. "Most automotive companies, whose vehicles use an estimated 20-100 processors each, depending on the vehicle’s features, agree that recovery will begin in the second half of 2022, but a normal supply won’t be met until well into 2023. Volkswagen doesn’t expect demands to be met until 2024," Brennen explained.

Further global events negatively impacting the PM industry were highlighted by Brennen, who then went on to say that many of these major disruptions should be viewed as opportunities. "They have forced companies to work smarter, be more efficient, and innovative. New production output levels are being achieved thanks to changes and innovations made because of the pandemic. Many companies report reductions in energy consumption, furnace atmosphere gasses, scrap, and waste that is sent to landfills as a direct result of operating more efficiently."

"Some companies have replaced older equipment with the latest computer controlled Industry 4.0 technology. This 'Internet of Things' approach allows equipment to 'talk' to each other and learn the best parameters for the process. Automation within the industry continues to grow as a solution to the overall shortage of workers. From pick-and-place robots at the compacting presses and furnaces, to 100% vision system inspections, automation will continue to increase."

"The PM industry is alive and well, landing back on its feet, and on its way to recovery," noted Brennen.

North American metal powder shipments

The MPIF reported that total estimated 2021 North American metal powder shipments increased by 8.1% to 359,928 mt.

Total iron powder shipments increased 7.8% to 307,105 mt. Stainless steel, copper, nickel, and aluminium powder shipments all increased by an estimated 3% to 11%. Estimated shipments for 2021 include stainless steel powder, 6,349 mt; copper and copper base powder, 13,605 mt; nickel powder, 4,263 mt; and aluminium powder 19,591 mt. Refractory powder had a strong showing in 2021 after decreased shipments over the past few years. Molybdenum shipments increased an estimated 33.5% to 563 mt. Tungsten powder shipments increased by an estimated 106% to 3,115 mt, and tungsten carbide powder shipments increased an estimated 13.7% to 5,338 mt.

Refractory powder had a strong showing in 2021 after decreased shipments over the past few years. Molybdenum shipments increased an estimated 33.5% to 563 mt. Tungsten powder shipments increased by an estimated 106% to 3,115 mt, and tungsten carbide powder shipments increased an estimated 13.7% to 5,338 mt.

Historically, iron powder shipments have been the best barometer of the health of the PM industry.
explained the MPIF, but there will likely be a correction as the auto industry downsizes engines from 8-cylinders to 4-cylinders, and the acceptance of hybrid (HV) and electric (EV) vehicles.

PM and friction-grade iron powder shipments were up 6.6% to 275,309 mt. Welding applications increased by 30.2% to 14,309 mt. Cutting, scarfing, and lancing applications increased by 21% to 822 mt. Miscellaneous uses increased 11.5% to 16,665 mt.

Metal powder activities
"Powder producers continue to respond to the needs of the industry by developing new and improved materials and additives for conventional press and sinter, MIM, and metal AM. Over the past two years, dry lubricants have been in limited supply and high-demand, forcing companies to seek alternatives. The demand to improve 'value-added' machining has resulted in new high green strength materials that are suitable for green machining," continued Brennen.

With the electrification of the automobile increasing, soft magnetic and soft magnetic composites are being researched by all major iron powder producers. "Most have ongoing collaborative efforts with their customers and academia to identify higher permeability, lower core loss, and increased part strength materials and processes. The MPIF Standards Committee is keeping a keen eye on this development."

MIM and AM powder producers were reported to be seeing strong demands for materials. "Generally, the materials of choice are stainless steels and low-alloy steels, but there is considerable developmental work being performed on aluminium, titanium, and an array of other metal powders and alloys," added Brennen. Total 2021 North American MIM and AM powder shipments increased by an estimated 5-10% to 3,934,767-4,202,178 kg. Of this amount, an estimated 360,000 kg is dedicated to AM.

"Improving powder quality will benefit both MIM and AM. A narrower particle size distribution range, greater sphericity, fewer satellites, and less internal porosity will improve throughput, mechanical properties, and overall process consistency. Typically, these powders are manufactured by gas atomisation, but capacity has been added recently for plasma atomisation and research continues to develop water atomised low-alloy materials for MIM and AM."

Conventional Press & Sinter
The MPIF stated that PM parts makers report a continued surge from the industrial sector, requiring value-added, near-net-shape parts...
that have cost-effective lean-alloy materials, with high material utilisation rates. Most have realised increased backlogs, month after month. Disrupted supply chains have resulted in the re-shoring of some PM parts, but not to the extent that most had hoped.

"The general feeling from the conventional press & sinter parts makers is high single-digit to low double digit-growth for non-automotive applications. The current outlook for automotive applications is not as good due to supply chain disruptions," added Brennen.

The MPIF estimates over 70% of the iron powder shipped is used for parts in internal combustion engine (ICE) passenger vehicles. Unfortunately, it appears HVs have limited use of, or are not using, powder forged connecting rods and PM main bearing caps. And, obviously, EVs don't have connecting rods and main bearing caps.

"To put things into perspective, there is roughly 9 kg of iron powder used for powder forged connecting rods and main bearing caps in an 8-cylinder engine. So, as HVs and EVs gain greater acceptance, we can expect iron powder shipments to decline until other applications pick up the volume."

"Each year, we estimate the amount of PM in a North American passenger vehicle. In 2021, there were roughly 15 million vehicles sold, about 500 thousand more than 2020, but 2 million less than pre-COVID 2019. The semiconductor shortages had a devastating effect on vehicle sales as car lots were empty."

The automotive manufacturers reportedly diverted the semiconductors to produce the higher-margin large pick-up trucks and SUVs over the lower-margin sedans. "This was great news for the PM industry as the large passenger vehicles consume an average 27.2 kg per vehicle, followed by the midsize crossover vehicles at 18.1 kg and the sedans at 9.1 kg. Our best estimate for EVs, less the battery, ranges from 1.8-3.6 kg of PM. Taking everything into consideration, the estimated average weight in a 2021 North American passenger vehicle remained at 16.8 kg," explained Brennen.

The semiconductor shortage wanes, and HVs and EVs gain greater acceptance, the PM weight in passenger vehicles will likely decrease 2-3% annually without new applications, it was stated. However, there are opportunities to introduce the use of powder forged connecting rods and PM main bearing caps in HVs, and new applications in EVs.

"But we can't depend solely on the automotive industry. In 2001, MPIF launched the PM Industry Vision and Technology Roadmap. One of the six priorities identified was 'Focus on emerging product needs' that noted: 'Reliance on the internal combustion engine is decreasing and PM producers must develop materials and systems required for emerging fuel cell and hybrid-electric vehicle technology.' That was over twenty years ago, and we are still talking about it today..." Brennen said.

**Refractory metals and hard materials**

It was reported that in 2021, the tungsten market significantly increased on an overall basis with continued strong growth in the semiconductor market, driving demand for high purity tungsten powder due to the demands for newer generation chips used in 5G, personal computers, super computers, smartphones, electric vehicles, smart TVs, and other 'Internet of Things' devices. Tungsten powder for the defence industry also remained strong. Another positive trend that boosted tungsten powder shipments was North American customers buying from domestic producers instead of Asian producers whose supply chains represented significant delays and risk.

The tungsten carbide market moderately improved but was still impacted by a reduced North American oil and gas exploration and a depressed coal mining market. There was a moderate increase in demand for tungsten carbide for cutting tools and wear parts due to a resurgence in manufacturing, but the demand was impacted by shortages in raw materials and labour, as well as transportation issues and rising costs.

North American oil and gas rig counts finished the year up 65% over 2020, which had the lowest levels since 1949. At the end of 2021, the North American rig count was 676 compared to a twenty-year average of 1,514 and the most recent five-year average of 842. In 2021, coal production in the US was up 8% over 2020 according to the US Energy Information Agency, but 2020 was one of the worst years on record.

**PowderMet2022 included a presentation on the state of the North American Powder Metallurgy industry by MPIF President Rodney Brennen**
Reduced automotive production resulted in inconsistent demand for cutting tools. Other manufacturing sectors picked up in 2021, but, again, shipping backlogs and COVID-19 lockdowns in China disrupted raw materials.

"Longer transportation timeframes have had a significant impact on international shipments of tungsten concentrates and other raw materials. The uncertainty has led manufacturers to increase inventories to avoid the possibility of running low on raw materials. For the most part, increased prices did not have a discernible impact on demand from many industrial manufacturers in the North American market," added Brennen.

North American molybdenum powder demand was estimated to be up by 33%. Molybdenum is used in PM applications for such industries as aerospace, automotive, medical, defence, industrial, and electronics. Demand for these applications surged in 2021 increasing the need for molybdenum powders for the diverse PM parts that service these markets, reported the MPIF.

**Powder Metallurgy outlook**

In his concluding remarks, Brennen stated, "I believe the industry will be able to adapt and overcome, but we will need the mindset and resources to adjust to the changing environment. As an industry, we need to showcase our strengths and work together to advance the technology. We have a lot of advantages over other metal-forming technologies."

"Many companies in our industry have aggressive programmes to become carbon-neutral, sooner than later. Last year we learned about iron powder being used as an energy source, combusting it with hot gases to drive an engine, producing sustainable electricity. We also learned about a sustainable energy-focused infrastructure for storing zero-emission metal-hydride energy. This innovative, safe, and renewable energy storage solution utilises high-density PM pellets."

"Other non-traditional applications for metal powders include water purification, thermal management, and solar energy. And how about the research to remove oxygen from moon dust? The process byproduct is metal powder that one day could be used to make structures on the moon."

"These are just a few examples of creative uses and new opportunities for metal powders. We need to set our sights long-term, not just on meeting our monthly goals. We need to invest in R&D to create new applications and uses for metal powders and PM parts. And we need to work together for a common goal."

"We have a lot to look forward to as we advance the PM technology," Brennen told the audience as he concluded his PowderMet2022 presentation.

www.mpif.org
**Rio Tinto and Nano One announce partnership and $10M investment**

Rio Tinto has entered into a strategic partnership with Nano One® Materials Corp, a battery materials provider based in Barnaby, Canada. The agreement includes the supply of iron and lithium products, collaboration and a US $10 million investment into Nano One. The partnership is expected to accelerate Nano One’s multi-cathode commercialisation strategy and support cathode active materials manufacturing in Canada for a cleaner battery supply chain.

Rio Tinto and Nano One will, on closing of the agreement, enter a strategic collaboration agreement that includes a study of Rio Tinto’s battery metal products, including iron powders from the Rio Tinto Fer et Titane facility in Sorel-Tracy, Quebec, as feedstock for the production of Nano One’s cathode materials.

Rio Tinto will contribute knowledge from its Critical Minerals and Technology Centre, which has developed experience in the extraction and processing of critical minerals such as lithium and scandium, as well as minerals from Canada, the United States, and other international sources to further drive localisation of the lithium-ion battery value chain.

“The global transition to a low-carbon electrified economy will require millions of tonnes of battery materials, so it is critically important to produce these materials efficiently and with the lowest environmental footprint,” stated Dan Blondal, CEO of Nano One. “Rio Tinto’s partnership and support complement our recent announcement to acquire Johnson Matthey’s LFP business in the nearby community of Candiac, Quebec and amplifies the Government of Canada’s Mines-to-Mobility initiative, which aims to encourage a localised battery ecosystem to serve the broader North American market. Rio Tinto brings deep experience in high volume production and technology commercialisation, as well as a growing battery metals business. We are excited to be partnering with Rio Tinto, our shared vision will see many opportunities for collaboration as we drive for change.”

Nano One’s patented One Pot Process and metal to cathode active material (M2CAM) technologies form a unique manufacturing platform that enables nickel-rich (NMC), iron-rich (LFP) and manganese-rich (LNMO) lithium-ion cathode active materials to be made sulfate-free from a range of battery metal sources with fewer steps, lower costs, less complexity and a much smaller environmental footprint. The technology applies to all lithium-ion battery chemistries for applications in electric vehicles, renewable energy storage and portable electronics.

Rio Tinto will collaborate as required on technical and business matters in developing, designing, constructing and operating cathode production facilities. Nano One will issue 1,000,000 non-transferable share purchase warrants to Rio Tinto as consideration for its technical and support services. Each warrant will entitle Rio Tinto to purchase one share at an exercise price of CAN $4.00 for a period of twelve months from the date of issuance.

“Localised, clean and secure supply chains are critical for the success of the energy transition that is now underway and this requires partnerships with innovative companies like Nano One to help us differentiate, disrupt and accelerate the path to a net-zero future,” stated Marnie Finlayson, Managing Director of Rio Tinto’s Battery Materials portfolio. “We are pleased to back and support Nano One’s ambitions to drive for change and we look forward to bringing Rio Tinto’s deep experience and know-how in commercialisation and large scale projects to this exciting initiative.”

www.riotinto.com
www.nanoone.ca

**Tekna and Uniformity Labs sign titanium supply agreement**

Uniformity Labs, Fremont, California, USA, has signed an agreement with Tekna Holding ASA, Sherbrooke, Quebec, Canada, which will see Tekna supply Ti64 5/25 and Ti64 45/105 for Uniformity to produce its advanced titanium powders for Laser Beam Powder Bed Fusion (LPPF-LB) Additive Manufacturing.

Uniformity’s engineered powders and processes are said to enable faster production of repeatable parts, at higher density with no compromise in quality. Tekna’s powder atomisation technology uses hydro-energy and all process gasses are recycled in closed loops, achieving greener production. Together the companies will help industrial customers produce greener, more sustainable parts.

“We’re excited to collaborate with Tekna for the supply of highest quality titanium powders for LPBF,” stated Adam Hopkins, founder, and CEO of Uniformity Labs. “This agreement opens a critical North American material resource for us. The complementary nature of our businesses produces an economic benefit for our customers who gain through higher printer throughput and repeatability, and a supply chain security benefit from the use of materials produced entirely in North America.”

Luc Dionne, CEO of Tekna, commented, “We are extremely proud that Uniformity Labs has selected us to supply titanium powders. This is a testament to Tekna’s supply reliability and reaffirms that our product quality matches with a wide range of industry requirements.”

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Powder Metallurgy enables James Webb Space Telescope to view distant galaxies

Since its launch in late 2021, the James Webb Space Telescope (JWST) has been providing humanity with a unique glimpse into space, from never-before-seen stars in distant nebulae to new representations of familiar sights like Jupiter. The telescope – the largest optical telescope in space – is designed for infrared astronomy and its high resolution and sensitivity allows it to view objects too early, distant or faint for the Hubble Space Telescope. This is enabled by eighteen hexagonal mirror segments, gold plated and made of beryllium.

The beryllium used to make Webb’s mirror was mined in Utah and purified at the Brush Wellman (now Materion Corporation) facility in Ohio. The particular type of beryllium used in the Webb mirrors is called O-30 and is a fine, gas atomised powder.

“Beryllium is very lightweight, a third lighter than aluminum, extremely stiff and can be polished very well. It also functions well at cryogenic temperatures which made it the perfect material for the telescope,” stated Keith Smith, vice president – Nuclear and Science, Materion. “The telescope features a special grade of gas atomised beryllium which is lightweight and has the properties needed for the telescope’s primary mirror.”

To construct the mirror segments the beryllium powder was placed into a stainless steel canister and pressed into a flat shape, a process known as Hot Isostatic Pressing (HIP). Once the steel canister was removed, the resulting beryllium slab was cut in half to make two mirror blanks, some 1.3 m across. Each mirror blank was used to make one of the eighteen mirror segments. The first two mirror blanks were completed in March 2004.

Once the mirror blanks passed inspection, they were sent to Axsys Technologies in Cullman, Alabama, to be shaped into their final design. The process began with cutting away most of the back side of the beryllium mirror blank, leaving a thin rib structure. The ribs are about 1 mm thick and although most of the metal is gone, the ribs are enough to keep the segment’s shape steady. This makes each segment very light, with each beryllium mirror segment around 20 kg in mass. A full primary mirror segment assembly, including its actuator, is about 40 kg.

After the shaping stage, SSG/Tinsley, Richmond, California, ground the mirrors’ surfaces, smoothed and polished them before they were sent to undergo cryogenic testing. The initial cryogenic testing, by Ball Aerospace, began in 2009. After around two years of testing, the mirrors and information gathered using laser interferometers were sent back to SSG/Tinsley for a final polish in June 2011. By the end of 2013, all of the assembled mirrors were at NASA Goddard, awaiting their housing, which arrived in 2015.

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Kymera sells calibration powders based on new MPPA standard

Kymera International, a speciality materials company headquartered in Raleigh, North Carolina, USA, has received a master Carney flowmeter in line with a new standard approved by the Metal Powder Producers Association (MPPA) Standards committee. The new standard has approved a new test method standard regarding the flow rate of non-free-flowing metal powders using a Carney flowmeter funnel.

Prior to this, no Carney funnels are said to have been calibrated for this flow metric, but, rather, tested the apparent density of the powders. The new calibration powder is a 316L stainless steel screen cut that was tested for stability and repeatability of flow time over an extended period.

Kymera has now 200 g quantities of this calibration powder available to purchase with which buyers can test their own Carney flowmeter funnels. A new funnel should have a flow time of 31.0 ± 0.5 seconds for 150 g; funnels with a flow time of fewer than 28 seconds are invalid.

The MPPA Standards Committee intends to coordinate an inter-laboratory test programme in 2022 in conjunction with ASTM Committee B09 on Metal Powders and Metal Powder Products to determine the precision of the new Carney flow rate test method. A valid flowmeter funnel will be required for participation.

www.kymerainternational.com
www.mpif.org

PowderMet2023 Call for Papers

The programme committee for the International Conference on Powder Metallurgy & Particulate Materials (PowderMet2023), which is scheduled to take place at Caesars Palace, Las Vegas, Nevada, USA, from June 18-21, 2023, has issued a call for papers and presentations covering the latest developments in Powder Metallurgy materials, processes, and applications.

Sponsored by the Metal Powder Industries Federation (MPIF) and its affiliate APMI International, the four-day event is co-located with the Additive Manufacturing with Powder Metallurgy Conference (AMPM2023). Abstracts covering any aspect of PM and particulate materials technology are invited. The abstract submission deadline is November 5, 2022.

www.mpif.org
Prof Jose Manuel Torralba to receive 2022 Ivor Jenkins Medal

The UK’s Institute of Materials, Minerals and Mining (IOM3) has announced that Prof Jose Manuel Torralba, Director, IMDEA Materials Institute, Spain, has been awarded the 2022 Ivor Jenkins Medal. The prestigious award is presented to individuals in recognition of a significant contribution that has enhanced the scientific, industrial or technological understanding of materials processing or component production using Powder Metallurgy and particulate materials.

“Nowadays, you can’t really award individual scientific honours, because research work is always a collective endeavour,” stated Torralba. “I think this award is a recognition, not only for me, but also for all the people I have worked with over the years.”

Prof Torralba completed studies as a Metallurgical Engineer at the Technical University of Madrid – UPM and Armament and Materials Engineer at Escuela Politécnica del Ejército, EPSE. He has also earned two PhD degrees: Dr. Eng. Metallurgy (UPM) and Dr. Eng. Armament (EPSE).

Torralba has been Head of the Materials Science and Engineering Department, vice-rector for Academics Infrastructures and vice-rector for Research and Innovation at MSE at Universidad Carlos III de Madrid (UC3M), as well as Deputy Director of Institute IMDEA Materials, Director-General for Universities and Research of Madrid Regional Government and Higher Artistic Arts Studies. He is currently a Professor of MSE at UC3M and Director of IMDEA Materials Institute.

Previous winners of the Ivor Jenkins Medal include Roger Lawcock (2021), Prof Herbert Danninger (2020), Dr Leo Prakash (2019), David Whittaker (2018), and John Dunkley (2016). “Above all, I feel very honoured to share this award with so many very important and widely recognised researchers and technologists who have been references for me during my career,” added Torralba. “And even more so because it is an international recognition that comes from such a prestigious institute in my area of work as the IOM3.”

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Kymera sells calibration powders based on new MPPA standard

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www.kymerainternational.com
JPMA announces new president and board members

The Japan Powder Metallurgy Association (JPMA), based in Tokyo, has announced the appointment of a new president and members of the board during its General Assembly held on May 19, 2022.

The association reported that Hiroshi Ii of Japan’s Diament Corporation assumes the role of president, replacing Nobuhiro Hashimoto of Sumitomo Electric Industries, Ltd. The board members were confirmed as follows:

Permanent board members
Mitsuhiro Goto, Sumitomo Electric Industries, Ltd
Yoichi Inoue, Fine Sinter Co., Ltd
Masashi Kikuchi, Porite Corporation
Tsuyoshi Hasegawa, Kobe Steel, Ltd
Shoichi Tokumaru, JFE Steel Corporation

Shoeki Katano, Höganäs Japan K.K.
Shuzo Sonoda, Fukuda Metal Foil & Powder Co., Ltd.

Board members
Junichi Takahashi, Iwaki Diecast Co., Ltd.
Yoshitake Nakashima, NTN Advanced Materials Corporation
Takashi Suzuki, NAPAC Co., Ltd.
Masayoshi Nishimura, Fukuisinter Co., Ltd.
Tetsuya Shimizu, Daido Steel Co., Ltd.
Takayuki Yoshida, Dowa Electronics Materials Co., Ltd.
Jiro Bando, Nippon Atomized Metal Powders Corporation
Naoya Takahashi, Mitsubishi Materials Techno Corporation

Executive Director
Yoshio Uetsuki

Auditors
Seiji Shimizu, NTN Advanced Materials Corporation
Yasushi Mori, Nippon Atomized Metal Powders Corporation

www.jpma.gr.jp

Hiroshi Ii is the JPMA’s new president (Courtesy JPMA)

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Powder Metallurgy Design Excellence
Award winners shine light on metal powder industry

The winners in the 2022 Powder Metallurgy Design Excellence Awards competition, sponsored by the Metal Powder Industries Federation (MPIF), were announced during the International Conference on Powder Metallurgy and Particulate Materials (PowderMet2022), held in Portland, Oregon, USA, from June 12–15, 2022.

This year’s winners are said to showcase outstanding examples of PM’s unique ability to challenge competing technologies, stated the MPIF. From lightweighting to complex geometries, Powder Metallurgy provides component designers with the ability to utilise advanced engineering methods that add up to part-to-part uniformity for improved product quality, shape and material flexibility, application versatility, and more.

In the design competition, a total of nine Grand Prizes and eighteen Awards of Distinction were presented across the manufacturing categories of conventional Powder Metallurgy, Metal Injection Moulding and metal Additive Manufacturing. Here, we highlight the Powder Metallurgy winners.

Grand Prizes

Automotive – Engine category PM
A Grand Prize in the Automotive – Engine category for conventional PM components was awarded to GKN Sinter Metals and its customer Pierburg, for an aluminium metal-matrix-composite outer gerotor for an Italian luxury sports car dry sump pump. It is reputedly the first aluminium gerotor used in a dual-material aluminium-steel pump gear for a production vehicle application.

The inner profile of the gerotor for this high-performance application was critical for it to function in conjunction with a steel inner rotor with a different thermal expansion coefficient. The part provides a 50% reduction in rotating mass, which becomes even more significant with six gerotors per gang pump assembly.

MIM and metal AM
Further Grand Prize winners included parts made by MIM from Kyerim Metal Co., Ltd; ARC Group Worldwide and INDO-MIM Pvt Ltd, along with components produced by metal AM from Divergent Technologies, Inc, and 3DEO Inc.

Awards of Distinction

Automotive – Engine category PM
In the Automotive – Engine category for conventional PM components, an Award of Distinction was given to Nichols Portland LLC, a division of Nichols Portland Inc., for an eccentric ring used in a variable displacement oil pump. The sinter-hardened parts provide enhanced performance compared with prior generation designs that used steam-treated as-sintered parts.

In the same category, an Award of Distinction was also presented to DSB Technologies, LLC, formerly SSI Sintered Specialties LLC, and its customer Purem by Eberspaecher, for a 309L stainless steel sensor.
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boss that is welded to an automotive exhaust system and holds a sensor for monitoring engine performance.

**Automotive – Transmission category PM**

In the Automotive – Transmission category for conventional PM components, an Award of Distinction was given to Burgess-Norton Mfg. Co., for drive & driven sprockets, a pressure plate, and a sector gear, made for BorgWarner, and used in an automotive transfer case. The sprockets are warm-die compacted from FL-4405 with admixed nickel.

**Automotive – Chassis category PM**

In the Automotive – Chassis category for conventional PM components, an Award of Distinction was presented to Metalpo Ind. Com Ltda and its customer Haldex do Brasil Ind e com Ltda, for a rack used in a braking system for trucks. The rack is made from diffusion-alloyed FD-0405, warm-die compacted and case hardened to achieve good wear properties.

**Lawn & Garden/Off-Highway PM**

In the Lawn & Garden/Off-Highway conventional PM components category, an Award of Distinction was given to Alpha Precision Group, a division of Nichols Portland Inc., for a camshaft assembly used in a family of engines ranging from 19–27 hp for consumer lawn and garden machines. The assembly comprises six PM components (a cam gear, four cam lobes, and a thrust washer). All five parts are assembled to the precision ground shaft by means of highly automated, specialised assembly cells.

This category also included a winning entry from FMS Corporation and their customer TEAM Industries for a spider dampener insert, part of a torque spider sub-assembly for ATV transmissions. The part was originally designed as a metal casting that required secondary machining, but was re-designed for PM in order to eliminate the need for extensive machining operations.

**Hand Tools/Recreation PM**

In the Hand Tools/Recreation category for conventional PM components, an Award of Distinction was given to Porite Taiwan Co., Ltd., for a ring gear, used in the gearbox of a cordless drill. It is divided into two parts due to the multi-section appearance. The two PM parts are machined, pressed for alignment, followed by a plastic injection overmould operation.

**Industrial Motors/Controls & Hydraulics PM**

In the Industrial Motors/Controls & Hydraulics category for conventional PM components, an Award of Distinction was presented to Nichols Portland LLC, a division of Nichols Portland Inc., for a pump head sub-assembly for fluid delivery. The assembly comprises six PM parts, an inlet plate, eccentric ring, inner and outer gerotors, a spline coupling, and an outlet plate.

**MIM and metal AM**

Further Awards of Distinction included MIM parts from INDOMIM Pvt Ltd., OptiMIM (a Form Technologies Company), Advanced Powder Products Inc., ARC Group Worldwide and PTI (Polymer Technologies Inc.). Metal additively manufactured component winners included Azoth and Amaero.

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Where ideas take shape.
Powder Metallurgy’s challenge: How does automotive’s reliance on model-based decision making impact our industry?

With the automotive industry’s adoption of a model-based engineering approach dependent on access to reliable information, the limited data available for PM materials is putting the industry in a vulnerable position compared to wrought or cast materials. As Ian Donaldson, Director Advanced Engineering Applications at GKN Sinter Metals, explains, in order to compete for its place in the rapidly changing automotive supply chain, it is imperative that the PM industry moves away from a primarily document-centric approach that relies on engineering specification sheets and limited material databases and toward developing more comprehensive databases.

As is well known, the speed of automotive development has been increasing rapidly, with conceptualisation to product launch windows continuously narrowing. Although not on par with some consumer electronics, the automotive industry must comply with a myriad of safety requirements and legislative requirements, while meeting the ever-expanding desires from consumers for more interconnected features not present in the electronics industry.

Decades ago, to cope with these demands, the automotive industry adopted a model-based engineering (MBE) approach to enable an understanding of product performance from a component level and aid in decision making throughout the product cycle. The motivation was to reduce costs and development time while detecting design defects earlier. The integration of this approach across the system domain is visualised in Fig. 2.

A key component for MBE to be successful is reliable data in appropriate databases for computer aided design (CAD). While its initial adoption was for automotive electronic systems, it has spread throughout the value chain to static and dynamic material properties for structural components.

Here lies the problem for the Powder Metallurgy industry, since there is much less data available in CAE databases for PM than for wrought or cast materials.

Automotive system engineering unravelled

The use of CAD was introduced decades ago in the automotive industry, stimulating a transition from 2D prints to 3D models, which became the industry standard for designing products and tooling. While it was embraced by the OEMs, the adoption was much slower further downstream in the value chain.
Automotive model-based decision making

Automotive OEM companies realised that an approach with virtual rather than physical prototypes provided a means of reducing design time with improved efficiency and reduced costs through virtual versus physical testing.

Complying with legislative directives for safety, fuel economy and reduced emissions has been a focus of the automotive industry for decades, with significant shifts in those directives – such as dealing with climate change – accelerating reactions to comply in the automotive industry. More recently, with the unforeseen socio-economic disruption from the COVID pandemic, this evolution has become unparalleled, with the convergence of rapidly evolving consumer preferences, emerging technology, dramatically shifting business landscapes (such as disrupted supply chains and the mass exodus of highly skilled labour through early retirement) and government directives. All these drivers combined further complicate the already complex and high-volume vehicle supply chain and the supplier sub-chains that feed into it [1].

The automotive industry is familiar with the intricacy of vehicle requirements and supply chains. Adaptability and agility are demanded from both the OEM and the supply base. An early example of how this evolved is evident with integrated electronic control systems that are now booming in automobiles: each model year sees the introduction of more advanced systems to meet consumer demand for vehicles that are not only safe and reliable, but also comfortable and pleasurable to drive [2]. These control systems are integral with the vehicle operations such as anti-lock brakes and sensor systems for engine control and power trains. In addition, consumer features such as power auto-adjustable seating, info-systems, rain sensors, heating/cooling systems, and steering assist must be considered.

With the extreme pressure from existing requirements and upcoming demands, system engineers needed to turn from the historical document-centric approach to model-based design tools. Key aspects of the

![Fig. 2 A visualisation of MBE integration across the system domain. The system model is constrained by the specifications. Information views are shared across the domains. PM has typically fallen into the Mechanical domain](image)

![Fig. 3 Visual of a traditional automotive system showing multiple electronic control units (ECU) and the systems they control [5]](image)
document-centric methods that are a problem when dealing with 2D prints or documents such as engineering specifications are that they are limited by their lack of acceptable traceability (e.g., history), that information is not captured in a useful manner for other areas of design that can or will be impacted by changes, and that they are disconnected from the system, which leads to silo approaches in various interconnected disciplines.

To capture and maintain that information, there has been a consistent rise in the use of computer models to support the definition and design of complex systems [3]. The model (defined as a simplified, or idealised, description or conception of an abstract, particular system, or process, often in mathematical terms) that is put forward as a basis for theoretical or empirical understanding, or for calculations and predictions [4], was key to the rapid growth in complexity in automobiles, particularly electronics.

The use of models allowed for improved communication between design groups with a reliable characterisation of system, subsystem, and component functions. Modern cars may have up to 100 electronic control units (ECU), which control such vehicle functions as engine, powertrain, transmission, brakes, suspension, entertainment system, sensor systems and more (see Fig. 3) [5].

Today’s automobiles are better than ever: more reliable, safer, smarter, more ecological, and increasingly equipped with state-of-the-art technology. In 2010, 35% of a car’s cost was for electronics, with an estimate of over 50% projected by 2035 [6] comprising a complex matrix of electrical, electronic and software components. To achieve this level of sophistication, model-based systems engineering (MBSE) methodology supporting the conceptualisation, requirements, design, analysis, verification, and validation associated with the development of complex systems, is employed [7].

**Placing models at the centre of system design**

MBE emphasises the use of rigorous visual modeling techniques throughout the System Development Life Cycle (SDLC). Model Based System Engineering (MBSE) is a specialisation of MBE that applies MBE principles and best practices to systems engineering applications, to allow improved engineering productivity and efficiency across whole systems. Using MBSE, system models are more flexible, consistent, and scalable across all sub-systems; communication of requirements can be streamlined, by making all key input and output parameters available to all model users, and the traceability and linkage between requirements and their methods of verification is improved.

The resulting reduction of requirement redundancies and automatic validation of test case verification could result in the elimination of entire tracking departments, and teams have the ability to continuously update and manage component design inputs through parametric relationships with vehicle level inputs. Every individual with access to the model can not only see and verify their subsystem, but also view all the interactions of the subsystem with other parts of the entire system, minimising cross-functional issues and miscommunication [8].

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*Fig. 4 V diagram representing the development, from conceptualisation to release, of a vehicle, with a relative cost impact at each phase of the cycle. The lower portion of the V diagram represents the typical PM producer’s role. Gold arrows represent iterative changes or improvements that add time and cost.*
With MBSE, the authority is moved from documents to digital models. Implementing MBE allows engineering teams to understand the influences of design modifications down to a component level, with overall design intent maintained through analysis of a system design before it is manufactured. To help visualise the impact of this approach, Fig. 4 shows a V diagram of the design stage through to the validation stage [9] with some additional annotations [7].

This diagram allows visualisation of the conceptualisation to product launch cycle for new vehicles. At system design, the process flow typically moves to Tier 1 suppliers, which are then moved down into the Tiers for supply of components or subsystems (represented as the red dashed line).

For mechanical components or subsystems, there will be concepts for utilising material processing routes such as cast, wrought or PM processing leading to requests being sent out for quotation resulting in proposals sent back with exceptions or modifications. A contract would be awarded with timelines to build prototypes, then tool designs would proceed, samples processed, and components would be built for testing.

Historically, the prototypes would be physically tested with an expectation that design modifications would be required. So, the purpose of physical testing is to detect design deficiencies or product issues due to low confidence in the product design and is impact on the system. Information would be fed back to the supplier from the test and design changes would be made to address deficiencies. This iterative approach adds cost and significant time. If unit testing passes and moves into system or operation testing, then fails, there is huge cost impact and additional delay to the timeline.

With MBE, a framework is established to drive out waste through engineering linking at various levels, which allows engineers to focus on value-added tasks. By modelling a domain for the vehicle system where there is a shared system database linking all of the other domains, providing a view of the structure and requirements, the impact of designs modifications can be determined (see the forged PM side gear in Fig. 5).

The impact of MBE on the PM industry

Other than at the largest companies, the PM industry is primarily document centric, relying mainly on engineering specification documents, limited material databases for physical, static and dynamic properties. This is counter to the fundamental prerequisite for MBE that reliable data is available electronically (usually in software databases for structural components), linked, and comprehensive. Viewing the steel industry as an example, a wealth of data exists for physical, static, and dynamic properties in academic, government, web-based, and built in FEA software databases (e.g., Ansys, Catia and nCode) for both wrought steel and cast iron.

Some of the issues that exist for PM are that while properties exist in publications, they have often not been through rigorous critical evaluation or included in databases; tensile data published in standards are discrete datapoints, with little statistical data; limited engineering stress-strain curves are available, particularly as data files; and fatigue endurance is only recorded at one R ratio (R = -1) and developed via the staircase method, with limited statistical information.

While the multitude of variations in PM material modifications and processing provides a diverse portfolio of solutions to engineering problems, it is difficult to effectively capture the impact of these process variations in databases. While relationships for properties as a function of density utilising the existing data can be extended through interpolation, and limited extrapolation, there must be a transfer of that existing data into databases, specifically those supporting modelling software.

Without the data, design engineers will either estimate downgraded values or - worst-case scenario - exclude PM from consideration [7]. Both scenarios are detrimental to the PM industry. For the data that exists, if it is not complete or accurate, then the engineers will apply a more strin-
gent safety factor to that data. These safety factors, uncertainties of user requirements, manufacturing errors, and operational environment variation coupled with a conservative approach to the statistical variation in the PM process constrain opportunities or removes PM as a viable alternative to automotive applications. An aspect that has changed making this scenario more intricate is that for new customers with applications where existing empirical data in similar designs for a material selection has proven effective will not be accepted without being proven by a model.

To address the current landscape, stress-strain curves can provide the engineer with the data to understand the elastic and plastic regions, plus the impact of low strain rare strain hardening. Parameters can be calculated, and a more accurate assessment can be made, which would improve the consideration potential.

For many industries, including automotive, structural fatigue and its prevention are of extreme concern. The data available to the design engineers in literature and standards was limited almost exclusively to rotating beam fatigue endurance limit data developed from the staircase method, not an S-N curve. While a 90% survival confidence was provided, there was still a high degree of uncertainty for the engineers, therefore, they would utilise more conservative safety factors, effectively penalising PM.

### Actions to reduce the impact of MBE on PM

Until recently, PM fatigue data available to the end user consisted of only for \( R = -1 \). A protocol was developed for expanding PM fatigue data beyond a stress ratio \( R=-1 \) for use in modelling [10,11]. The protocol involves producing flat bending fatigue bars (per ISO 3928), both in the notched and un-notched condition, then testing at three different stress ratios \( (R=-1, R=0, R=0.5) \) at three different densities with 100 specimen per test to develop a Haigh diagram. The Haigh diagram displays the mean stress and stress amplitude pairs and describes the mean stress sensitivity such that fatigue can be assessed for several densities. This provides additional information for material databases, building a more complete description of the PM fatigue design space for the designer. Fig. 6 shows the test specimen utilised and Fig. 7 shows the Haigh diagram for FLC2-4208 [7].

Efforts within the industry to increase PM material data have occurred such as the Global PM Property Database, but this needs to be expanded. It should be noted that for the design engineers, especially in the US, there is the need to have strain-controlled fatigue data for materials exhibiting sufficiently measurable plasticity. This has been partially addressed by the MPIF in the engineering information section of Standard 35 for PM Structural Parts [12] but this type of data needs to be uploaded into modelling.
1. Select material from a database or create your own material
2. Quasistatic, linear elastic structural simulation requires isotropic elasticity properties only
3. An example of material properties for specific physics
4. Many material models available to handle specific physics

Fig. 8 Images from Ansys Workbench Material Editor/Selection for MPIF FLC-4805 (chosen in step 1) showing physical, static and dynamic properties that can be accessed for modelling.

Other efforts to get PM data into the German FKM Guide for Analytical Strength Assessment of Components [13] are underway. Efforts to upload PM material property data into data-bases such as ANSYS Granta need to occur from the PM industry through the support of individual companies. This database consists of Material Data Sheets (MDS) also known as Data Cards, for the simulation software. An example showing a MPIF FLC-4805 MDS dataset is shown in Fig. 8.

Conclusion

This article has discussed the proliferation of model-based engineering in the automotive industry, and its objectives to reduce cost, time, and defects through flexible, consistent models that are linked to providing...
communication of requirements to all model users. With a foundation of reliable data in databases, every individual with access to the model can not only view and verify his or her subsystem, but also view all the interactions of their subsystem with other parts of the entire system. This goes beyond just electrical systems, connecting other domains such as the mechanical component level with modelling on physical, static and fatigue properties.

The PM industry needs to introduce more complete data into the databases that are utilised by the designers, as there will be less opportunity to physically test iterations of design optimisation in future, due to increasingly complex vehicle systems and highly reduced launch timing. In addition, without database information in FEA software, PM will be either be penalised in our properties (downgraded) or won’t have the opportunity to quote new business.

It is imperative for the PM industry to work towards developing more comprehensive data such as tensile stress-strain curves with associated data, fatigue at different R ratios with notch effects, and physical properties necessary for electrification. Without more efforts, the PM industry may be excluded from future opportunities.

Author
I W Donaldson, FAPMI
GKN Sinter Metals LLC
Auburn Hills, MI, USA
ian.donaldson@gknpm.com
www.gknpm.com

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Part 4: Centrifugal and other special atomisation methods

In the Winter 2021 issue of PM Review, we began our four-part series on metal powder atomisation. Over the course of this series, two atomisation experts, Joe Strauss and John Dunkley, have offered our readers a valuable overview of the principles of atomising technology, atomised powders and their applications. In this final instalment in the series, Strauss and Dunkley present those special atomisation methods such as centrifugal, ultrasonic, pressure (single-fluid) atomisation, and two-fluid atomisation with unconventional media. While perhaps not as widely known as gas or water atomisation, each of these specialist methods of metal powder atomisation has its own unique applications – some industrially significant and some highly niche.

Previous instalments of this review have dealt with the most commonly used two-fluid atomisation techniques – that is, when one fluid (molten metal) is broken up by another (water or gas). This section will cover other atomisation methods, including those that produce metal droplets by mechanical disintegration of the melt. Some of these methods are well-established and are industrially significant, with installed capacity of 50–100 kt/y, such as centrifugal atomisation. Ultrasonic atomisation has been commercially used for many decades for low-temperature alloys, but recent developments have extended the operating temperature, which further increases the range of alloys that can potentially be processed. We will also look at pressure – or single-fluid – atomisation, which has very limited use, and will briefly mention some two-fluid methods using unconventional media (oil and cryogenic gas).

**Centrifugal atomisation**

This is also sometimes referred to as rotary atomisation and, in principle, means the breaking up of liquid metal by centrifugal forces. A spectacular illustration of one embodiment of the concept is shown in Fig. 1. Here, a stream of metal – in this case, steel – is falling at 30 t/h onto a rotating disc or cup which is about 600 mm in diameter. As this was rotating at low speed to make very coarse particles, it is easy to see what is happening. The liquid is accelerated to the peripheral velocity...
of the disc and then either forms drops or ligaments which decay into drops. If the flow of metal is large enough and the disc small enough, the melt can sometimes form sheets on leaving the disc.

Rotary atomisation is very simple to model in some cases. The basic equilibrium of centrifugal and surface tension forces means that we can write:

\[ D = \frac{k}{\omega} \times \left( \frac{\gamma}{\rho d} \right)^{0.5} \]

Where:
- \( d \) is the diameter of the disc or cup
- \( \omega \) is the angular velocity of the disc or cup
- \( \rho \) is the density of the melt
- \( \gamma \) is the surface tension of the melt

Thus, we can readily estimate the particle size, which is inversely proportional to the speed of rotation, proportional to the square root of the surface tension of the melt, and inversely proportional to the square root of melt density and cup diameter. The above relationship can be used to examine the practical feasibility of making any required powder size. It is clear that high surface tension and low density (e.g., Ti, Al, Mg) produces powder that is coarser, while low surface tension and high density (e.g., Pb, Sn) results in finer powder. There are two major issues to be addressed when considering the use of this type of centrifugal atomiser:

- Material properties for the spinning cup or disc (temperature/strength limitations and reactivity)
- The flight distance for droplets to solidify

Clearly, if the material, such as Ti, is high melting and very reactive, finding a material or design for the disc is very challenging. Likewise, if very coarse particles are desired, the flight distances may demand a huge vessel, perhaps over 10 m in diameter. Such units are in operation, but only when large volumes of powder are needed and continuous operation can be carried out. Systems of this size are difficult to clean out for alloy/material changes, thus these systems are usually dedicated to a single material.

One of the most valuable attributes of this process is the very tight particle size distribution that can be achieved. The standard deviation of the log-normal distribution \( (d_{90}/d_{50}) \) produced is far lower than achievable in two-fluid methods, where anything less than 2.0 is difficult to achieve. In the best cases, centrifugal atomisers can achieve standard deviations of 1.4 or even 1.3. This means that yields in a narrow range – e.g., of 50–100 µm powder – where two-fluid atomisation cannot achieve more than 40% can be increased to over 67% in some cases, and -140 + 40 µm increased from ~58 to 90%.

The fact that the basic process involves all the droplets moving away from each other means that satelliteing is rare, and, when carried out in an inert atmosphere, very good particle sphericity can be produced. A further advantage over two-fluid methods, is that the energy needed to drive the cup is minimal, especially when compared to driving a compressor for gas atomisation. And, even in an inert gas-purged system, the specific gas consumption is very low, adding further to the economic advantages.

A major field of application for centrifugal atomisation is in the production of electronic grade solder powder needed to produce solder pastes. The specifications for this product call for excellent sphericity and low oxygen content (e.g., <100 ppm) and narrow size ranges such as for Type 4 solder (-38 /+20 µm) are demanded. In addition, the alloys are low melting,
dense, and have low surface tension, so the production of fine powders is achievable. Simple plain carbon steels are used for the disc as they can withstand the temperature and erosion by the alloy. Fig. 3 shows a centrifugal atomisiation system with a 2.5 m diameter chamber that uses a 30 mm diameter disc operating at 60,000 rpm to process ~ 200 kg/h of SAC solder (Sn-Ag-Cu). Such units have now been built with continuous melting and conveying of the powder to an in-circuit classifier.

Zinc is another metal that is widely produced, especially for use in alkaline batteries, using centrifugal atomisation. Here, particle size is again required to be quite narrowly distributed, and a coarser size is needed. Productivity of over 1 t/h is readily achieved, but the coarser particle size requires a larger vessel, as large as 10 m. Continuous melting is common and continuous conveying of the product to the sieving station is normal. Disc materials are less easily sourced but can be found.

Aluminium is also a candidate but, due to its low density and high surface tension, the physical demands on the cup drive are more severe for finer powders as it must be operated at very high rotational velocities. Thus, applications are mostly for coarser products in the 100–700 µm range. Magnesium is a difficult material from a safety perspective, but is not as aggressive to metallic cups as aluminium. Recently, a plant was built that produces ~100 µm median powder at 200 kg/h (bear in mind that, due to relative densities, this is equivalent in volume to almost 1t/h of solder!).

Applications for ferrous and like melts are obviously very demanding on the cup material. The Rapid Solidification Rate (RSR) process, developed by Pratt & Whitney, uses a water-cooled copper disc, and can handle very reactive materials, including superalloys, titanium, FeNdB, and steels. The special feature of this process, as its name implies, is that the spray is blasted with helium gas to quench the spray. This is a huge cost at present and may well not now be used, as the rapid quench is no longer the main reason for its use. The fact that the whole system is able to be evacuated, allowing vacuum melting of superalloys, makes it rather costly, and it is highly likely that later applications have changed the detailed arrangements shown in the published drawing (Fig. 4).

Since RSR’s inception, Ervin Industries (the sole licensee of Pratt & Whitney’s RSR process) has improved and expanded the technology from lab scale to full production and has enhanced the technology to produce MIM-sized powder. The company’s current capacity is capable of supplying production quantities for numerous alloys and applications. The powder is characterised by high sphericity and low satellites, with particle sizes from 1-1000 µm.

The ‘standard’ centrifugal atomiser is very large in diameter and also does not quench the powder well. To address both limitations for a product demanding rapid quenching, a water quench arrangement was developed to process a ferrous powder from a 1.2 t furnace. This allowed over 99% yield of the product size needed. As well as metals, this technique has been demonstrated to work on slags (at up to 5 t/min), molten salts, and some low-viscosity glasses.

In addition to the liquid-fed atomisers discussed above, a significant niche has been found for the Rotary Electrode Process (REP) or the Plasma Rotating Electrode Process (PREP). Here, a bar feedstock is rotated at high speed (10,000 rpm or more) and the tip of it is melted, in REP, by a direct arc struck onto it, and in PREP, by a transferred arc plasma flame from a torch. The latter avoids the problem (especially acute with titanium) of potential tungsten inclusions caused by wear of the counter-electrode. However, both systems use the rotating bar as the anode, which makes the conduction of high electrical power through a rapidly rotating workpiece chal-
There has been some work done using lasers as the melt heat source, which eliminates the issue of electric power transmission. While the particle size distribution is very narrow, as in other centrifugal processes, the productivity of the process is modest, in the order of tens of kilograms per hour. The high cost of accurately straight bars, and the necessity of stopping with a stub left behind, makes the costs of the process high. Recent developments in China have shown that this process can be engineered to make finer powders than was previously claimed (~100 µm median size), primarily by increasing the rotational velocity of the workpiece.

**Ultrasonic atomisation**

It is well known that ultrasonic vibration can create a spray of droplets for cold liquids. If carried out on molten metal, powder can be produced. However, the material challenges for the wetted surface are significant and, until very recently, applications were restricted to low-melting temperature solders. The ultrasonic atomisation process has some major advantages:

1. The atomised droplets move very slowly, so a large chamber is not needed
2. The particle size distribution of the spray is very narrow, almost as good as centrifugal atomisation (SD ~1.4)
3. Energy and gas use are modest

However, there are also several limitations:

1. Productivity is very limited – e.g., 30-50 kg/h for solders
2. Productivity falls as frequency is increased to reduce particle size
3. As the atomiser is a tuned system with a fixed resonant frequency, it can only produce one size distribution (alloy dependent). In addition, there are only a limited range of frequencies available.

4. Some solder alloys can erode the ‘horn’ (vibrating) surface.

The technique involves the creation of a film of liquid, which must wet the surface, and the subsequent vibration of that surface. The waves produced always have a characteristic wavelength, depending on the frequency of vibration and melt properties. See Figs. 7 & 8.

Past applications of ultrasonic atomisation were limited by the horn material (temperature limitations and reactivity with the melt) and the Curie temperature of the ultrasonic transducer (for non-cooled horns), which is why its uses were restricted to low-temperature solders. Recent developments have greatly extended the temperature capability by water cooling the horn. In one configuration, the system is similar to a conventional arc button melter, wherein the hearth plate is ultrasonically vibrated. In addition, a wire feed provides a continuous material supply (as shown in Fig. 9), although the use of wire as the material feedstock is somewhat limiting to alloy development, as custom wire production is costly and not possible for all alloys.

In another configuration, conventional bottom-pour induction crucible melting is used to supply a melt stream to the vibrating hearth plate (Fig. 10). The atomisation rate is reported to be up to 3 kg/h. Although this widens the scope of alloys, pouring a continuous and consistent melt stream at such a low rate is difficult. In both configurations, scaling up to conventional production rates may not be possible, so these systems address niche applications. In any event, these advancements in ultrasonic atomisation do have their place in the production of proof-of-concept powders, which are in demand.
Other two-fluid techniques: Oil/hydrocarbon atomisation

One of the disadvantages of water atomisation is that the process intrinsically causes oxidation of the powder. Using a non-volatile hydrocarbon, preferably having a high flash point, in place of water is quite possible using very similar equipment and should mitigate – or eliminate – oxidation. However, there are important differences that must be borne in mind:

1. The lower specific heat of hydrocarbons means that higher liquid/metal ratios are needed to avoid excessive slurry temperatures
2. Nitrogen purging is obviously mandatory to avoid ignition by the melt
3. Solvent recovery in drying is mandatory for economic and environmental reasons

4. As well as some hydrogen generation, the hydrocarbon may be cracked into methane, ethane, or pyrolysed into carbon, etc.

5. Extensive safety precautions are needed to protect against fire

The resulting powders are similar in size to water atomised ones made with similar pressures, but differ significantly in some respects:

- Low oxygen content – no surface oxidation
- As a result, the particle morphology is less irregular and more spherical in nature
- There is some risk of carbon pick-up

Some of the results are shown in Figs. 11 and Table 1.

Clearly, Zn and Al, with very strong oxide films, show a large increase in AD (apparent density) when oil atomised, a direct indication of more spherical particles. Cu10Sn bronze, on the other hand, has little reaction with water, so the effect is lessened; for Ni20Cr, it is very marked. NiCrBSi alloy, which forms a borosilicate oxide layer which is molten at the solidus of the alloy, shows only a small effect. In Table 1, we see that aluminium picks up a lot of oxygen when water atomised, but only ppm with hydrocarbon. Higher melting alloys seem to react with the hydrocarbon, especially Ni20Cr which has a lot of carbide-forming Cr in it.

This technology has been used for tonnage steel powder production by Sumitomo and others, but was found not to be economically viable. It would seem well suited to processing aluminium, as gas/air atomisation is so dangerous. In addition, much of the aluminium produced is made into flake for pigments and coatings by milling in a hydrocarbon. It is not uncommon to ship the powder as a paste; thus, if the atomisation hydrocarbon is the same or compatible with the milling hydrocarbon, the cost of ‘drying’ and solvent recovery systems may be eliminated.
Other two-fluid techniques:

Cryogenic liquid atomisation

As in the case of hydrocarbons above, it is easy to imagine that using a liquid inert gas could have advantages, such as extremely low oxygen pickup and eliminating carbon pickup. However, liquid gases are not very dense with respect to water (or oil) and deliver less energy to the melt. Also, liquid gases are always used at, or above, their boiling point, while in water atomisation the aim is always to avoid much boiling, for practical reasons. Additionally, the quenching power of liquified gases is relatively poor due to the Leidenfrost effect.

Researchers have carried out trials on the use of liquid nitrogen and argon at pressures of hundreds of bar, but results were not very encouraging and costs unattractive. The results in Fig. 12 show huge gas/metal ratios from 5–15 being used to atomise copper, while conventional gas atomisation seems to result in finer powders using only 2–5 gas-metal ratio (GMR).

Pressure (single-fluid) atomisation

A process where pressurised liquid is forced through a nozzle is, of course, the most common way to form a spray of droplets in the case of water, gasoline, etc. In principle, this can be done with molten metals, but the obvious problem is how to pressurise the melt, and then how to find a nozzle that will not be eroded by the high-velocity melt. Sheikhaliev carried out experiments on a range of lower melting alloys, and one of the authors, working with his data,
supplied a major facility for atomising molten lead at ~2 t/h. For this metal, it was possible to use a centrifugal pump to pressurise the melt, and a steel nozzle had excellent life. The plant has been operating for over twenty years, making 0.5–1.3 mm shot. Operating costs are very low, and the unit is almost completely automated with conveying to in-line screening. A major advantage of the swirljet nozzle used is that standard deviation of the product is almost as good as that achieved in centrifugally atomised powders, around 1.4–1.5. This means that yields of narrow size ranges are excellent. However, the atomisation system is large (~10 m diameter) and open; however, lead is one of few metals that can be easily cooled in open air. It is also true that to make finer powders one needs to operate at higher pressures with smaller nozzles, further intensifying problems with nozzle wear or clogging.

**Conclusion**

Over this series of articles, the authors have attempted a comprehensive overview of atomisation methods for making metal powders with an emphasis on what is currently used in production and methods that have potential. The principal methods are gas (including air) and water atomisation, especially for higher melting alloys, while non-ferrous metals such as Pb, Sn, Zn, Al, etc, are sometimes processed industrially with a wider range of methods, including ultrasonic and centrifugal atomisation.

The range of demands on metal powders is very wide, and includes requirements for shape, size, chemistry (both bulk and surface), flow, bulk density, magnetic and microstructural properties, colour, reactivity and sintering activity. Such a huge range of demands leads to the selection of different atomising techniques, as well as post-atomising processes, chief of which are size control (sieving and classification) and heat treatment (annealing/reduction).

These articles can only serve as an introduction to a vast field of research, much of it proprietary and unpublished. The metal powder industry has a few giants, and many participants in very narrow niches, which use specific methods to exploit valuable markets. The authors, with almost a century of experience between them, have been involved in building and upgrading a large number (>100) of atomising plants worldwide, but still cannot claim that this is a comprehensive treatment of such a vast subject.

**Authors**

Joseph Tunick Strauss, PhD
Engineer, president
HJE Company, Inc.
joe@hjeco.com
www.hjeco.com

John J Dunkley, PhD, FREng
Chairman
Atomising Systems Limited
jjd@atomising.co.uk
www.atomising.co.uk
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Email: pmchina@unirischina.com pmchina@unifair.com
Web: www.pmexchina.com
Precision and energy efficiency in PM press technology: Insights from Ceramitec 2022

After a four-year interruption due to the COVID-19 pandemic, Ceramitec, the leading trade fair for the ceramics industry, reopened its doors at the Munich Exhibition Centre this June. Although the focus of Ceramitec is on ceramic production technologies, many exhibitors also offer and showcase products for the Powder Metallurgy industry – in particular, powder compaction technology for press and sinter PM. Dr Georg Schlieper visited the trade fair on behalf of PM Review, and spoke to a number of suppliers of powder compaction technology about the latest developments and trends in the industry.

From June 21–24, 2022, around 10,000 visitors attended the Ceramitec trade fair in Munich for the first time since 2019, following the COVID-related cancellation of the 2020 trade fair and postponement of the 2021 edition. Showcasing over 350 exhibitors, this exhibition of ceramic and related production technologies was a welcome opportunity for networking and knowledge exchange for producers of technical and non-technical ceramics and their associated technologies.

However, the difficult geopolitical context in which it was held meant reduced visitor numbers, compared to prior years, and limited international participation. Though life is returning to a tentative normality in the wake of the COVID pandemic, some countries, such as China, still faced strict travel restrictions at the time of the event, and growing economic uncertainty caused by supply chain disruptions and the Russian invasion of Ukraine have impacted some companies’ willingness to invest in travel and exhibition stands. Nevertheless, for those who were able to attend and take advantage of the networking opportunities on offer, the event was a great success, and marked an optimistic return for Ceramitec’s organisers.

In the exhibit hall, I spoke to six of Europe’s largest producers of powder compaction technology for the press and sinter PM industry about their latest product developments, and their view of trends in PM press technology. Two themes were common: the PM industry and its customers are demanding ever higher precision, and greater energy efficiency.
The trend towards fully electric presses seen in previous years at Ceramitec continues, because electric presses are so much more energy efficient than hydraulic presses. Small carbide products, such as indexable inserts, are manufactured on presses in the range of 160 kN; here, electric presses have completely replaced the hydraulic presses. Dorst now offers electric presses up to 2000 kN press force. Servo-hydraulic auxiliary units are used for higher compaction pressures. Dorst sees itself as a pioneer in the field of powder press digitisation, and Schmidt stated that a separate business unit is now working on this topic. Not only does Dorst develop system solutions, it also offers customer support in the introduction of digital services and the Internet of Things (IoT). The software Dorst IoT Solutions enables the networking of presses and the evaluation of production data. “This leads to deep insights into the manufacturing process and the condition of the machine, which is of great value for quality assurance and machine maintenance,” stated Schmidt.

Sacmi

The main focus in the PM space for Sacmi, Imola, Italy, a renowned manufacturer of powder presses, was the compaction of helical gears (Fig. 3). “The system developed by Sacmi is completely controlled from the control panel of the press where all parameters of the part are set,” stated Andrea Zaccherini, General Manager of the Metal Product Unit of Sacmi. Sacmi’s innovative concept works with rotating punches and dies. All movements are servo-assisted and synchronised to the required precision by the press software, with helical angles up to 30° and higher being possible. The system is extremely flexible, enabling the production of complicated parts featuring an internal helical gear.
According to Zaccherini, programming the press for a helical gear is as easy as programming a press for standard cylindrical PM parts. Setup times have been substantially reduced with the newly developed tooling concept. Electric powder presses from 100–800 kN and hydraulic presses up to 12,000 kN nominal press force are produced by Sacmi, and all machines can be connected to the digital data system of the user. Zaccherini told *PM Review* that Sacmi is focused on responding to the concerns in the wider PM industry regarding the challenges posed by the transition to electromobility, and the resulting reduction in the production of internal combustion engines (ICEs), as well as the increasing demand for sustainable production technologies and workflows. He explained that Sacmi is constantly improving the energy efficiency of its presses, and that new functions and new features are being developed to aid in opening new markets for PM press and sintered parts.

**Maschinenfabrik Lauffer GmbH**

Traditionally, Maschinenfabrik Lauffer, Horb, Germany, has focused on the production of powder presses with high press forces and, therefore, entered the development of electric presses relatively late. As well as its traditional offerings, Lauffer also offers fully electric presses for smaller products and high cycle rates, as well as press cells with fully automatic green part handling (Fig. 4). According to Markus Oechsle, board member for technology & engineering at Maschinenfabrik Lauffer, a key advantage of press cells, apart from their compact design, is the comprehensive software that controls all of the cell’s components. In the past, the software controlling the press, green handling and, if necessary, further downstream processes, all came from different sources. This often led to interface problems between different automated units, as well as increasing process time. According to Oechsle, the integrated software within Maschinenfabrik Lauffer’s press cells is faster, less vulnerable, easier to operate and more sustainable.

Lauffer is currently seeing an increase in demand for large hydraulic presses in the sintered steel sector. According to Oechsle, composite components made of two or more different materials are increasingly being pressed. As an example, he mentioned components with a soft core and a hard surface, or vice versa.

**Osterwalder AG**

Osterwalder, Lyss, Switzerland, mainly supplies presses to the carbide industry. The company stated that it is focused on the further development of electric presses, which it suggests are almost the only press in demand in this sector. With press forces of up to 5000 kN, Osterwalder presses are probably among the largest electrically driven powder presses. Thorsten Matusche, Global Head of Sales, Osterwalder AG, stated that the energy savings offered by Osterwalder’s electric presses, compared to that of conventional hydraulic presses, could be up to 80%.

Besides these energy savings, he stated that the use of electric presses allows for an increase in the accuracy of powder compacts, as electric press systems can be controlled more precisely than hydraulic drives. Another important factor is maintenance; users of...
hydraulic presses will be familiar with the problem of leakage at sealing elements. High-power hydraulics also require cooling with water and, after coming to a standstill, take time to warm up for the next production run. In addition, an electric press does not require a press pit, generates much less noise and is more durable than a hydraulic press.

Osterwalder also offers a system for pressing helical gears. The decisive factor in this technology seems to be that both the punches and the die are rotated during the compaction process. Matusche told PM Review that the helical gear project was realised in collaboration with a Chinese customer during the pandemic. "Since the Swiss service technicians could not travel to China, the entire commissioning of the press was carried out with the help of Osterwalder’s Chinese engineers and via video calls," he said. "That was a great challenge, which was ultimately successfully passed."

Osterwalder is currently investing significant efforts in software development in order to meet the requirements of Industry 4.0 and the IoT. An important topic for Osterwalder in this context is the prevention of staff operating errors. The smart press largely takes over the setup process based on predefined parameters stored in the software, thus saving setup time and preventing damage due to human error.

Roboworker Automation GmbH

For thirty years, Roboworker Automation, Weingarten, Germany, has been developing automation systems in the periphery of powder presses, including deburring and green machining solutions, as well as various solutions for repalletising, inspection, laser marking, packing, Additive Manufacturing production support equipment, and more. This year’s Ceramitec marked the first time that the company presented an entire powder press cell, under the name Roboworker Press Cell (RPC), including a fully servo-driven electric powder press (Fig. 6). Powder presses from 120–300 kN nominal press force, working on the ejection principle, are available. All Roboworker press automation platforms can be fully integrated into one control architecture.

Astrid Müller, Marketing Manager of Roboworker Automation, stated that Roboworker’s RPC technology meets the highest standards in all major decision-making criteria (such as optimal product quality and process stability, increased productivity, maximised user friendliness and ergonomics, compact layout, Industry 4.0, interface technology to the next process steps, and maximum containment at an outstanding price-performance ratio).
System 3R International AB

A subsidiary of the Georg Fischer Group, System 3R, Vällingby, Sweden, manufactures systems for rapid tool change on powder presses (Fig. 7). The unique reference system of System 3R can carry a workpiece from one machine to another without time-consuming realignment. By working within fixed references, System 3R converts internal setup time to external setup time. The concept centres on defining each machine’s zero point once and once only, allowing fixed references for all machines and a common system for a user’s entire workshop.

The benefit of this tool change technology is a significant reduction of tool setup times. System 3R technology is used for electrode manufacture and EDM machining of press tools and for assembling press tools. Henrik Nordquist, Product Manager Tooling, gave an example: He said that on a single level powder press the tool setup time is usually between one and four hours; with the 3R system, this can be reduced to 15 minutes or less. The system can be used with all press types.

Nordquist also mentioned that the precision of PM parts is significantly improved by System 3R technology, so that subsequent grinding operations can, in many cases, be eliminated, as tool positions and angles are set much more accurately. Another consequence is that tool crashes due to geometrical errors in the setup are virtually eliminated because the alignment of punches and dies is so much more accurate.

Conclusion

Digitisation and sustainability, the major overarching topics currently being discussed throughout the manufacturing industry worldwide, were also present at Ceramitec. Considerable efforts have been made by powder press manufacturers to make progress in digitisation, readying machines for Industry 4.0 and the smart factory. The most striking advances in terms of the sustainability of PM production are energy savings of up to 80% through the use of fully electric powder presses.

The atmosphere in the PM industry seems to have brightened significantly after COVID, despite concerns about the challenges posed by electromobility. Progress is being made in the development of new markets, and some press manufacturers once again report rising sales. Nevertheless, enormous challenges remain – above all, the contribution that the PM industry will have to make to further reduce its carbon footprint. Powder press manufacturers have already made some progress on the way to climate neutrality, but there is a lot of work left to do.

The next Ceramitec will be held from April 23–26, 2024, at Messe München, Munich, Germany.

Author

Dr Georg Schlieper
Essen, Germany
georg.schlieper@hotmail.de
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Historic traditions and new innovations: refractory metals and hard materials at the 20\textsuperscript{th} Plansee Seminar

After a five-year hiatus, delegates from twenty-seven countries gathered once more to attend the Plansee Seminar in Reutte, Austria, this June. Here, the most knowledgeable minds from the refractory metals and hard materials world, both industrial and academic, gathered to discuss the present and future of this important sector of Powder Metallurgy (and maybe enjoy some in-person networking). Here, Bernard North provides his knowledgeable impression of the conference as a whole and outlines its opening sessions and technical programme.

Since 1952, Plansee has held a week-long seminar on refractory metals and hard materials at its headquarters near Reutte in the beautiful Austrian Tyrol, initially every three and, later, every four years. The 20\textsuperscript{th} Seminar was to be held in 2021, but was delayed a year due to the COVID-19 pandemic. It was with much anticipation that the attendees finally arrived at The Plansee Group campus on May 30, 2022, and it is no exaggeration to say that there was a palpable sense of joy at being able to meet up again, in person, with so many industry colleagues after over two years of significantly constrained travel and face-to-face interaction.

Plansee Seminar Chairman Dr Karlheinz Wex welcomed the participants and emphasised the organisers’ desire to hold true to Paul Schwarzkopf’s vision of a week of personal networking to build relationships and promote knowledge exchange within the industry. In his opening address, he reflected on the difficulties generated by both the pandemic and the current geopolitical situation, and stressed the importance of technological innovation in responding to economic and societal megatrends.

There were 384 attendees at the seminar, coming from twenty-seven countries, with 85\% visiting from Europe; 10\% from the Americas; 4\%, Asia; and 1\%, Africa. Some governments’ approaches to COVID-19 reduced the level of international participation, most notably from Asia, and China in particular – from

Fig. 1 Heiterwangersee, close to Plansee Group’s headquarters (Courtesy Bernard North)
where there would normally have been a large number of participants. Among the organisations in attendance, 56% were universities (this author was impressed by the active research being undertaken in refractory metals and hard materials at several universities); 28% from industry; 14%, research institutes; and 2%, ‘other.’

The programme included seventy-eight presentations and 110 poster presentations; 188 of a planned 203, owing to some scheduled presenters being unable to attend due to illness, travel restrictions, or other causes. The unpresented content was still included in the abstracts provided to the participants. To enable the greatest opportunity possible for knowledge sharing, the organisers avoided scheduling concurrent sessions, and offered significant status to posters, which were readily accessible for most of the conference and were highlighted in a special three-hour evening poster session. Table 1 breaks down, according to this author’s judgment and allowing for some simplification, the main areas of technical focus covered by the presentations and posters.

The Hard Materials Group of the European Powder Metallurgy Association (EPMA) also held a half day meeting during the seminar, with several pertinent presentations – in particular, one on Additive Manufacturing and one on the use of reclaimed materials.

Attempting to summarise overall impressions from a conference with about 200 contributions inevitably involves some generalisation and subjectivity on the part of this author. That stated, he hopes his impressions from the 20th Plansee Seminar in this article will be of benefit to readers.

<table>
<thead>
<tr>
<th>Presentation category</th>
<th>Opening session</th>
<th>Hard materials</th>
<th>Refractory metals</th>
<th>Total</th>
<th>Summary comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>History of Plansee Seminar, effects of macro economic and societal trends (especially environmental), reviews on hard materials and refractory metals</td>
</tr>
<tr>
<td>Analytical techniques/modelling</td>
<td>42</td>
<td>16</td>
<td></td>
<td>58</td>
<td>Advances in analytical techniques, modelling sophistication</td>
</tr>
<tr>
<td>Solid material development</td>
<td>25</td>
<td>16</td>
<td></td>
<td>41</td>
<td>Co and W substitution in hard materials, high entropy alloys, high temperature superalloys. Modelling.</td>
</tr>
<tr>
<td>Nuclear applications</td>
<td>2</td>
<td>9</td>
<td></td>
<td>11</td>
<td>Fusion (especially small spherical tokamaks) and high temperature fission reactor- driven development</td>
</tr>
<tr>
<td>Additive Manufacturing</td>
<td>13</td>
<td>14</td>
<td></td>
<td>27</td>
<td>Modelling and practical studies, primarily laser powder bed for refractory metals and binder jet or fused filament plus sinter for hard materials</td>
</tr>
<tr>
<td>Joining</td>
<td>4</td>
<td>4</td>
<td></td>
<td>4</td>
<td>Welding, brazing, and sinter joining of refractory metals</td>
</tr>
<tr>
<td>Chemical Vapour Deposition</td>
<td>17</td>
<td>17</td>
<td></td>
<td>17</td>
<td>TiCN/Al203 and TiAlN, and derivatives thereof, for metalcutting applications</td>
</tr>
<tr>
<td>Physical Vapour Deposition</td>
<td>26</td>
<td>26</td>
<td></td>
<td>26</td>
<td>TiAlN and more complex nitrides, as well as borides and carbides, primarily for metalcutting applications</td>
</tr>
<tr>
<td>Ores/oxide processing</td>
<td>4</td>
<td>4</td>
<td></td>
<td>4</td>
<td>Processing of ores and reclaim materials</td>
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<tr>
<td>Other</td>
<td>6</td>
<td>4</td>
<td></td>
<td>10</td>
<td>Various subjects including medical applications, energy reduction in processing, edge preparation</td>
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<tr>
<td>Total</td>
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<td>132</td>
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<td>203</td>
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Table 1 The main areas of technical focus covered by the presentations and posters at the 20th Plansee Seminar
Opening sessions

Plansee Seminars 1952–2022 – A view on a very special congress
In this session, Prof Herbert Danninger (Vienna University of Technology, Austria), reflected on the history of the Plansee Seminar (Fig. 2). In 1921, Paul Schwarzkopf founded the Plansee company (named for the lake whose outflow cuts through the factory site), with a focus on refractory metals and, later, hardmetals (cemented carbides) in Reutte, Austria. In 1938, he moved to the USA to escape Nazi rule in Austria, returning after WWII to resume his leadership of the company in a then-divided Austria where travel and communication were difficult. Inspired by a conference in the (then new) area of Powder Metallurgy held at the University of Graz in 1948, he became determined to hold a substantive seminar focused closely on refractory metals and hard materials. The result of this ambition – the first Plansee Seminar – took place in 1952. The programmes for the 1948 and 1952 conferences are shown in Fig. 2.

From the seminar’s early days, practices were established which continued for decades, and some to the present: a full week without concurrent sessions; simultaneous translation of presentations; documented proceedings in German and English; the provision of excellent food, music, evening entertainment and plenty of opportunities for the participants to form social as well as professional bonds. Until 1977 (with a single exception) the seminar was held every three years; the frequency was then reduced to every four years. The content has developed with time as new technologies became important to the industry, most notably chemical and physical vapour deposition of thin coatings, and, later, Additive Manufacturing.

Fig. 2 Prof Herbert Danninger presented a reflection on the history of the Plansee Seminar

Fig. 3 Programme cover for the First International Powder Metallurgy Conference in July 1948 (left) and Plansee June 1952 (right)
Molybdenum and tungsten, the greener metals?

Dr Herman Walser, formerly of Global Tungsten & Powders, Austria, gave a detailed talk on molybdenum and tungsten from the standpoint of how ‘green’ they are and discussed some of the steps being taken to improve this (Fig. 4). Firstly, he warned against the practice of ‘greenwashing’ (whereby organisations select data and/or use limited analysis to make their products or processes look environmentally friendlier than they really are) and specifically mentioned four international standards used to guard against that practice and force suppliers to follow standardised methods in their reporting: ISO 14044 (lifecycle assessment), ISO 14064 (quantification and reporting of greenhouse gases at the organisational level), ISO 14067 (same, but at the product level), and ISO 20400 (sustainable procurement guidelines, with a ‘balanced scorecard’ including benefits).

Specific to anthropogenic greenhouse gases, CO$_2$ is estimated to comprise 76% of global emissions, of which ~8% is estimated to arise from metals processing (primarily iron and steelmaking). Mo and W are relatively low volume, and their manufacturing comprises less than 0.1% of total CO$_2$ generation, but on a specific (i.e., kg CO$_2$/kg of metal) basis their numbers are relatively high, in the range 10-20 kg of CO$_2$/kg of Mo or W. Most of this is in the mining and extraction process steps. Dr Walser referenced work by the International Molybdenum Association on Mo and by Chalmers University on W. In addition, the Austrian consulting company RFU has developed sustainability models and has ranked and scored commodities, including metals, from a low of C- to a high of A+. RFU rated both Mo and W at B-, apparently reasoning that the metals’ societal benefits were insufficient to fully overcome environmental downsides.

Dr Walser discussed the ‘Three R’s’ of Reduce, Reuse, and Recycle as being useful ways to characterise approaches to reducing environmental impacts, and usually costs as well. For Reduce, examples include product performance improvements (for example, a rule-of-thumb is that cemented carbide products’ performance typically doubles every ten years), smaller and/or more near-net-shape parts, and improved efficiency in furnace heating. For Reuse, examples include regrinding/reconditioning of solid hardmetal drills and coal mining roof bits, as well as reconditioning of solid W anodes in X Ray machines. For Recycle, Mo has an 81% rate when used in steels but is less in other applications, and the total end-of-life metric is not accurately known. W, however, has the highest end-of-life metric of all metals that have been studied at 30% (International Tungsten Industry Association [ITIA] study), greatly aided by the very high 63% recycle proportion in cemented carbides. For WC powder, there is a fourfold reduction in CO$_2$ generation where it is recycled through the chemical route (used for green scrap, grinding sludges, and unsorted hard scrap or used products), while for zinc reclaim material the CO$_2$ generation is close to zero, depending on how the electricity for processing is generated.

“Specific to anthropogenic greenhouse gases, CO$_2$ is estimated to comprise 76% of global emissions, of which ~8% is estimated to arise from metals processing (primarily iron and steelmaking).”
An outlook on the hardmetal industry after two years of world pandemic and recent instability in Europe

In her presentation, Prof Dr Susanne Norgren of Sandvik AB and Lund University, Sweden, referenced recent ITIA statistics on W usage which showed that ~61% of global W is used in cemented carbides, and that, by market, use had grown in defence and mining & construction, but had declined in transportation – largely due to the steep drop in civil aerospace and the automotive industry during the coronavirus pandemic (Fig. 5, 6). She then summarised several megatrends and discussed their apparent, and anticipated, effects on the hardmetal industry.

With world population continuing to increase and an increasing proportion of those people living in cities, it is expected that construction work needing a lot of steel will correspondingly increase; steel machining is a major use of hardmetals, and an area in which the use of CVD and PVD coatings has a huge effect on performance. With steelmaking shifting from C to H₂ to reduce iron ores, Norgren noted that it will be interesting to see how that affects steel inclusions, which in turn affect machinability.

Vehicle electrification is expected to drive some reduction in machining due to the elimination of the internal combustion engine (ICE) in battery electric and fuel cell vehicles. However, hybrid vehicles will still use ICES, and the need to lightweight vehicles will demand some use of high-strength steels and aluminium alloys. Other effects of vehicle electrification on the hardmetals industry include the high use of Co for vehicle batteries (Fig. 7) which, coupled with concerns on ethical sourcing and lingering health questions, has reenergised research on Co substitution by other transition metals – not a new subject (Dr Norgren mentioned Leo Prakash’s early work on WC-CoNiFe as an example) and long commercialised for certain corrosion-resistant or...
non-magnetic applications – but evidenced by, for example, several papers at this Plansee Seminar, and the US Government’s funding of Desktop Metal’s research on the subject. However, there are many performance and practical barriers to Co substitution, including CVD adhesion on metalcutting inserts. Finally, the drive to electrification drives a big increase in mining (with associated need for wear- and impact-resistant materials including hardmetals) for the ores of metals used in batteries, fuel cells, electric motors, and electrical conductors.

Digitisation is another clear trend, and Dr Norgren referenced recent Seco work on etched QR codes on individual metalcutting inserts, which has numerous advantages such as linkage to application conditions, problem resolution, and scrap/used insert sorting to improve recycling effectiveness.

Additive Manufacturing, for all materials, is growing at more than 20% per year and is starting to have a significant role in the field of cemented carbides – initially for their associated steel cutter bodies, but more recently for hardmetal components themselves, albeit so far for high Co (≥ ~12 wt.%) grades outside the ‘sweet spot’ of cemented carbides, due to densification limitations. The technology permits complex geometric features such as cooling channels and ‘lightweighting’ by voiding low-stressed areas of components, and Dr Norgren showed Varel oil and gas drilling nozzles as an example. This theme was continued by several presentations and posters later in the seminar.

Finally, advances in the type and precision level of analytical techniques for materials characterisation is a hot area; Dr Norgren mentioned the increased interest in in-situ small angle neutron scattering, and subsequent presentations and posters at the seminar included many other examples.

Key takeaways from the technical programme

Cobalt reduction/elimination in hardmetals

Several papers elaborated on the Co replacement theme summarised by Dr Norgren in the opening session. Grades requiring excellent corrosion resistance or non-ferromagnetic behaviour have long been made with binder metals other than Co, or with much-reduced Co, using Ni, Cr, Fe and (less commonly) other metals. Sophisticated thermodynamic modelling combined with building on prior practice produced promising materials, and it may be safe to say that comparable combinations of hardness and toughness to conventional hardmetals with Co binder may be obtained (Fig. 8, 9).

What was clear, however, talking to hardmetals manufacturers during the event, is that for most applications of hardmetals, other properties are also critical – in particular,
thermal fatigue resistance, as well as the advantages of a Co binder for the width of the ‘C-window’ (to avoid undesirable embrittling phases), magnetic properties for ease of quality assurance, CVD coating compatibility, W (and Cr dopant) solution in the binder metal to stabilise a single (face centered cubic) phase to improve fatigue resistance, and control of the scrap and used product streams to aid reclaim use are very important. For non-Co binders to advance much further these issues would need to be solved or somehow side-stepped. In practice, most hardmetal products are used in high-value applications where no performance loss will be tolerated.

Recycling/sustainability
Some papers presented during both the Plansee seminar and the EPMA Hard Materials session elaborated on the themes discussed by Dr Walser. What struck this author was the discussion of the use of zinc reclaim WC-Co in a commercial grade, whereby a marketable ‘public virtue’ was made of hard reclaim use, though this is typically done as a matter of course...

Coatings
CVD and PVD coatings are immensely important to the performance of metalcutting tooling, and there were many papers and posters on these subjects. In summary, in the CVD area it appears that CVD TiAlN is finding some commercial application in interrupted cutting (usually milling) of ferrous alloys, while in PVD a broad range of TiAlN derivatives (whereby Ti is wholly or partially substituted by other metallic species) show promise. In addition, TiB₂, which combines very high hardness with lubricious properties, remains an area of interest and further development (Fig. 10).

Advanced nuclear (especially fusion) reactor applications
At the 19th Plansee Seminar in 2017, this author was struck by the significant number of contributions linked to hardmetal demand for the divertor and other first wall components of nuclear fusion reactors. At that time, the main driver was the very large-scale, long-term international ITER reactor project. This theme was continued at the 20th Plansee Seminar, but this time with a notable emphasis on small, spherical tokamaks, made by advances in (relatively) high-temperature superconductors, and being developed by startup private/public-funded companies, and which are physically much smaller in shorter lead time projects.

In brief, dependent somewhat on the individual intended component, materials for these applications need to be able to handle extremely high heat fluxes, have extreme resistance to damage by high-energy neutrons, sufficient high-temperature thermal fatigue resistance, high neutron capture cross section, acceptable transmutation products, and (to reduce the damage from any unintended air leaks)
good oxidation resistance. Metallic tungsten is used in ITER and offers much of what is required property-wise, but grain growth at elevated temperature embrittlement of the material, oxidation resistance is mediocre, and these concerns are driving a wide range of materials developments including Cr-alloyed W (Fig. 11), investigation of non-sag (alkali metal doped) W, WTiFe high-temperature ‘superalloys’, metal-bonded W2B, and both metal-bonded and binderless WC.

From questions posed after presentations and some conversations this author was involved in during break periods, there is clearly a school of thought that no materials could actually survive the extraordinarily severe environment in a commercial power-generating reactor; whether or not that is true should become apparent over time.

High-entropy materials
High-entropy materials were defined by at least one author as being five or more component atomic species in solid solution (for metallic alloys) or the metal atom sub-lattice of, for example, a carbide or nitride phase. Some existing commercial materials may already satisfy, or at least approach, this definition (for example, the WTiTaNbC ‘gamma’ phase common in steel turning metalcutting hardmetal grades) but clearly it is an active research field, and the seminar included examples in refractory metals, both the binder and hard phase in cemented carbides, and PVD coatings.

The basic principle is that high entropy (disorder) contributes to high thermodynamic stability, as well as decreasing stacking fault energy, and thus impeding dislocation flow – in summary, improving materials’ high-temperature strength, while one or more of the components may also improve oxidation and/or corrosion resistance. The multiple alloying elements also reduce thermal conductivity.

Refractory metal oxides for antimicrobial applications
A single paper was presented, by Prof Dr J Peter Guggenbichler of AMIStec GmbH, describing the very powerful antimicrobial action of Mo and W oxides and related compounds. Prof Dr Guggenbichler is a medical doctor (more specifically a pediatrician), and he spoke with great passion of the associated problems of hospital infections and the growing issue of antibiotic and disinfectant-resistant bacteria. Petri dish images illustrated the effectiveness of Mo and W refractory metal oxides in killing such bacteria, and the presenter explained how the causative mechanisms cannot be circumvented by genetic variants of the bacteria as it evolves. In talking to both the presenter and others at the seminar it became clear that there was both prior art and strong agreement that the work is valid, and it will be interesting to see if and how the results are implemented,
for example by developing and marketing paints of such oxide particles to coat key surfaces inside hospitals.

Additive Manufacturing
Additive Manufacturing was a major focus area, primarily Laser Beam Powder Bed Fusion (PBF-LB) for refractory metals, and the presentations covered at least four different techniques for the AM of cemented carbide components. The latter is showing clear growth with, initially, very high Co (tough, but not very hard) grades being commercialised, but with a clear downward trend in Co level and/or grain size to get closer to the 'sweet spot' of cemented carbide compositions, grain sizes, and applications.

For this author, one highlight was a report on the successful AM of a mainstream hardmetal grade used for metalcutting drills and end mills (Fig. 12). This aspect of the Plansee Seminar will be reported upon, in greater detail, in the Autumn issues of PIM International and Metal AM.

Conclusion
In his farewell address, Dr Kestler reinforced the goals of the Plansee Seminars, which have continued since their inception under Paul Schwarzkopf, and are aptly summarised by the statement: “To sinter the participants to a dense PM community.” He then announced that the 21st Plansee Seminar will be held May/June 2025, thus returning to its regular pre-pandemic schedule, and minimising conflicts with other major PM conferences and trade shows.

Kestler finally expressed his earnest desire that the impact of COVID-19 will continue to lessen, and that conflicts will be resolved, to allow fuller international participation at the next seminar. We can all agree with this sentiment. This author has been fortunate to have attended five Plansee Seminars and has always found them to be highly beneficial and educational events; the Plansee Group is to be commended for continuing this wonderful tradition through three generations of leadership. Here’s looking forward to 2025!

Author
Bernard North
North Technical Management, LLC
Greater Pittsburgh Area
Pennsylvania, USA
bnorth524@msn.com
Tailoring a speciality alloy for Additive Manufacturing: From powder production to parameter optimisation

Ultra-high temperature materials, such as niobium-base alloys, have been limited to simple geometric designs due to their high working temperatures and related production costs. Now, thanks to the development of commercially available Nb-base alloy powders, it is possible to additively manufacture complex-shaped, high-performance components from this material. To do so, it is important to understand the full workflow, from powder production and characterisation, to determining the optimal process parameters for these speciality materials. In this article, Taniobis GmbH and Alloyed Ltd detail the process of preparing, characterising, and processing two such alloy powders.

Ultra-high temperature refractory alloys have the potential to perform at temperatures exceeding $-1050\,^\circ C$ – outperforming even the most advanced Ni- and Co-base superalloys – due to the ceiling imposed by the strengthening phase stability and their high melting point. Niobium-base alloys such as C-103 are of particular interest, due to their relatively low density and good thermal conductivity, as well as excellent temperature and time-dependent mechanical properties (Fig. 1) [1, 2, 3].

As a result, Niobium-base alloys are commonly used in propulsion systems within the space and defence industry [4]. Until recently, typical applications have been limited to products with simple geometries made from sheet and bar; for instance, expansion chamber skirts made from TIG welded sheet. This is because ingot production is expensive and these alloys are challenging to fabricate into complex shapes due to their high hot working temperature. Because of the high cost of manufacture, C-103 is, by comparison, the most readily manufacturable, if not the strongest, Nb alloy on the market today.

Near-net shape manufacture of these alloys was previously not possible, as investment casting presents challenges around mould reactions and insufficient superheating, as well as being cost prohibitive for economic reasons such as loss of the alloy in gates [5]. Processing these unique high-temperature alloys in powder form allows for their near-net shape.

![Fig. 1 Creep performance of various high-temperature alloys showing the superiority of Nb alloys. Data for superalloys extracted from [3]](image)
manufacture using Laser Beam Powder Bed Fusion (PBF-LB), Electron Beam Powder Bed Fusion (PBF-EB), Directed Energy Deposition (DED), and other advanced forms of Powder Metallurgy. These technologies have major advantages over conventional processing, including cheaper part production thanks to their more efficient use of material and the ability to produce geometrically complex components with minimal waste or post-processing.

The ability to manufacture complex shapes from C-103 [6] and FS-85 (here described for the first time) via PBF-LB enables new applications such as structures for high-velocity flight and re-entry guidance, and enables the production of higher temperature gas turbines for power generation and jet propulsion. This article will describe in detail the preparation of Nb alloy powders for application in advanced metal powder-based manufacturing technologies.

### Alloy powder preparation

Nb-base C-103 and FS-85 alloy powders developed at Taniobis GmbH, Germany, are commercially available in the form of AMtrinsic® C-103 or AMtrinsic® FS-85 pre-alloyed powders [7]. Due to the lack of suitable crucible materials for conventional gas atomisation, they are atomised by Electrode Induction-Melting Gas Atomisation (EIGA) [8] of pre-alloyed electrodes. In this study, the electrodes were electron beam melted with dimensions of ca. dxl = 45 x 650 mm. Prior to their use, a 90° tip was machined to fit the shape and dimension of the induction coil. The pre-alloyed rods were atomised in a purified Ar (4.6, Linde) atmosphere through a Laval nozzle and the as-obtained raw powders sieved to remove the fine powder fraction (< 10 µm). Finally, the sieved powders were classified through 63 µm, 105 µm and 150 µm meshes. This classification provided powders with particle size distributions typically applied in PBF-LB (10–63 µm), PBF-EB (63–105 µm) or DED (105–150 µm).

### Alloy powder characterisation

C-103 and FS-85 PBF-LB alloy powders were fully chemically characterised by a combination of ICP-OES and carrier gas hot extraction/combustion analysis, as well as morphologically by X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM)/Energy Dispersive X-Ray Analysis (EDX). Their flowability was investigated using Hall Flow measurements.

The chemical compositions of the C-103 and FS-85 powders,

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*Table 1 The chemical composition of C-103 and FS-85 powders determined spectroscopically (ICP-OES) and by carrier gas hot extraction/combustion analysis.*
Nb-base high-temperature alloy powders determined spectroscopically (ICP-OES) and by carrier gas hot extraction/combustion analysis, are provided in Table 1. For comparison, the overall composition and the composition of selected spots determined by EDX are given. The chemical compositions of the atomised powders correspond well with those of conventionally processed materials. However, due to the much higher surface areas, the contents of the light elements (i.e., C, N and O) are slightly higher than in the cast solids. Investigations by XRD, shown in Fig. 2, point to the fact that C-103 and FS-85 alloy powders crystallised in the body-centred cubic crystal structure. A comparison with pure Nb shows very similar appearance of the XRD patterns with the typical 110, 200 and 211 beta-phase reflections. Accordingly, C-103 and FS-85 can be considered as single-phase materials.

For application in powder bed Additive Manufacturing processes, good powder processability is mandatory [9]. A spherical particle shape is one important requirement to guarantee free flow and ensure a homogeneous distribution of the powder in each individual coating step. Other prerequisites are the absence of satellites, i.e. attachment of smaller particles on the surface of larger particles or agglomerates. The absence of pores or voids in the powders is necessary to avoid the inclusion of porosity in the built part. Both C-103 and FS-85 PBF-LB powders show an ideally spherical particle shape, as can be seen from the SEM images in Fig. 3. They have smooth surfaces and are fully deagglomerated. In addition, satellites are absent and, consequently, the powders possess very good flow properties. Their Hall Flow, according to ASTM B213, is 12 s (C-103) and 8 s (FS-85). Particle size measurements by means of laser diffraction indicate narrow distributions with d50 values of 34 µm and 39 µm. Tap densities are in the range of 5.5 g/cm³ (C-103) and 6.5 g/cm³ (FS-85). The higher density of FS-85 is attributed to its substantial Ta and W contents.

From the polished cross-sections shown in Fig. 4, it can be concluded that the particles are fully dense. Voids, defects or inhomogeneities are not observed. Interestingly, the BSE images of both C-103 and FS-85 show structural features with a more or less pronounced dendritic appearance. Similar observations have been made for Nb and Ta-modified Ti base alloys [10]. In C-103, they do not appear clearly, while the BSE image from FS-85 undoubtedly shows flower-like dendritic features. In addition,
the contrast in the image of FS-85 is significantly higher than that of C-103.

The EDX images of C-103 and FS-85 powder provided in Fig. 5 show clear differences in the distribution of the elements. In C-103, chemical variation of the main components Nb and Hf is observed. Nb appears enriched in the dendritic phase while Hf is enriched in the inter-dendritic phase. This is clearly expressed by the different chemical compositions, which are highlighted in Table 1 of spots 1 and 2 in the Hf map of C-103. While the dendrite-type features contain 90.5 wt.% Nb and 8.5 wt.% Hf, the volumes between the dendrites consist of 79.2 wt.% Nb and 19.6 wt.% Hf. The secondary components Ti and Zr appear homogeneously distributed throughout the particle.

The element distribution in FS-85 is very different. None of the elements appear to be homogeneously distributed throughout the particles. There is a clear separation into Nb/Zr and Ta/W enriched volumes. In contrast to C-103, Nb appears with higher concentration in the inter-dendritic phase associated with Zr, whereas Ta and W occur preferentially in the dendrite phase. The chemical fluctuations of the elements in both phases are significantly more pronounced than with C-103. While spot 1 – which indicates the composition of the inter-dendrite phase – consists of 68.2 wt.% Nb, 21.1 wt.% Ta, 5.8 wt.% W and 4.9 wt.% Zr, the values in the dendritic structures (cf. spot 2) are 58.3 wt.%, 29.3 wt.%, 10.4 wt.% and 1.9 wt.%, respectively.

C-103 and FS-85 powder particles were also investigated by means of Electron Backscatter Diffraction (EBSD) to generate information on crystal size, structure and orientation. The average grain size of C-103 particles, at approx 20 µm, appears to be slightly coarser than in FS-85. This might be a consequence of the higher number of constituents in FS-85 than in C-103 and, conse-

Fig. 5 EDX images of polished cross sections of C-103 (top) and FS-85 (bottom) alloy powders recorded at 2500 x magnification. The chemical composition of the entire area and selected spots 1 and 2 are provided in Table 1

Fig. 6 EBSD of C-103 (left) and FS-85 (right) powders showing the grain structure within the powder particles
quently, a higher entropy of the FS-85 system, exhibiting extensive crystallisation. Such an effect is well known for refractory metal high-entropy alloys.

**Alloyed’s process for AM parameter development**

The additive manufacturability of C-103 and FS-85 was assessed by PBF-LB in a protective argon atmosphere using a Renishaw AM 400 pulsed fibre laser metal AM machine with a 1075 nm wavelength. Additively manufacturing any new alloy or composition requires single track experiments to be carried out at various AM machine settings to acquire information on melt pool thickness and depth. This is key to ensuring the melt pools overlap, creating sound builds without any remnant unfused powder. A single track also helps parameter selection by adjusting the trade-off between a stable scan track and keyhole formation due to high enthalpy. Fig. 7 provides a schematic of the various AM machine parameters tested. A snapshot of the single track samples is also shown; these were metallographically analysed to determine scan track stability and soundness. The scan track width and one-dimensional energy density were plotted along with the ranking of the tracks based on the stability post metallographic analyses. This is shown in Fig. 8 and can be used as a map to visualise the effect of operating parameters on additive manufacturability.

The AMtrinsic C-103 and FS-85 powders, after being thoroughly characterised as described in the previous section, were additively manufactured with varied process parameters according to the design of experiment strategy. Cubes of dimension 10 x 10 x 10 mm were manufactured with varying processing parameters (shown in Table 2) at a fixed layer thickness of 30 µm. A meander laser scan path was applied with a rotation of 67° between consecutive layers.

Fig. 9 shows a snapshot of one particular DOE strategy of twelve cubes being additively manufactured. Once the optimised process parameter was narrowed down, a full test bar build was undertaken. After manufacturing the cubes, a full microstructural characterisation was performed to correlate the process parameters and microstructural attributes. The density of the cubes and the AM defects concentration (cracks and porosities measured through microstructural characterisation) were correlated with the build parameters such as laser power, exposure time, hatch and point distance.

The influence of the processing parameters such as laser power, scan speed, hatch, powder bed thickness, etc, on the quality of the...
Parameter | Range
--- | ---
Laser power | 200 W and 300 W
Exposure time | 70 µs
Hatch distance | 70 µm to 110 µm in steps of 10 µm
Point distance | 30 µm, 40 µm, 50 µm and 70 µm

Table 2 Range of parameters used for design of experiment to determine the additive manufacturability of FS-85 and C-103 alloys

Fig. 8 Process parameter and microstructure stability plot generated by characterising single tracks made from various operating conditions for FS-85

Fig. 9 Cube build of C-103 and FS-85 (top) as a part of the design of experiment strategy. Full test bar build (bottom) with the optimised Additive Manufacturing parameters

build can be assessed by investigating its density/porosity. It can be seen that, as the laser power (all other parameters remain unchanged) is lowered from 300 to 200 W, defects – or pores – are significantly reduced around the corners, borders and bulk (Fig. 10).

Characterisation of additive manufacturability

Density comparison of C-103 and FS-85

Cubes with density ≥ 99.9% were obtained by applying optimised processing parameters. A comparison of corners, borders and bulk microstructure has been made and the micrographs for C-103 and FS-85 are shown in Figs. 11 and 12, respectively. It can be seen that both alloys are readily processable through Laser Beam Powder Bed Fusion.
Advanced chemical and microcharacterisation / EBSD
Additive Manufacturing using PBF-LB has a significant impact on the development of the morphology of the materials used. This can be illustrated for FS-85 by comparing the powder morphology shown in Fig. 5 with that of the material additively manufactured by PBF-LB shown in Fig. 13.

When exposed to the laser beam on the powder bed, the powder melts completely. Moreover, the underlying layers are also melted and, accordingly, each individual layer is remelted several times throughout the process. In the molten layers, the individual atoms are randomly distributed, with maximum disorder; they exhibit maximum entropy. Since the cooling rates for PBF-LB are extremely high at around $10^5$ K/s, a thermodynamically favoured partial demixing with the formation of dendrite-like structures observed in the powder particles can no longer take place. The remaining structure, therefore, has a very high entropy and random element distribution.

At the deepest part of the melt pool (i.e., at the solid/liquid boundary), a slight segregation of the alloy may occur. The reason is that the individual alloy components solidify with different rates, causing local segregation. Two such melt pool boundaries are indicated in Fig. 13 in the tungsten map by a dashed line. The melt pool boundaries are likewise visible, though not highlighted, in the Nb, Ta and Zr maps.

To make sure all additively manufactured components fulfilled the composition specification for C-103 and FS-85 standards, advanced chemical analysis such as ICP and LECO were applied. Table 3 shows the oxygen concentration measured using LECO for powders and the final components. This level of quality check is required for the stringent qualification of various classes of components for space applications. In general, a slight increase of oxygen (140–250 ppm) was observed, caused by the PBF-LB processing.

Advanced electron backscattered diffraction examination of the AM parts was performed to assess the grain structure in the as-built components. EBSD maps of C-103 and FS-85 (Fig. 14) show predominantly (101) and (111) textures, respectively. This change in texture from cube on the edge to cube on the corner dependence could be attributed to the difference in chemical composition leading to a difference in solidification texture during the Additive Manufacturing of powders using PBF-LB.
Mechanical performance

The mechanical performance of the additively manufactured FS-85 and C-103 at room temperature was measured using standard ASTM E8 tests. Rectangular blanks of dimension 55 x 10 x 10 mm were machined into cylindrical dumbbell specimens with threads on either end. The samples were tested in tension in a 30 kN Instron tensile testing machine at a strain rate of 0.005 mm/min. Fig. 15 shows the room temperature performance of additively manufactured FS-85 and C-103.

It is found that FS-85 is significantly stronger than C-103. The corresponding ultimate strengths are approximately 750 MPa and 565 MPa, respectively. On the other hand, C-103 exhibits a significantly higher strain-to-failure of ~20–22% compared with ~6–7% in FS-85. Alloyed is currently performing ETMT measurements to investigate the high temperature capabilities of these materials. Experimental details will be published separately [11]. As evident from Fig. 16, an excellent high-temperature performance can be observed for both alloys at elevated temperatures. Either of the alloys produced by PBF-LB is clearly outperforms C-103 in in terms of strength and density compensated strength. In accordance with room temperature investigation, FS-85 is the first choice when searching for new alloys for service in high-temperature environments [11].

Outlook for component manufacture

Both these Nb alloys proved to have superior additive manufacturability and mechanical properties comparable to conventionally processed alloys. These alloys, therefore, need to be manufactured into prototype components to prove the validity of these alloys in actual component manufacture for space applications.

Authors

Dr Markus Weinmann
Senior Scientist, Taniobis GmbH
markus.weinmann@taniobis.com

Dr Shaumik Lenka
Materials Design Engineer, Alloyed Ltd

Dr David Crudden
Director of Alloy Development, Alloyed Ltd
Dr André Németh
Director of Group Synergy,
Taniobis GmbH

Dr Melanie Stenzel
Director of Marketing,
Taniobis GmbH

References


[7] AMtrinsic® is a registered trademark of Taniobis GmbH


[9] D Huck-Jones, C Langley, ‘Beyond particle size: Exploring the influence of particle shape on metal powder performance,’ Metal Additive Man-
ufacturing, Winter 2017 (Vol. 3 No. 4), pp. 99–103


Fig. 15 Mechanical properties of C-103 and FS-85 alloys at room temperature processed by PBF-LB

Fig. 16 High-temperature tensile tests (ETMT) of yield strength C-103 and FS-85 processed by PBF-LB
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Lubricants are a necessary addition to the Powder Metallurgy compaction process, reducing ejection forces from the tool, maintaining product quality, and increasing tool life. Depending on the application, different amounts and types of lubricant are needed to address issues related to green density and product geometry. In this article, researchers from Penn State University, North American Höganäs and Abbott Furnaces review the compaction and sintering effects of three commonly used lubricants – Acrawax® C, Intralube® E, and Intralube® HD – to shed light on the best application for different types of lubricant, and the effects these choices can have on final part quality.

In the compaction process, force is applied to the top and bottom of the powder metal compact before pressure is applied to consolidate the powder. As a result of this, force is also exerted on the sides of the die by the compact. Lubricants such as Acrawax C are added to the powder metal mix in the range of 0.25 wt.% to 1.5 wt.%, to reduce the interparticle friction in the compact and provide a mechanism to reduce the friction between the powder metal compact and the die wall during compaction and ejection. Additionally, without the aid of a lubricant, the compact quality may be compromised, and the overall die life can be greatly reduced. Once the compact has been formed and ejected from the die, it is loaded into a sintering furnace where the metal particles continue to bond in the presence of a reducing atmosphere and heat. Although the lubricant is a necessary element for the compaction process, it is important to completely remove the lubricant during the initial sintering process in order to ensure the parts are adequately sintered. The PM sintering process can thus be broken down into three primary steps. The first step is the thermal removal of the lubricant that was added to the metal powder to aid the compaction process. If care is not taken to ensure proper lubricant removal, the lubricant will dissociate at increased temperatures, forming soot at 545°C [1]. This soot can act as a barrier between the particles and limit the area of interparticle bonding surfaces. The result may be a lack of particle necking during

![Fig. 1 Schematic of the forces produced during the compaction process](image-url)
sintering, or a reduction in the mechanical properties of the sintered component.

The second step in the sintering process is the removal of any oxides that may be present on the surface of the particles and, thus, act as a barrier between particles. The oxides are removed through the reaction between the reducing atmosphere in the furnace and the presence of heat. The final step in the sintering process, once all barriers to inter-particle contact have been removed, is the sintering of the particles together through diffusion at an elevated temperature, typically 1120°C.

As the applications of conventional press and sinter PM have grown, the desire to improve the complexity and properties of sintered compacts has also increased. This, too, requires higher compacted densities and the ability to press parts in increasingly complex shapes. These factors demand that lubricant performs better to reduce the compaction pressures and ejection forces required to produce these compacts. This has led to the development of innovative lubricant systems, such as Höganäs’s Intralube E and Intralube HD, that were specifically aimed at these advanced compaction applications [2,3]. This does not, however, eliminate the need for these lubricants to be removed in the sintering process.

In the same way that compaction technology continues to advance, new sintering technology continues to be developed to remove lubricants more efficiently from the compact without causing soot formation. One recent innovation in sintering has been Abbot Furnace’s Vulcan System™. This latest technology uses convective heating to provide a very controlled temperature range for lubricant removal. It also has the ability to accurately adjust the dew point of the atmosphere in the lubricant removal stage of the process. This technology has made it possible to achieve improved properties compared to conventional processes while also complementing the latest compaction technology to produce components with better properties that are cost competitive.

**Effect of lubricants on compaction**

The development of new lubricants such as Intralube E and Intralube HD has previously been shown to substantially reduce compaction pressure. Likewise, the same compaction pressure needed to produce a green density of a compact containing Acrawax C will now produce green densities that are ~2% greater in some of the most common materials blended with Intralube HD. Similarly, when compared to equal amounts of Acrawax C in a mix, the use of Intralube E may reduce the ejection forces on the compact by as much as 20%, for a compact of equal green density.

By using warm compaction at 70°C and Intralube E, the producer may choose to reduce the amount of lubricant or may retain the higher lubricant content and generate as much as a 50% reduction in the ejection forces. When considering the use of Intralube E or Intralube HD, the question is which one is best suited for the compaction capability versus the desired green density.

When comparing equivalent amounts of lubricant in the mix, Intralube HD is better suited for green densities of 7.2 g/cm³ and greater. Higher green densities are achieved with the same amount of compaction pressure. Likewise, ejection forces may be as much as 7% less in a system that uses Intralube HD, however, it is important to

---

“As the applications of conventional press and sinter PM grow, the desire to improve the complexity and properties of sintered compacts also increases.”
note that, by increasing the amount of Intralube E in the system, the green density is still lower, and ejection forces become lower than those of the original Intralube HD system (Figs. 3, 4, 5, 6).

**Effect of lubricants on sintering**

It has long been recognised that one of the key variables to successfully sintering a compact is the time required to remove the lubricant. Also, the introduction of water into the preheat section of the furnace reacts with soot that may form with the dissociation of the lubricant.

The radiant style heating used in conventional sintering technology heats the compact too rapidly and results in the lubricant dissociating to form soot that is detrimental to the quality of the part and the furnace.

To evaluate the effect of the lubricant types, amounts, green densities, and loading, testing was conducted with a sample matrix consisting of FC-0208 compacted to three densities (6.8, 7.0, and 7.2 g/cm$^3$) with three types of lubricant (Acrawax C, Intralube E, and Intralube HD) mixed at three amounts (0.30, 0.50, and 0.75 wt.%), then sintered in a single-stacked and a double-stacked configuration, on a conventional furnace and in the Vulcan Process.

Weight loss and transverse rupture strengths were measured for all configurations and compared.

As illustrated in Fig. 7, as the green density increased, the amount of weight loss was reduced with each lubricant amount. It is important to note that the total weight loss is higher than the amount of lubricant.

![Fig. 3 Comparison of green density versus compaction pressure of different lubricant types](image1)

![Fig. 4 Comparison of ejection energy versus green density of compacts containing Amide wax and Intralube E](image2)

![Fig. 5 Compaction pressures for various amounts of Intralube E and Intralube HD](image3)
in the mix because there is also a loss of weight due to the reduction of the oxides on the metal powder particles. The result is the need for even more water to react with the soot. This approach is often not as successful as desired. In the case of high-density compacts, the steps and time needed to remove the lubricant and react the soot make it even more difficult to produce the desired quality.

Like the compaction technology and the development of better lubricants, new sintering technology has been brought to the market that uses convective heating to ensure that the compact is heated into a temperature range where the lubricant will melt, wick out of the part and vaporise without overheating and causing sooting. The result is a system that can remove all the lubricant from the part. Fig. 8 illustrates, that regardless of lubricant amount, green density, or type of lubricant, all the lubricant is removed and the oxides on the particles reduced.

Mechanical properties of samples produced with a conventional sintering process and the Vulcan Process with various lubricant types, lubricant contents, green densities, and sintering conditions were measured. The transverse rupture strength (TRS) of those samples sintered in the conventional furnace are consistently lower and showed more variation than those sintered under similar conditions in the new
process. In all cases, the double-stacked condition produced a lower strength; however, this can be attributed to the larger thermal mass of the load. A larger thermal mass will slow the heating of the samples to the sintering temperature, thus reducing the effective sintering time.

With all the lubricant removed from the compact, it makes sense that the initial green density and heating rate would play a larger role in determining the strength, as seen in the Figs. 9 and 10. It is important to note that the amount and type of lubricant has little impact on the properties achieved by the new process, except at the higher densities (Fig. 10). Intralube E is lower in strength at 7.2 g/cm³. As shown in the compaction data in Fig. 5, the better choice of lubricant for higher densities would be the Intralube® HD. Likewise, since the free pore density at a 7.2 g/cm³ green density is 98%, 0.75 wt.% lubricant is the highest quantity of lubricant that can be in the mix. Although this case would not be seen in typical production, it was included in this study for completeness of the data.

### Conclusion

As the need for improved properties pushes the density of compacts higher, new lubricants and sintering technology have evolved to meet the challenge. Lower compaction pressure and ejection forces are possible with the Intralube products. Likewise, complete lubricant removal is possible with the new Vulcan Process.

Tests show that Intralube HD is best suited for densities of 7.2 g/cm³ and above; however, similar compaction results can be achieved with the Intralube E lubricant for densities below 7.2 g/cm³. That said, however, the amount of lubricant is not important when using the Vulcan Process. Because the lubricant is removed completely, the benefits of lower compaction can be fully utilized. Intralube HD is thus best suited for higher accuracy and complexity requirements.

“New sintering technology has been brought to the market that uses convective heating to ensure that the compact is heated into a temperature range where the lubricant will melt, wick out of the part and vaporise without overheating...”
and ejection forces associated with an increase in lubricant amount can be realised without a negative effect on the final sintered product.

The dominant variables in the sintering process are now the green density and sintering time/temperature. Higher green densities produce enhanced properties, and, if a similar sintering time at temperature is seen by the products, the amount of lubricant and type can be selected to optimise the compaction process without affecting the final sintered quality.

Authors

Jacob P Feldbauer and Scott E Coble
Pennsylvania State University, Dubois, PA, USA

Amber Tims, PMT
North American Höganäs Company, Hollsopple, PA, USA

Stephen L Feldbauer, PhD
Abbott Furnace Company, St. Marys, PA, USA

References and further reading


TECHNICAL TRENDS IN METAL-CUTTING TOOLS: AN OVERVIEW OF ONGOING INNOVATION IN ONE OF PM’S KEY MARKETS

Cutting tools for metal processing applications represent one of the primary markets for the Powder Metallurgy industry. Here, PM technology makes it possible to produce cutting tools with complex geometries to near-net shape, a feat not possible using conventional manufacturing methods. Despite the basic technologies of metal-cutting tools having existed for several decades, tool manufacturers continue to introduce new products which can provide substantial benefits. In this article, Bernard North, North Technical Management, LLC, overviews developments in materials, design and software that are driving innovation in this important sector of PM.

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www.malvernpanalytical.com

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www.nslanalytical.com

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www.riotinto.com

Sino-Euro Mat. Tech. of Xi’an Co., Ltd. 30
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Tekna 11
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GEA Group AG 20
www.gea.com

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<table>
<thead>
<tr>
<th>Company</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>GKN Powder Metallurgy</td>
<td>13</td>
</tr>
<tr>
<td><a href="http://www.gknpm.com">www.gknpm.com</a></td>
<td></td>
</tr>
</tbody>
</table>

### COMPACTION PRESSES, TOOLING & ANCILLARIES

<table>
<thead>
<tr>
<th>Company</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorst Technologies</td>
<td>06</td>
</tr>
<tr>
<td><a href="http://www.dorst.de">www.dorst.de</a></td>
<td></td>
</tr>
<tr>
<td>Erowa AG</td>
<td>14</td>
</tr>
<tr>
<td><a href="http://www.erowa.com">www.erowa.com</a></td>
<td></td>
</tr>
<tr>
<td>Osterwalder AG</td>
<td>26</td>
</tr>
<tr>
<td><a href="http://www.osterwalder.com">www.osterwalder.com</a></td>
<td></td>
</tr>
<tr>
<td>Progrit GmbH</td>
<td>49</td>
</tr>
<tr>
<td><a href="http://www.progrit.ch">www.progrit.ch</a></td>
<td></td>
</tr>
<tr>
<td>Sacmi</td>
<td>25</td>
</tr>
<tr>
<td><a href="http://www.sacmi.com">www.sacmi.com</a></td>
<td></td>
</tr>
<tr>
<td>SMS group GmbH</td>
<td>42</td>
</tr>
<tr>
<td><a href="http://www.sms-group.com">www.sms-group.com</a></td>
<td></td>
</tr>
<tr>
<td>System 3R International AG</td>
<td>27</td>
</tr>
<tr>
<td><a href="http://www.system3r.com">www.system3r.com</a></td>
<td></td>
</tr>
</tbody>
</table>

### SINTERING EQUIPMENT & ANCILLARIES

<table>
<thead>
<tr>
<th>Company</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandas Metalicas Codina S.L.</td>
<td>54</td>
</tr>
<tr>
<td><a href="http://www.codinametal.com">www.codinametal.com</a></td>
<td></td>
</tr>
<tr>
<td>DSH Technologies, LLC</td>
<td>35</td>
</tr>
<tr>
<td><a href="http://www.dshtech.com">www.dshtech.com</a></td>
<td></td>
</tr>
<tr>
<td>Edward Orton Jr. Ceramic Foundation</td>
<td>53</td>
</tr>
<tr>
<td><a href="http://www.ortonceramic.com">www.ortonceramic.com</a></td>
<td></td>
</tr>
<tr>
<td>Fluidtherm Technology Pvt. Ltd.</td>
<td>55/57</td>
</tr>
<tr>
<td><a href="http://www.fluidtherm.com">www.fluidtherm.com</a></td>
<td></td>
</tr>
<tr>
<td>Gasbarre Products, Inc.</td>
<td>OBC</td>
</tr>
<tr>
<td><a href="http://www.gasbarre.com">www.gasbarre.com</a></td>
<td></td>
</tr>
<tr>
<td>MUT Advanced Heating GmbH</td>
<td>40</td>
</tr>
<tr>
<td><a href="http://www.mut-jena.de">www.mut-jena.de</a></td>
<td></td>
</tr>
<tr>
<td>PVA TePla AG</td>
<td>23</td>
</tr>
<tr>
<td><a href="http://www.pvatepla.com">www.pvatepla.com</a></td>
<td></td>
</tr>
<tr>
<td>Sunrock Ceramics Co</td>
<td>31</td>
</tr>
<tr>
<td><a href="http://www.sunrockceramics.com">www.sunrockceramics.com</a></td>
<td></td>
</tr>
<tr>
<td>Ultra Infiltrant</td>
<td>17</td>
</tr>
<tr>
<td><a href="http://www.ultra-infiltrant.com">www.ultra-infiltrant.com</a></td>
<td></td>
</tr>
</tbody>
</table>

### Alphabetical index

- American Isostatic Presses, Inc. .. 51
- Bandas Metalicas Codina S.L. ....... 54
- BluePower Casting Systems GmbH ... 19
- Bodycote ................................ 39
- Dorst ................................... 06
- DSH Technologies, LLC ............. 35
- Edward Orton Jr. Ceramic Foundation .. 53
- Eltra GmbH ......................... 41
- EPSI .................................... 24
- Erowa AG ................................ 14
- Euro PM2023 ........................... 96
- Fluidtherm Technology Pvt. Ltd. ... 55/57
- Formnext ................................ 62
- Gasbarre Products, Inc. ............ OBC
- GEA Group AG ......................... 20
- GKN ...................................... 13
- Global Tungsten & Powders Corp. ... 15
- Hexagon Product Development Pvt. Ltd. .. 56
- Höganäs AB ........................... 1F
- Imerys Graphite & Carbon ............ 16
- Isostatic Toli Services ............. 51
- Kymera International ................ 29
- Malvern Panalytical Ltd ............ 37
- Microtrac Retsch GmbH .............. 47
- MIM2023 ................................ 86
- MUT Advanced Heating GmbH .......... 40
- NLB Corporation ..................... 36
- NSL Analytical Services, Inc. ...... 33
- Osterwalder AG ....................... 26
- Phoenix Scientific Industries Ltd .. 44
- PM China 2022 ....................... 80
- PowderMet2023 / AMPM2023 ........... 70
- ProGrit GmbH ......................... 49
- PVA TePla AG .......................... 23
- Rio Tinto QMP ......................... 04
- Sacmi .................................... 25
- Sino-Euro Mat. Tech. of Xi’an Co., Ltd. .. 30
- SMS group GmbH ...................... 42
- Sunrock Ceramics Co .................. 31
- System 3R International AG .......... 27
- Tekna .................................... 11
- Topcast SRL ................................ 08
- Ultra Infiltrant ....................... 17
- Wohlers Associates, Inc. ............ 59
- World PM2022 ........................... IBC
HIP EQUIPMENT AND SERVICES

American Isostatic Presses, Inc.  51
www.aiphip.com

Bodycote  39
www.bodycote.com

EPSI  24
www.epsi-highpressure.com

Isostatic Toll Services  51
www.isostatictollservices.com

POST-PROCESSING

NLB Corporation  36
www.nlbcorp.com

QUALITY AND TESTING

Eltra GmbH  41
www.eltra.com

Microtrac Retsch GmbH  47
www.microtrac.com

CONSULTING & TOLL SINTERING

DSH Technologies, LLC  35
www.dshtech.com

Wohlers Associates, Inc.  59
www.wohlersassociates.com

EVENTS

Euro PM2023  96
www.europm2023.com

Formnext  62
www.formnext.com

MIM2023  86
www.mim2023.org

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RAPID + TCT 2023
May 2–4, 2023
Chicago, IL, USA
www.rapid3devent.com

MIM2023
February 27–March 1, 2023
Costa Mesa, CA, USA
www.mim2023.org

Hannover Messe 2023
April 17–21, 2023
Hannover, Germany
www.hannovermesse.de

Event listings and media partners

If you would like to see your Powder Metallurgy related event listed in this magazine and on our websites, please contact Kim Hayes, kim@inovar-communications.com
REGISTRATION OPEN

9 - 13 October 2022
Lyon, France

worldpm2022.com
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