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Research and development key to future success of PM

The state of the global Powder Metallurgy industry has been widely discussed at all the main PM industry events this year. The industry's trade associations have all reported positive results and forecasts of continued growth, albeit at a moderate pace, have been the main message.

Growth forecasts for PM are, of course, dependent on the growth of the end-user market, and in the press and sinter business this is predominantly the automotive sector. It may signal concern, therefore, that GM is looking to close five of its car production facilities, with the loss of 14,000 workers, citing a move towards electrification in its future model range.

Clearly, change will not happen overnight, and the PM industry is well positioned to continue offering solutions that increase efficiency in traditional power plants, as well as taking advantage of opportunities in new electric and hybrid systems.

Research and development is key to meeting the needs of any industry, and in the Powder Metallurgy industry this is not in short supply. As witnessed at all the major PM conferences, academic research appears to be very much alive. This is also the case in industry, as can be seen in our report on Rio Tinto Metal Powders and Catalus Corporation, both of whom are actively committed to R&D programmes.

Paul Whittaker
Editor, Powder Metallurgy Review

Cover image
A wide range of PM parts can be manufactured with powder from Rio Tinto Metal Powders (Courtesy Rio Tinto Metal Powders)

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

Volkswagen investing $50 billion in electrification plan

Volkswagen Group, headquartered in Wolfsburg, Germany, has stated that it will invest almost €44 billion ($50 billion) on developing and mass producing electric cars, autonomous driving and new mobility services by 2023. The automotive company stated that, through this plan, it could become the most profitable manufacturer of electric cars. Dr Herbert Diess, Chairman of the Board of Management of Volkswagen, told *Reuters* during a news conference in Wolfsburg, that he also hopes to have an outline agreement on cooperation with Ford by the end of 2018, with the initial focus being on commercial vehicles.

During the news conference, Diess reportedly stated that mass producing electric cars will help Volkswagen to reduce the cost of these vehicles to a cost in line with current diesel vehicles. VW further stated that it plans to increase productivity in its factories by 30% by 2025, by building a number of vehicles from different brands on one production line. "Volkswagen must become more efficient, more productive and more profitable in order to finance the high expenditure in the future and stay competitive," Diess was reported to have said.

At the end of November 2018, Volkswagen's management outlined its plans to convert plants in Zwickau, Emden and Hannover to produce electric vehicles and provide job guarantees to workers until 2028. Zwickau currently produces the VW Golf and VW Estate, and is expected to produce the first ID. electric vehicle in 2019, amidst a ramp up of the facility to a production capacity of 330,000 electric vehicles.

www.volkswagenag.com

VW's ID. model will be launched as a compact-class electric vehicle in 2020

General Motors announces plant closures in move towards autonomous and electric vehicles

General Motors, Detroit, Michigan, USA, is expected to cut 14,000 staff from its North American workforce and put five plants up for potential closure. Factories concerned include assembly plants in Detroit, Michigan; Lordstown, Ohio; Warren, Michigan; Baltimore, Maryland; and Oshawa, Ontario, Canada. The company also stated that it will stop operating two additional factories outside North America by the end of 2019.

The majority of factories affected by GM's restructuring produce cars which will not be sold in the USA after 2019. In total, six car models are expected to be discontinued through 2019, with nine car models remaining across its four brands.

The restructuring comes as GM moves to discontinue production for several of its car models and shifts focus toward autonomous and electric vehicles. In a statement to *The New York Times*, Mary Barra, GM CEO, commented that as cars and trucks become more complex, the company will employ more computer coders but fewer engineers for internal combustion engines. "The vehicle has become much more software-oriented," she stated. "We still need many technical resources in the company."

www.gm.com

Kymera International sold to Palladium Equity Partners

Palladium Equity Partners, LLC, New York City, USA, a private investment firm, has announced that one of its affiliated funds has acquired Kymera International (the collective of ACuPowder International, ECKA Granules and SCM Metal Products), from Los Angeles-based private investment firm Platinum Equity. The terms of the transaction were not disclosed.

The Kymera group of companies produces a variety of specialty materials, powders, pastes and granules used in a wide range of metallurgical, chemical and industrial processes, including Powder Metallurgy, metal Additive Manufacturing, and Metal Injection Moulding (MIM). Many of the company's products are custom developed for specific customer applications in a variety of end-markets, including chemical, speciality auto, general industrial, mining and aerospace, among others.

The company is headquartered in Durham, North Carolina, USA, and has global production capabilities across the US, Australia, China, Europe and the Middle East. Under Platinum Equity's ownership, it saw significant growth from two copper powder plants to become one of the largest manufacturers of speciality aluminium and copper powders worldwide.

"Kymera's success reflects the culmination of a strategy to acquire multiple speciality material companies across the globe and integrate them operationally under one brand," said Jacob Kotzubei. "Starting with the carve out of SCM Metal Products, we partnered with management to build on the platform over time, and supported the company's organic growth through investments in R&D and deployed our M&A&O® resources to source and execute three add-on acquisitions. The result is a high-performing, well-diversified business with a dynamic leadership team led by Barton White."

Palladium stated that it is backing the Kymera management team with the goal of pursuing various avenues of growth, including accelerating the expansion of the company's product portfolio and pursuing complementary acquisitions in the speciality materials industry.

"We are proud of the results we have achieved under Platinum," added Barton White, Kymera's CEO. "We look forward to working with Palladium and leveraging their industry experience to accelerate our expansion plans, while continuing to focus on serving our customers."

www.kymerainternational.com

Sandvik reports record Q3 operating margin

Sweden's Sandvik Group has reported its financial results for the third quarter 2018. The company reported an order intake of SEK 24,192 million for the quarter, an increase of 9% compared to Q3 2017 (SEK 21, 888 million). An adjusted operating margin of 18.9% was said to be a record high for a third quarter.

Adjusted operating profit for Q3 2018 was reported at SEK 4,587 million, an increase of 37% compared to Q3 2018 (SEK 3,338 million). Earnings for the quarter were said to have been positively impacted by a net capital gain of SEK 618 million, generated by the divestment of Sandvik Hyperion. Excluding positive effects from changed exchange rates, structure and metal price effects, the adjusted operating profit improved by 25%.

Order intake and revenues in the third quarter improved organically by 9% and 10% respectively, with a reportedly strong contribution from all three business areas. Sandvik Materials Technology reported an increase in orders of 22%, while orders for Sandvik Mining and Rock Technology increased organically by 8%, and Sandvik Machining Solutions also reported an organic order growth of 8%.

Björn Rosengren, President and CEO of Sandvik Group, stated, "In the third quarter, order intake improved significantly in all three business areas on the back of strong progress in most customer segments and in the three major geographical regions. [...] I am also pleased that we made progress on reshaping the business portfolio toward improved long-term sustainable value creation as we closed a number of acquisitions and completed earlier-announced divestments."

www.home.sandvik

AMG announces strategic restructuring

As of January 1, 2019, AMG Advanced Metallurgical Group NV, Amsterdam, the Netherlands, will form two new strategic operating divisions: AMG Technologies and AMG Critical Materials. AMG Technologies will be comprised of its existing Engineering and Titanium Alloys businesses, replacing AMG Engineering. AMG Critical Materials will consist of seven operating units, namely Vanadium, Superalloys, Tantalum & Lithium, Graphite, Silicon, Aluminium and Antimony.

Employing around 3,300, AMG operates globally with production facilities in Europe, the Americas, Asia and Africa, with customer service offices in Russia and Japan.

www.amg-nv.com

Melrose issues latest trading update for GKN

Melrose Industries PLC has issued a trading update for the four months from July 1–October 31, 2018. The group acquired GKN plc in April 2018 after receiving the support of GKN's shareholders. According to the update, Melrose has seen strong revenue growth in the Aerospace and Powder Metallurgy segments, with the group currently trading in line with the board's expectations for 2018.

The Powder Metallurgy division achieved revenue growth in the period of 9% compared to the same period in 2017, with improved margins. The group stated that this positive result offers confidence that the 14% margin target for the division will be achieved in the medium term.

The Aerospace division achieved revenues up 6% compared to the same period in 2017, and good progress is said to have been made on margin, including improvements to the division's performance in North America. Melrose stated that, with an experienced and incentivised management team, the division is said to be making the necessary improvements to achieve acquisition objectives.

Revenue in the Automotive division was flat for the period compared to 2017. The margin was reported to be lower, but Melrose stated it expects planned operational improvements identified at the time of its acquisition to positively impact performance in 2019. In November 2018, Liam Butterworth was appointed as the new CEO of the Automotive division, and a new management team is currently being assembled from various internal and external sources with the aim of further enhancing the performance of the business.

Overall, Melrose stated that it is confident the GKN businesses it acquired in April 2018 will offer good opportunities for value creation over the medium term. The group will present its full year results in March 2019, and will host a Capital Markets Day in London, UK, on April 3, 2019, focused on its Aerospace and Automotive divisions.

Christopher Miller, Melrose Chairman, stated, "Melrose has a proven business model, which has been successful over many years and through several economic cycles. We are confident that there is an outstanding opportunity to make significant and lasting improvements to the performance of the GKN businesses. Whilst certain end markets may be unpredictable, the group is on track to meet our expectations for this year. We are excited by the future prospects of the group and look forward to delivering significant value for shareholders."

www.melroseplc.net

Linde and Praxair successfully complete business merger

Linde plc, Guildford, UK, has successfully completed the merger between Praxair and Linde AG announced in December 2016. The combined company has adopted the Linde name and will be listed on both the New York Stock Exchange (NYSE) and the Frankfurt Stock Exchange (Prime Standard segment).

Now that the business combination has been completed, the companies stated that they will focus on finalising the divestitures required by the respective antitrust authorities. Necessary divestitures include, in particular, certain sales in the United States, which Linde AG is required to complete by January 29, 2019. Until the completion of the majority of such divestitures, Linde AG and Praxair are obliged to operate their businesses globally as separate and independent companies and not coordinate any of their commercial operations.

At the time of the merger's announcement, it was stated that the combined company will be governed by a single Board of Directors with equal representation from Linde and Praxair. Linde's Supervisory Board Chairman, Professor Dr Wolfgang Reitzle, was expected to become Chairman of the new company's board, while Praxair's Chairman and CEO, Steve Angel, was expected to become CEO and a member of the Board of Directors.

www.linde.com

Sandvik acquires Chinese company Kunshan Ousike Precision Tools

Seco Tools, Fagersta, Sweden, a division of Sandvik Machining Solutions, has reached an agreement to acquire Chinese company Kunshan Ousike Precision Tools Co., Ltd (OSK), a supplier of solid carbide round tools based in Kunshan, Jiangsu. In 2017, OSK reported revenues of SEK 120 million and employed a staff of ninety.

Klas Forsström, President of Sandvik Machining Solutions, stated, "The acquisition is aligned with Sandvik Machining Solutions' focus on growing the round tools business. We are already today well positioned in China but OSK will bring us even closer to customers."

"I am very happy that we have reached an agreement to acquire OSK and include them in the Seco family," added Lars Bergström, President of Seco Tools. "OSK serves customers in the electronics and die and mould industries and this is an important step for Seco to improve its position in the fast growing Chinese market. Our combined expertise will strengthen the product offering to customers."

The transaction is expected to close during the first half of 2019, subject to relevant regulatory approvals.

www.secotools.com | www.osktool.com

Retech to relocate manufacturing to Poland

Retech Systems LLC, based in Ukiah, California, USA, and a wholly-owned subsidiary of Seco/Warwick, Swiebodzin, Poland, is to relocate much of its manufacturing and assembly - previously carried out at its California plant - to facilities in Swiebodzin. The Ukiah office is set to be downsized, with Retech stating that it will retain its experienced engineers, lead technical directors, technologists and service staff.

The company added that key leadership roles will continue to be filled, and its R&D Center continue to be built up. A West Coast office will be maintained in California, alongside the company's recently opened East Coast office in Buffalo, New York, USA.

Earl Good, Retech President, stated, "This is an effort to both strengthen our organisation and to satisfy our customers' expectations. Ultimately, we are confident that the new organisational structure and footprint will enable Retech to be much closer to our global customers while improving our competitiveness in the industrial markets we serve."

Retech expects that the change will better position the company to support both large capital projects and regular customer service needs. The move is said to be the result of a reinvestment in Retech by both its own management team and the team of Seco/Warwick.

www.retechsystemsllc.com | www.secowarwick.com

Plansee invests in start-up for industrial digitalisation

Plansee Group, Reutte, Austria, has participated in a funding round of the Speedinvest Industry fund to become one of its core investors. The fund comprises €50 million of growth capital, available for developing and subsidising industry and technology-centred start-ups.

Karlheinz Wex, a member of the Executive Board of Plansee, stated, "We are investing because we want to see, assess and ideally further develop new ideas for digitisation in the industrial environment at a very early stage. The participatory interest was a cornerstone in the efforts to complete the group's digital transformation by 2021."

"The intelligent use of our data is a prerequisite for simplifying the working relationship with our customers and for controlling our production operation more intelligently," he added.

The Speedinvest Industry fund is expected to provide financing primarily to companies focusing on areas such as big data & analytics, the smart factory, and new business models in the industrial domain. The fund is aimed at founders from across Europe, but places special emphasis on Germany, Austria and Switzerland as a result of being based heavily in industry.

www.plansee.com | www.speedinvest.com

thyssenkrupp reveals plan to split group into two independent companies

thyssenkrupp AG, headquartered in Essen, Germany, is undertaking a reorganisation of the group which will see it split into two independent listed companies. The Management Board of thyssenkrupp stated that it expects this new structure to allow the businesses to develop better and concentrate on their strengths.

Both the capital goods and materials businesses will continue to use the name thyssenkrupp, but will be managed as independent, listed companies with direct access to the capital markets, thyssenkrupp Materials AG and thyssenkrupp Industrials AG. Following the split, thyssenkrupp Industrials will consist of three units: the elevator business, the automotive supplier business, and core plant construction. The elevators unit will remain unchanged in its current configuration, while Components Technology will focus on the automotive business. The slewing (Bearings) and the forging business (Forged Technologies) will be spun off from the division. A new addition will be the System Engineering division, which will build production lines, for example for cars, and is currently part of Industrial Solutions.

thyssenkrupp Materials will consist of Materials Services, the 50% interest in the future steel joint venture, the slewing bearings and forging businesses, as well as the marine business. The result is expected to be a materials group that combines steel and stainless steel production, materials trading and steel-related processing, and can take advantage of consolidation opportunities from a position of strength.

"We are planning to create two independent companies with a common DNA and strong roots from over two-hundred years of common history," stated Guido Kerkhoff, Chairman of the Management Board of thyssenkrupp AG. "But we have more in common than just history – a common understanding of performance and values. Above all, we are driven by a strong desire to be a technology leader. Acting responsibly with our employees is at the heart of our culture [...] Both companies will remain 'thyssenkrupp'."

Existing stockholders will continue to hold 100% of thyssenkrupp Materials AG and, initially, a clear majority of thyssenkrupp Industrials AG. The remaining stake will initially be held by thyssenkrupp Materials AG.

www.thyssenkrupp.com

With a production of over 30 million camshafts per year at ten locations, thyssenkrupp is the global market leader in the field of assembled camshafts

Tekna opens expanded metal powder production facility

Metal powder manufacturer Tekna Plasma Systems Inc., Sherbrooke, Quebec, Canada, has expanded its second plant and implemented a new manufacturing infrastructure. The result of a $5.5 million investment by the company, the expansion has doubled the size of its metal powder production facilities.

The additional space created will reportedly be used for the immediate and future deployment of new metal powder production units, the introduction of new research infrastructure and the relocation of part of its administrative staff. Rémy Pontone, Tekna's Vice President, Sales and Marketing, stated, "This investment will enable us to follow and support the growth of our clients through our existing products and to launch new innovative products on the industrial market." Luc Dionne, Tekna CEO, added, "This expansion, which is part of our five-year growth plan, will increase our annual metal powder production capacity to over 1,000 tonnes. Our world-class manufacturing infrastructure and our accreditations in terms of the strictest quality standards make Tekna a reliable partner that our clients can count on to ensure their current and future success."

Tekna manufactures metal powders for MIM, AM, HIP and thermal spray, including Ti64 titanium alloy powder, tungsten carbide powder, tantalum powder and molybdenum powder. It also produces a range of turnkey plasma systems for the production of metal powders. In August, the company revealed plans to invest up to $128 million over the course of five-years to expand its global manufacturing output and boost R&D capabilities, in a project benefiting from $33 million in financing from the Canadian government.

www.tekna.com

Carpenter acquires LPW Technology

Carpenter Technology Corporation, Philadelphia, Pennsylvania, USA, has acquired LPW Technology Ltd for approximately $81 million. LPW develops and supplies advanced metal powders and lifecycle management solutions. LPW is based in Widnes, Cheshire, UK, and has additional processing operations near Pittsburgh, Pennsylvania, USA.

Tony R Thene, Carpenter's President and Chief Executive Officer, stated, "Our aggressive development in key aspects of Additive Manufacturing demonstrates our commitment to build on our industry-leading position in this space. The acquisition combines LPW's metal powder lifecycle management technology and processes with our technical expertise in producing highly-engineered metal powders and additively manufactured components."

Carpenter stated that lifecycle management technology is becoming increasingly important to understanding how materials behave before, during, and after production in Powder Bed Fusion (PBF) Additive Manufacturing. Understanding powder behaviour will continue to be critical as AM becomes more widely adopted and implemented across various industries.

Carpenter's portfolio also includes recent investments in Puris, a titanium powder producer; CalRAM, a leader in Electron Beam and Laser Beam Powder Bed Fusion AM services; and the construction of an Emerging Technology Center in Athens, Alabama, USA.

www.cartech.com | www.lpwtechnology.com

Arcast to supply large-scale research gas atomiser to CEIT

Arcast Inc., Oxford, Maine, USA, is to supply a large-scale research inert gas atomiser to the Centro de Estudios e Investigaciones Técnicas de Gipuzkoa (CEIT), San Sebastián, Spain. CEIT is a non-profit research centre and carries out applied industrial research projects under contract, working closely with clients' R&D departments.

The Materials and Manufacturing division at CEIT includes Powder Metallurgy research, and is currently expanding its capabilities to develop new alloy powders. The new atomiser will allow the use of various atomising geometries to produce complex alloys in batches of 50–250 kg. These features are said to offer a good capacity and capability to address the growing needs of the metal powder market. Arcast stated that it hopes to work with the team at CEIT to create larger quantities of advanced metal powders in the future.

www.ceit.es | www.arcastinc.com

SINTERmat receives funding boost

SINTERmat, Dijon, France, has reported it has received development funding from the Definvest Fund, the fund of France's Ministry of the Armed Forces, managed by French investment bank Bpifrance, as well as from a number of private investors. This funding will enable the company to acquire equipment and initiate industrial production, as well as finalising its installation in new premises in Montbard, France.

SINTERmat is a spin out from the University of Burgundy which aims to promote university public research in the field of PM and in the emergence of Spark Plasma Sintering (SPS) technology, and to provide its customers with innovative materials solutions based on PM techniques. The company stated that its solutions are designed to meet the needs of manufacturers for small and medium-scale series production in emerging markets such as luxury goods, defence, aeronautics and energy.

SPS makes it possible to agglomerate nanopowders of different types under the effect of a strong electrical impulse, and thus to obtain parts of very high strength and density that are suitable for use in fields such as automotive, aerospace and defence, as well as in the luxury consumer goods industry. The funding boost is expected to allow SINTERmat to begin industrial production immediately with the purchase of a sintering machine with unique capabilities in France and Europe.

"I am very pleased to have the support of the Definvest Fund," stated Foad Naimi, Director and Founder of SINTERmat. "This involvement gives our project the solid foundation that we will need to accelerate our growth and industrialise SPS technology. This stage marks the beginning of a human adventure for SINTERmat. I will be attentive to encourage the cohesion and the involvement of the teams around the business project and its values: eco-responsible attitude, customer-centric innovation, autonomy, responsibility and excellence."

Florence Parly, Minister of the Armed Forces of France, commented, "Research, audacity, duality in innovation and the technical challenges identified are assets for defence, assets that we must encourage and make profitable. I am convinced that research and technological success are intimately linked. For our defence, I cannot imagine one without the other... SINTERmat concentrates all the qualities that the Ministry of the Armed Forces looks for in its ambitious will to innovate. I am proud of this new investment from Definvest."

www.sinter-mat.com

Liberty Powder Metals secures £4.6 million for metal powder atomisation

Liberty Powder Metals, Sheffield, UK, a subsidiary of Liberty House Group, has secured £4.6 million in funding from the Tees Valley Combined Authority Cabinet, UK, to support its acquisition of a vacuum atomisation system for the development and manufacturing of speciality alloy metal powders for use in industries such as metal Additive Manufacturing. The overall cost of the scheme is £9.83 million, with almost £4 million having been invested by Liberty and the CASCADE project.

The project will be based at the Materials Processing Institute in South Bank, Middlesbrough, UK, a not-for-profit research and innovation centre which supports industry to develop new materials, processes and technologies. As there are currently said to be only two such atomisers in the UK, the system will be set up on an open access basis to enable collaborative research programmes.

Jon Bolton, Chief Executive of Liberty Steel UK, commented, "As a group, we are committed to revitalising the metals and engineering industry through innovation and we're very proud to partner with the Tees Valley Combined Authority and the Materials Processing Institute to take forward a game-changing technology that will build a bright new future for these sectors in the UK and worldwide."

Chris McDonald, Chief Executive Officer of the Materials Processing Institute, added, "The Institute can bring a high level of scientific expertise to this project with our capabilities in advanced materials and we are delighted to support Liberty in the next phase of its powder metals project, which is essential for the continued development and refinement of Additive Manufacturing processes."

In 2017, Liberty Speciality Steels (then Tata) reported that it had identified metal powder production as a key strategic future product range in the sectors of oil & gas, automotive, and aerospace, a view upheld by the new leadership team. Under CASCADE, the company plans to establish a medium-term development programme to construct a large-scale atomising facility with annual production capacity of 400 tonnes per year, which it plans to increase to 1200 tonnes annually.

www.libertyhousegroup.com
www.mpiuk.com

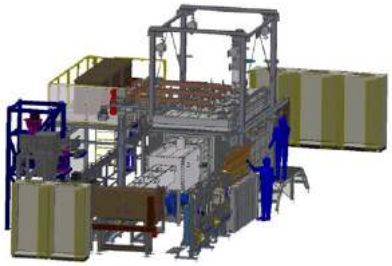
EU-funded CARBIDE2500 project to develop first 2500°C industrial furnace

Cremer Thermoprozessanlagen GmbH, Düren, Germany, has received EU funding for its CARBIDE2500 project to develop the first 2500°C industrial furnace. The project launched in May 2018 and is expected to conclude by the end of April 2020, with the total cost being reported at €1,331,000, of which the EU has contributed €931,700 through its Horizon 2020 R&D programme.

Cremer specialises in pusher furnace systems with graphite coatings which operate at extremely high temperatures, above 2000°C. These systems are used in the carburising process for carbide powders such as tungsten carbide (WC). According to the company, the economic downturn and subsequent recovery in Europe has seen increasing demand for higher strength materials which offer longer product lifespans and higher overall performance, allowing for lower operational costs.

Tungsten carbide is used in many different applications across multiple large industrial sectors, including automotive and aerospace manufacturing, construction, surface and underground mining, oil & gas exploration, as well as in many manufacturing industries (including paper, textiles, electronics, etc).

As a result of increasing demand, the global tungsten carbide powder market is expected to grow from €13.6 billion in 2016 to €22.91 billion in 2026, at a compound annual growth rate of 5.4%. Demand for other carbides, such as tantalum carbide or niobium carbide, is also increasing. Tests have proven that WC powder produced at 2500°C is three-to-five times higher strength than the same material produced at 2200°C. However, there are currently no industrial scale furnaces capable of operating at 2500°C.



The CARBIDE2500 industrial furnace could enable the production of tungsten carbide materials up to five times stronger

The CARBIDE2500 furnace will be the first industrial furnace capable of operating at 2500°C, thereby making it possible to produce higher strength carbides than currently possible.

www.cremer-polyfour.de

Höganäs celebrates 25th anniversary in China, adds upgraded mixing station

Höganäs has been active in China for 25 years

Sweden's Höganäs AB recently celebrated the 25th anniversary of its operations in China with a ceremony at its Qing-Pu site in Shanghai, China, attended by a number of guests including local government representatives, industry associations and customers. As part of the celebration, the company inaugurated an upgraded state-of-the-art mixing station at the plant.

The company has been active in China since In 1993, when it entered into a joint venture with a Chinese partner, later taking full control of the company. Höganäs has since made numerous investments in the country and Fredrik Emilson, Höganäs CEO, stated during the event that, "The Chinese PM Industry of today is considered as one of the world's most advanced. It is our ambition that this upgraded mixing facility will play an integral part of the continued success of the PM industry in China."

Xiangjun Ni, vice-mayor of Qingpu, commented, "Höganäs was one of the first foreign enterprises to establish itself in Qing-Pu. We are delighted with the continuous development of Höganäs and would like to express our best wishes for the future."

Speaking on the new mixing station, Mark Braithwaite, Head of Höganäs in the Asia-Pacific region, stated, "This shows our commitment to the China market and our plan and expectation to remain the market leader, while continuing to offer our market-leading powder mixes. We will continue to offer the highest level of services for our customers by continuing to develop the market."

"We have substantially upgraded the material handling process from when the powder comes from Sweden and to when it shall be delivered to the customer," added Richard Molin, Country Manager for South Korea and Head of Asia-Pacific operations. "We have put in our latest technologies in the new mixing station to significantly increase capacity and improve safety."

Charlie Chu, formerly General Manager at Porite Taiwan, a Japanese-owned, specialist Powder Metallurgy company, added, "Metal powder may look simple, but the mixing quality is very important for all users. When Höganäs started here in Qing-Pu 25 years ago, I was visiting this plant and I saw what they would be able to do in China. Much has happened since then and much has also happened in China with the growth of the automobile industry. I am certain that this upgraded mixing station will be good for the whole PM industry in China."

Zhirong Zhu, General Manager at NBTM New Materials Group, a China-based company engaged in the production and sales of PM machinery parts and soft magnetic materials, added, "The establishment of Höganäs in China twenty-five years ago was very helpful for China's PM industry. And twenty-five years later, when Höganäs upgrades its mixing station, it brings new big opportunities for China's manufacturers to also upgrade its own products."

www.hoganas.com

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Hi-line highlights the benefits of in-house nitrogen and oxygen generation

Hi-line Industries Ltd, Burton upon Trent, Staffordshire, UK, has launched its latest series of in-house nitrogen and oxygen generators. The new generators are said to be high-purity and low-energy, and use Pressure Swing Absorption (PSA) technology.

On launching its new generator series, Hi-line sought to highlight the benefits of in-house nitrogen and oxygen generation over bottled or tank deliveries. "Nitrogen and oxygen are two of the planet's most abundant gases, yet many businesses spend thousands in having it delivered, typically in cylinders or bulk tanks," the company commented. "Paying top prices for something that is essentially free simply does not make commercial sense."

According to Hi-line, the savings to be made by generating nitrogen and oxygen on site can be significant. It stated that many large gas-producing companies offer nitrogen at UHP (Ultra High Purity) of 99.99999%, while the application in hand may only require a purity of only 98% or 95%. Using an N_2 system from Hi-line, the cost of a 98% pure generator against a 99.99999% pure generator of the same flow is ten times cheaper.

A nitrogen generator system produced by Hi-line

Hi-line's N_2 generators use a different type of control technology to that used by traditional PSA N_2 generators. Using a variable speed type technology, the generator only runs when the process is calling for N_2; when no N_2 requirement is needed, the generator enters stand-by mode. On starting the generator, N_2 is delivered at the exact purity required, due to the incorporation of a buffer/polishing tank along with a high purity storage vessel on the skid, meaning no down-time is experienced whilst waiting to reach purity.

The cycle therefore has the potential to continuously produce high-quality nitrogen, twenty-four hours a day. Further, the incorporated carbon molecular sieve incorporated in Hi-line's N_2 generators is fully regenerative and has a life span of over 40,000 operational hours. Nitrogen gas is used in a wide range of industries where safe, inert environments are required, such as the petroleum, chemical, pharmaceutical, paint and varnish sectors, as well as in the production of ferrous and non-ferrous metals, together with electronic and glass products.

Aside from the cost advantages available, Hi-line noted a multitude of further advantages associated with in-house N_2/O_2 generation, such as independence from third-party gas supplies and market price fluctuations, as well as the elimination of logistical tasks associated with the processing and ordering of bottled or liquid nitrogen, as well as the management of suppliers. In addition, the generator equipment is said to be modular and flexible, and has very low maintenance requirements.

Hi-line is said to be able to design bespoke generator systems for customers that ensure the lowest possible running costs and smallest footprint. Manufacturing takes place at the company's new facility in Burton upon Trent, which is three times the size of Hi-line's previous headquarters.

www.hilineindustries.com

GeniCore showcases U-FAST sintering system

GeniCore, Warsaw, Poland, showcased its new U-FAST sintering system at the recent Euro PM2018 Congress & Exhibition in Bilbao, Spain. In the company's U-FAST (Upgraded Field Assisted Sintering Technology) method, the energy source is an impulse power supply with an operating voltage similar to that used in FAST or SPS type sintering. It can be used to sinter metal materials up to a maximum temperature of 2500°C, with a maximum pressing force of 350 kN.

U-FAST can reportedly be used to produce high-performance ceramics, metal matrix composites, super hard materials, functionally gradient materials and MMC composites with uniform microstructure and good physical properties.

Other products offered by GeniCore include innovative materials, such as Diamond Enhanced Cemented Carbide (DEC), produced using its Pulse Plasma Compaction (PPC) sintering method. DEC is described as a super hard material with a very high hardness to impact resistance ratio.

GeniCore solutions are used by customers in the tooling, power, electronics, automotive and firearms industries. The company stated that it is focused on establishing long-term cooperation with clients globally, including further development of its sales and service network.

www.genicore.pl

SMC Powder Metallurgy changes name to Catalus Corporation

SMC Powder Metallurgy, headquartered in St. Marys, Pennsylvania, USA, has changed its name, officially becoming Catalus Corporation on October 1, 2018.

SMC began as a division of St. Marys Carbon, founded by the late J E Lanzel, Sr. in 1939. The carbon business and Powder Metallurgy business became separate companies in 2008 and the change of name is aimed at helping distinguish between the two. "There is no change in our ownership," stated Steve Lanzel, President and CEO, "Our company is not for sale and is not on either side of an acquisition. Catalus will remain the same family owned business ready to break new ground in the powder metal industry."

Commenting on the name change, Dave Parsons, Vice-President of Sales, added, "We changed our name to Catalus Corporation to convey the catalytic impact our new operations can now have on our customers' success." In late 2017 SMC Powder Metallurgy Inc. began construction of a second manufacturing site, a new state-of-the-art Powder Metallurgy manufacturing facility at the St. Marys Airport Industrial Park. All current manufacturing is done at their plant in Galeton, Pennsylvania.

"In addition to manufacturing product, Catalus will begin doing more research and development work at the Galeton location," added Amy Schutz, Business Development Manager. "Early next year corporate headquarters will relocate to the new building and future expansions of our manufacturing capabilities will take place there as well."

www.CatalusCorp.com

FJ Industries plant approved as supplier to global automotive customer

FJ Industries A/S, Denmark, has announced that its FJ Sintermetal AB plant has been approved as a supplier by a global automotive customer. While FJ Industries did not name the customer, it stated that it is "a huge company within the automotive industry, supplying parts for several of the big OEMs."

FJ Sintermetal AB is located near Jönköping, Sweden. According to FJ Industries, the customer performed a thorough audit of the plant over two full days during September 2018. "We are extremely proud to announce that we passed the audit," stated FJ Industries. "We are now looking forward to get the serial production up and running."

While the majority of the parts manufactured by the plant have until now been non-automotive, FJ Sintermetal has been supplying parts to the automotive industry for a number of years. The automotive share of the business is now expected to increase significantly.

In addition to this recent supplier approval, FJ Sintermetal recently achieved IATF16949 certification, updated from the original 2015 TS16949. The company has reportedly been manufacturing components using Powder Metallurgy for more than thirty years, and also produces cast and machined parts as well as providing design consultancy services to its customers.

www.fji.dk

Stratasys offers insight into its new 'Layered Powder Metallurgy' technology

Stratasys, based in Minneapolis, Minnesota, USA, and Rehovot, Israel, has released further details of its new metal Additive Manufacturing platform currently being developed and designed for short-run metal applications. First unveiled earlier this year, the Additive Manufacturing platform is based on Stratasys' 'Layered Powder Metallurgy' (LPM™) technology, and is said to make production of metal parts quicker, easier and more cost-effective.

The company stated that it believes this technology will be of special interest to the Powder Metallurgy community. LPM is reported to offer improved efficiency and cost savings using standard Powder Metallurgy alloys, with high accuracy and controlled shrinkage, as well as extremely fast throughput. Developed internally over the past several years, Stratasys' platform incorporates the company's proprietary jetting technology. The first material to be made available for the system will be an aluminium alloy.

"We note that current approaches to 3D printing metal parts leave a lot to be desired – including slow post-processing, painstakingly intricate support removal, and hours of machining and grinding. Combined with the high cost of AM powders, this means each part is expensive, with a total cost of ownership that is too hard to justify," stated Rafie Grinvald, Director of Product Marketing and Management, Stratasys.

"Our new platform is being designed to transform the current metal Additive Manufacturing landscape – presenting a viable alternative to typical production methods – and helping customers dramatically reduce the costs of creating reliable, consistent production-grade, metal parts for short-run applications."

The LPM™ solution includes a three-step Additive Manufacturing process combining traditional PM with Stratasys' PolyJet™ ink-jet technology. The process includes printing of boundaries with proprietary thermal ink, powder dispensing and spreading, followed by compaction of the powder layer to achieve high density and controllable shrinkage.

The system aims to directly address the needs of customers who require production of pilot-series parts, small-batch manufacturing during product ramp-up and end-of-life, as well as customised, lightweight, complex parts. The offering is said to be ideal for such markets as automotive, aerospace and defence.

www.stratasys.com

Stratasys's LPM process combines both ink jetting and powder compaction (Courtesy Stratasys)

Sandvik acquires US manufacturer Dura-Mill

Sandvik Coromant, Sandviken, Sweden, a division of Sandvik Machining Solutions, has reached an agreement to acquire privately owned US-based company Dura-Mill Inc, Malta, New York, USA, a manufacturer of precision solid carbide end mills. The acquisition is said to enhance Sandvik Coromant's position and product offering in North America, primarily within the aerospace segment.

Klas Forsström, President of Sandvik Machining Solutions, commented, "The acquisition is aligned with Sandvik Machining Solutions' focus on growing the round tools business. Dura-Mill will add even stronger capabilities for managing customised end mills."

"I am very pleased that we have reached an agreement to acquire Dura-Mill and make them part of Sandvik Coromant," added Nadine Crauwels, President of Sandvik Coromant. "Dura-Mill is a world class manufacturer of solid round tools for the metalworking industry, serving industries like aerospace, automotive, power generation and medical. I am convinced that our combined knowledge in products and solutions will greatly benefit our customers."

Richard Walrath, CEO and Founder of Dura-Mill, added, "We are extremely excited about our new association with Sandvik Coromant who, as a global leader in Advanced Engineered products with special emphasis on tools and tooling systems, can now provide Dura-Mill access to a number of resources commonly required to continue to develop and launch select type products targeting growth opportunities worldwide."

In 2017, Dura-Mill reported revenues of $7.2 million. The transaction is expected to close before the end of 2018, with both parties having agreed not to disclose the purchase price.

www.sandvik.coromant.com
www.duramill.com

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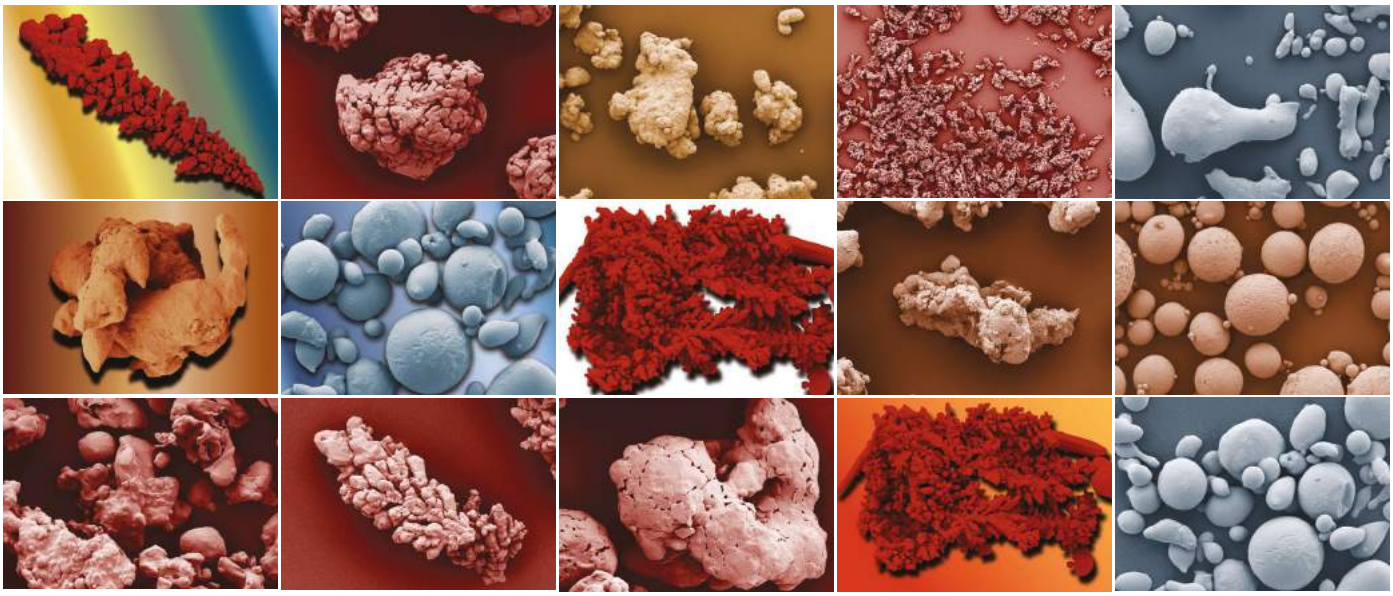

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www.makin-metals.com

Kennametal announces strong fiscal 2019 first quarter results

Kennametal Inc., headquartered in Pittsburgh, Pennsylvania, USA, has reported strong results for its fiscal 2019 first quarter ended September 30, 2018. Sales were reported at $587 million, compared with $542 million in the prior year quarter, an increase of 8%, driven by 10% organic growth and partially offset by a 2% unfavourable currency exchange impact. Sales were said to have grown in all segments and regions.

"We delivered strong first quarter results. The continued progress on our strategic initiatives of growth and simplification/modernisation, coupled with the ongoing strength of our end markets delivered significant year-over-year improvement in almost all facets of our business," stated Chris Rossi, President and Chief Executive Officer. "In addition to capitalising on healthy market conditions, we focused on strategically investing in our simplification/modernisation initiative where we can improve our customer service and increase productivity."

Operating income was reported to be $83 million, or 14.2% margin, compared to $52 million, or 9.6% margin, in the prior year quarter. Adjusted operating income was $84 million, compared to $59 million in the prior year quarter. Industrial segment sales of $321 million increased 8% from $297 million year-over-year, reflecting organic sales growth of 10%. Operating income was $59 million, compared to $32 million in the prior year quarter. Adjusted operating income was $59 million, compared to $36 million in the prior year quarter.

Widia sales of $49 million increased 8% from $45 million year-over-year, driven by organic sales growth of 11%. Operating income was $2 million, compared to operating loss of just under $1 million in the prior year quarter. Adjusted operating income was $2 million, compared to less than $1 million in the prior year quarter. The increase in adjusted operating income was driven primarily by organic sales growth.

Infrastructure sales of $217 million increased 9% from $200 million year-over-year, driven by organic sales growth of 10%. Operating income was $24 million, compared to $20 million in the prior year quarter. Adjusted operating income was $25 million, compared to $22 million in the prior year quarter.

www.kennametal.com

Johnson Electric reports growth in sales for first half 2018

Johnson Electric Holdings Limited, Hong Kong, has announced its results for the six months ended September 30, 2018. Following a record net income in the previous full year results, the company reported further growth in the first half of the 2018/19 financial year, posting total group sales of $1,678 million for the period, up 9% compared to the first half of the prior financial year.

Excluding the impact of acquisitions and foreign exchange rate changes, underlying sales increased 7%. Net profit attributable to shareholders was essentially unchanged year-on-year at $140 million. "Johnson Electric continues to deliver healthy top line growth from both of its Automotive Products and Industry Products divisions. The long term shifts towards more electrified, more controllable and more connected end-products underpin demand for our motion technologies and solutions," the report stated.

The Automotive Products Group (APG), excluding acquisitions, increased sales by 8% on a constant currency basis compared to the first half of the prior year. The strongest business unit performances came from automotive PM parts maker Stackpole International, Powertrain Cooling and Engine & Transmission Management, which are benefiting from the ramp-up of major customer programmes for a new generation of products.

APG's strong overall sales performance was reported to come against a subdued picture in terms of global automotive industry volume growth. North American light vehicle production grew by less than 1% during the period under review, as rising interest rates and higher vehicle prices have begun to impact demand. In Europe, production volumes rose by just over 1% and there has recently been a reduction in output, following the introduction of new emissions tests, that has caused significant delays to the launch of new vehicle models. It was also stated that in China, which has been the world's largest growth market for automobiles for the past decade, production growth slowed in the first half of the year to below 3%.

Commenting on the results, Dr Patrick Wang, Johnson Electric's Chairman and Chief Executive, stated, "Johnson Electric achieved satisfactory financial results for the six month period ended September 30, 2018, in the context of an increasingly challenging global operating environment. In the near term, the indications are that many of the factors that shaped the performance of the business in the first half of the financial year are set to continue in the second half – but with an increasing downside risk with respect to the global economy. Order volumes in China and Europe remain somewhat below anticipated levels, though the outlook for second half sales for the group as a whole currently looks broadly similar to the first half."

www.johnsonelectric.com


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Euro PM2019 heads for the Netherlands, issues Call for Papers

Euro PM2019 heads to Maastricht (Courtesy EPMA)

The EPMA has issued a Call for Papers for Euro PM2019, the association's annual Powder Metallurgy Congress and Exhibition, taking place in Maastricht, the Netherlands, October 13-16, 2019. According to the EPMA, Euro PM2019 is set to feature a world-class technical programme as well as a 5000 m^2 exhibition, showcasing the latest developments from the global PM Supply Chain

The Euro PM2019 Congress and Exhibition, along with social events such as the welcome reception and congress dinner, is expected to provide excellent networking opportunities for those within the PM industry.

The conference programme of plenary, keynote, oral and poster presentations will focus on all aspects of Powder Metallurgy, including PM structural parts, Additive Manufacturing, hard materials and diamond tools, Hot Isostatic Pressing, Metal Injection Moulding, new materials, processes and applications.

Authors are invited to submit abstracts of papers for presentation in the Technical Programme. These should be of original and unpublished work, with all abstracts submitted using the EPMA's online submission form by no later than January 23, 2019. The EPMA states that abstracts must be between 100-150 words in length and give sufficient information to allow the Technical Programme Committee to evaluate the proposed presentation.

www.europm2019.com

Ametek India opens $2.5 million Technology Solutions Centre

Ametek, Inc., headquartered in Berwyn, Pennsylvania, USA, has invested $2.5 million in a new Technology Solutions Centre at its Ametek Instruments (India) Pvt. Ltd. facility in Whitefield, Bangalore, India. The new centre will offer support to customers in designing new products, selecting the right equipment to meet their application needs, servicing and calibrating devices as well as providing hands-on demonstrations and training.

The Technology Solutions Centre is equipped with products from nearly thirty Ametek businesses. It showcases the company's aerospace, factory automation, imaging, power management, process analysis, test and measurement, and precision manufacturing instruments, along with a range of advanced motion control and speciality metal products.

"We are very pleased with our new Technology Solutions Centre. It represents a significant expansion of our technical and support capabilities in India and reflects the importance of our growing customer base in India," stated Milind Palsule, Ametek's Managing Director for India and the Middle East. "We now can provide customers with a wider range of services and support, including product demonstrations, training seminars and application workshops, along with factory-direct service, repair and support."

At the opening event, guests were given a walk-through of the new centre and provided with live demonstrations of Ametek's latest products and technologies. Among Ametek India's customers are said to be many of India's leading companies in aerospace, automotive manufacturing, energy production, glass, metal and steel processing, industrial and academic research, ultra-precision manufacturing and other high technology fields.

www.ametek.com

IOM3 makes plans for anniversary

The UK's Institute of Materials, Minerals and Mining (IOM3) has announced a programme of events to celebrate the 150th anniversary of its founding as the Iron and Steel Institute in 1869. The Iron and Steel Society, a division of IOM3, has taken the lead in putting together a programme of events to mark this important year in the history of the Institute.

The calendar of events includes an Inauguration Day on the exact date of the first official meeting of the Iron and Steel Institute, a series of technical conferences, social events, Younger Member events, local society events and associated activities such as a special anniversary issue of *Materials World*, a photographic competition and a virtual exhibition.

Full details will be announced on the IOM3's 150th anniversary microsite as they become available.

www.iom3.org/150

SMP releases EMC filters with high frequency stability

SMP Sintermetalle Prometheus GmbH & Co KG (SMP), Graben-Neudorf, Germany, a developer and manufacturer of inductive components, filter systems, magnetically soft materials, cores and mouldings, has released a new range of EMC filters with high frequency stability. These specifically-developed materials are said to be effective for frequencies up to the gigaHertz range.

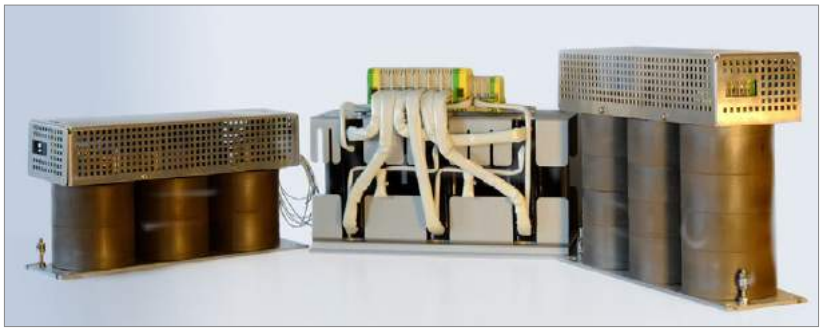
EMC filters reduce interference currents generated by parasitic effects and cyclic elements in power converter systems. The material plays an important part in achieving stable inductance over the entire frequency spectrum in order to maximise interference suppression. Compared with standard technologies, which use materials such as ferrite, electrical steel sheets and nanocrystalline metal sheets, interference levels with the new EMC filters from SMP can be as much as 40 dB[μV] (decibel microvolt) lower.

SMP's new EMC filters are reported to be compact, up to 30% lighter, and noiseless, being made from magnetostriction-free materials. The overall efficiency of the system is improved due to very low losses through the materials and, moreover, fewer filter components are needed, so volume is reduced and the cost-effectiveness of the power electronic system as a whole is significantly increased. The filters can be manufactured with single or magnetically coupled chokes, and so offer a choice for reducing common mode and differential mode interference.

SMP specialises in the development and manufacture of customer-specific filter systems and inductive components. The company's component portfolio is designed for currents of up to 2000 A, up to 3000 A for special applications, and for frequencies up to the gigaHertz range. The materials used in the new EMCs have been developed and manufactured by SMP specifically for this purpose, and have high saturation induction of up to 2 Tesla.

Individual EMC components can be produced with dimensions from 19–300 mm and weights of 0.05–130 kg, and the temperature class H (up to 180°C) insulation system is UL certified. Depending on the application, protection ratings up to IP66 are available, and HL classes according to EN 45545 can be specified depending on the requirements.

www.smp.de



Two EMC filters and a three-phase choke module from SMP (Courtesy SMP Sintermetalle Prometheus GmbH & Co KG)

Registration opens for EPMA's Hot Isostatic Pressing seminar

Registration is now open for the European Powder Metallurgy Association (EPMA)'s Hot Isostatic Pressing (HIP) Seminar, which will take place in Sint-Niklaas, Belgium, February 11–12, 2019. The deadline for registration is January 9, 2019.

Hot Isostatic Pressing is a process to densify powders and sintered parts in a furnace at high pressure and high temperatures. The applied pressure provides isostropic properties and 100% densification, which has become a viable and high performance alternative to conventional processes such as forging, casting and machining in many applications. Hot Isostatic Pressing is a competitive and proven manufacturing process for the production of complex and highly specified components, particularly in sectors that have highly demanding environments such as aerospace, offshore, energy and medical.

The 2019 seminar is titled 'Conventional HIP and Rapid Cool HIP: Developments in Material Property and Microstructural Relationships.' The seminar programme will feature presentations and case studies from industry experts, as well as a site visit to Engineered Pressure Systems International (EPSI) in Temse, Belgium.

The programme currently includes presentations from the following organisations:

- University of Birmingham
- Burgundy University
- IWM at RWTH Aachen University
- SMR Premium GmbH
- Linde
- Quintus Technologies AB
- University West (Sweden)
- SPM
- Bochum Univerty
- EPSI

www.seminars.epma.com/hip-2019

Dritev – Drivetrain for Vehicles congress set for July 2019

The VDI Transmission Congress 'Dritev – Drivetrain for Vehicles 2019', organised by VDI Wissenforum GmbH, will take place in Bonn, Germany, July 10-11, 2019. The congress is set to address current developments and challenges in the vehicle drivetrain industry, from electrification to Noise Vibration Harshness. Comprising a programme of lectures and parallel events, the show is expected to host more than 1,500 delegates, around 100 international exhibitors and 80 specialist speakers, making it what is believed to be one of the largest networking platforms for automotive powertrain and transmission development.

Noise Vibration Harshness (NVH) will be a special thematic focus at Dritev 2019. NVH refers to both audible and tactile vibrations in motor vehicles in the range from 20–100 Hz, and Dritev will showcase how innovative analysis techniques can be used to identify and reduce these vibrations. Another special topic will be the increase in powertrain power density, and the use of new materials and procedures to aid with this development.

Other topics up for discussion during the congress will include transmission and powertrain, future-oriented drive systems and concepts, transmission components, innovative materials and development methods, as well as the potential for optimisation in transmission manufacturing.

At the accompanying VDI specialist conference 'Powertrain Solutions for Commercial Vehicles', numerous powertrain development experts from Germany and abroad will discuss drive and transmission concepts, market development and possible operating strategies. In addition, the international VDI conference 'EDrive' will run parallel to Dritev, providing an in-depth look at the systemic and component-related development of electrified powertrains.

www.vdi-wissensforum.de

Around 100 international companies exhibited at Dritev 2018

International Conference on Powder Metallurgy in Asia heads to India

Registration is now open for the 5th International Conference on Powder Metallurgy in Asia, APMA 2019, which will be held from February 18-21, 2019, at the JW Marriot Hotel in Pune, India. The event is this year being hosted by the Powder Metallurgy Association of India (PMAI) and will welcome delegates from Asia and around the world.

APMA 2019 will be India's largest ever conference on Powder Metallurgy and particulate materials. The conference will showcase the capabilities of the PM industry through technical papers offering updates on research, industry developments and trends across the PM supply chain.

The all topic conference programme will be supported through a number of focused special interest seminars. The seminars include:

- Industrial PM (press & sinter) technology for auto, electrical and machine parts
- Powder Injection Moulding (PIM)
- Additive Manufacturing (AM)
- Hard metals & diamond tools
- Development of materials & alloys for emerging applications.

In the accompanying exhibition hall, PM parts manufacturers and suppliers of materials, services and equipment to the PM industry will showcase their goods and services, with many exhibiting in India for the first time. The PMAI stated that it also hopes to secure the attendance of a number of OEM buyers and key industry influencers.

APMA 2019 will be held at the JW Marriot Hotel in Pune, India

A number of social events will be organised for participants along with a gala dinner, sure to make APMA 2019 a truly memorable event. Delegate registration is available via the conference website, with discounted rates for academic and student registrations.

www.apma2019.com

Atomisation course set for March 2019 in UK

Andrew Yule, Emeritus Professor, Manchester University, UK, and John Dunkley, Chairman of Atomising Systems Ltd, Sheffield, UK, will hold the 12th edition of their popular Atomization for Metal Powders course on March 14–15, 2019, in Manchester, UK.

The intensive two-day course combines up-to-date practical information with theory and is expected to be of value to engineers working both in metal powder production and research & development. All current atomiser types will be covered for most metals, powder types and uses.

The course will also cover key instrumentation, essential theory and computer modelling, and look in-depth at plant design, operation and economics across the entire process chain, from melting to cooling, drying, dewatering, sieving, conveying, feeding and more.

An iron powder atomiser (Courtesy Atomising Systems Ltd)

To date, Yule and Dunkley's metal powder atomisation courses have been attended by 330 registrants from sixteen countries. A reduced discount rate is available for registrations before January 10, 2019. A discount is also available for multiple bookings from the same company.

www.cpfresearch.com/courses/amp-course

Aubert & Duval at professional motorsport show

Aubert & Duval, Paris, France, showcased its range of high-performance metals for the motorsport and automotive markets at the Professional MotorSport WorldExpo, Köln, Germany, November 7–9, 2018. The company supplies metal powders and HIPed parts, as well as bar products and die forgings. Its range includes high-speed steels, nickel and cobalt base alloys, titanium alloys and stainless steels.

Aubert & Duval has a history of partnering with customers to develop solutions for the motorsport market. Its latest solutions are said to address increasing demands for environmental friendliness, performance, reliability and cost.

www.aubertduval.com

EPMA Fellowship Award Winners named at Euro PM2018

The European Powder Metallurgy Association (EPMA) announced the recipients of its second annual Fellowship Award at Euro PM2018, held in Bilbao, Spain, October 14-18, 2018. The EPMA Fellowship Award recognises individuals in the scientific and/or academic community for significant contributions to the development of the Powder Metallurgy industry.

This year's recipients were Professor Paul Beiss, IWM – RWTH Aachen, Germany and Professor Dr Herbert Danninger, Technische Universität Wien, Vienna, Austria.

Professor Paul Beiss

Professor Beiss is a Graduate of Mechanical Engineering from RWTH Aachen, where he studied with a focus on production engineering until 1972, writing his doctoral thesis on copper extrusion. He became a professor for metallic materials in mechanical engineering at RWTH Aachen in 1994.

Beiss is a Fellow of the American Powder Metallurgy Institute and has been active with the EPMA since 2004, especially within the EPMA's EuroPress&Sinter sectoral group and RET working group.

Professor Dr Herbert Danninger

Professor Dr Danninger completed his doctoral thesis, titled 'Influence of the Manufacturing Parameters on the Properties of Tungsten Heavy Alloys', at the Institute for Chemical Technology of Inorganic Materials, in 1980. He was appointed as a full professor for chemical technology of inorganic materials in 2003.

Professor Paul Beiss (left) and Professor Dr Herbert Danninger (right) received the 2018 EPMA Fellowship Award (Courtesy EPMA)

In January 2016, Danninger was awarded the Doctor honoris causa of Universidad Carlos III de Madrid, Spain. He has been active with the EPMA since 2004, within the EuroHIP, EuroMIM, EuroAM and EuroHM sectoral groups and the EPMI working group.

www.europm2018.com

Seco/Warwick enters Japan precision tool steels market with custom vacuum furnace

Seco/Warwick, Swiebodzin, Poland, has developed a custom precision vacuum furnace system designed to meet the expectations and standards of an unnamed customer in the Japanese precision tool steels component market. This specialised system is said to reduce energy consumption through power optimisation and cycle time reduction, and is customised to work within the tight physical space limitations of the Japanese facility.

Maciej Korecki, VP, Vacuum Heat Treatment Furnaces at Seco/Warwick, stated, "Even though this is the first vacuum heat treatment furnace that we've introduced into the Japanese market, Seco/Warwick Group has been active in Japan for many years, delivering solutions from different product segments, for example, vacuum melting furnaces. Being present in this market enabled Seco/Warwick to better understand local needs."

Seco/Warwick manufactures a range of furnaces for numerous applications

"In terms of heat treatment processes, we already had the furnace that the client needed," he continued. "However, because the traditional solution was too big and did not fit the customer's tight physical space limitations, our engineers customised the furnace and created one that fits the limited manufacturing space perfectly. Transforming a horizontal furnace door into the special system of vertical opening and lifting was the secret sauce, keeping outstanding thermal process performance, especially with regard to quenching control."

Seco/Warwick's precision vacuum technology loading systems will be integrated into the customer's existing line, proving additional capacity within the same space and meeting customers' requirements for equipment footprint as well as production.

www.secowarwick.com

PM industry executives form PKPM Advisory Group

Rocco Petrilli, PRIMA Business Specialist, LLC, and Dr Michael Krehl, MTSG Consulting, have announced the formation of PKPM Advisory Group. The group will provide professional, commercial and technical consultation to the global Powder Metallurgy industry.

The group's founders stated that, like many global manufacturing fields, the PM industry is presently challenged by a shortage of the knowledge and experience required to maximise the technology's potential, in addition to an absence of university-based curricula. Because of this, it was stated, "there has been a perpetual recycle of top industry human capacity to satisfy (temporarily) these growing company needs. Additionally, given the retirement of many of the industry pioneers, the availability of true business and technology specialists for consultation has also diminished."

Both Petrilli and Dr Krehl have been employed in management positions in the PM industry and are said to be experienced in all aspects of the business. "Success in a PM business is so much about the people and their know how," stated Dr Krehl. "PKPM will apply its unmatched combined expertise to create swift and effective problem solutions to its global clients' most challenging needs."

PKPM will serve clients in the areas of strategy development/execution, manufacturing, sales marketing and business development, R&D, talent acquisition and retention. One speciality of PKPM will be advisory services involving mergers and acquisitions, including the valuation of acquisition targets, planning and execution of due diligence processes, and integration of the new enterprise.

"The combination of MTSG and PRIMA provides the PM world with the most capable consulting and advisory services in its history," added Petrilli. "PKPM looks forward to working with the most progressive PM players to advance their strategic growth objectives at a much faster and more effective rate."

Contact: rpetrilli@ppspi.com
michael.krehl@mtsg-consult.com

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(2) Magnetic materials mould;
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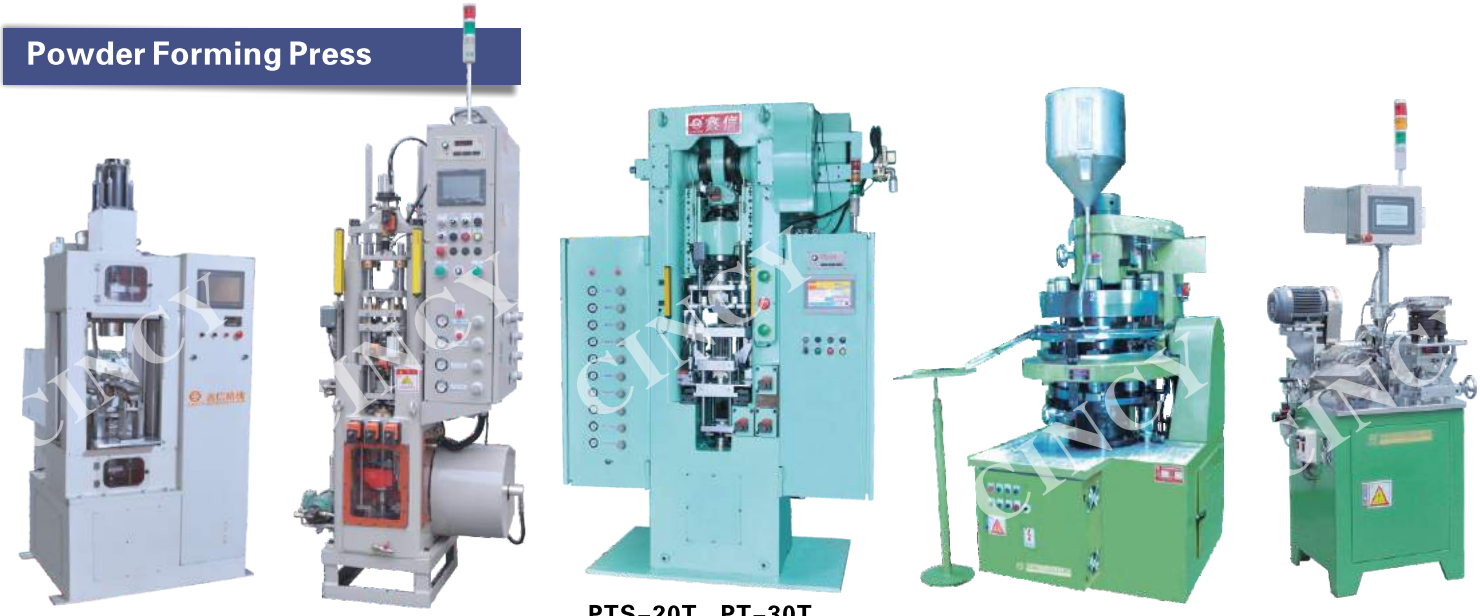
(4) Carbon brush、pharmaceutical mould;
(5) Inductors integrally molding mould;
(6) Metal or ceramic injection mould (MIM、CIM);
(7) Precision plastic or die casting mould;
(8) Cold forging mould;
(9) CNC powder molding press;
(10) Rotary type powder molding press;
(11) Upright type powder molding press;
(12) DR、square machining machine;
(13) Automation equipment;
(14)Fixtures, jigs, gauges;
(15) Diamond grinding wheel、alloy core cutter blade (NR series);
(16) Superhard alloys materials parts manufacture;
(17) Auto parts and other precision parts processing.

Powder Metallurgy Mould

Powder Forming Press



CC-CNC-5T~100T Servo Press Series

PB-3T、PB-6T Powder Forming Press

PTS-20T、PT-30T PT-40T、 PT-60T Powder Forming Press

Rotary Type Powder Forming Press

Multi-function Processing Machine

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EPMA names winners in its 2018 Powder Metallurgy Component Awards

During the opening Plenary Session at the Euro PM2018 Congress and Exhibition, Bilbao, Spain, October 14–18, 2018, the European Powder Metallurgy Association (EPMA) revealed the winners of its 2018 Powder Metallurgy Component Awards. The awards are open to companies who manufacture components made by the following Powder Metallurgy processes:

- PM Structural (including Hard Materials and Diamond Tools parts)
- Additive Manufacturing
- Hot Isostatic Pressing (HIP)
- Metal Injection Moulding (MIM)

The winners of this year's Powder Metallurgy Component Awards are as follows.

PM Structural Component award

The winner in the PM Structural Component category was Gevorkyan, s.r.o, Vlkanová, Slovakia, for a driving flange designed in cooperation with a leading power tools producer (Fig. 1). According to its designers, the part is brand new and has never been produced using any other technology.

The part was originally developed for CNC machining from conventional bars, however, by adopting PM technology for its production, Gevorkyan stated it was able to achieve a significant reduction in price in comparison to machining. The driving flange is compacted on a CNC hydraulic press using all three upper axes and all four lower axes. To ensure a high hardness for the surface layer and tough core of the part, case hardening is also used. CNC turning is then used to ensure a precise internal diameter, and CNC milling used to create four counter bars for screws.

The company stated that it expects to spread the concept globally in the coming years, and aims to completely replace the older generation of flanges with the new design.

Additive Manufacturing award

The award in the Additive Manufacturing category was presented to Rosswag GmbH, Pfinztal, Germany, for its Forgebrid® process (Fig. 2). The production method combines open die forging and Laser Beam Powder Bed Fusion (LB-PBF) processes, benefitting from the advantages offered by each process. To manufacture a component, a basic body is conventionally forged and machined to produce a plane surface. Onto this surface, the functionally optimised section of the component is added using LB-PBF.

Using this combined method enables Rosswag to preserve resources and thus save production costs, in addition to reducing machining time and the consumption of coolants and lubricants. Moreover, the material remnants produced during sawing and forging of the component base can be recycled into metal powder for use in the Additive Manufacturing process.

Rosswag stated that the forged component area offers excellent mechanical-technological properties, especially with regard to fatigue strength. The complex segments of the part, produced by metal AM, are then manufactured in such a way as to add value which could not be achieved by conventional manufacturing. The hybrid production process is therefore an ideal method to meet safety requirements and still achieve functional optimisation of the component.

Fig. 1 Gevorkyan, s.r.o received the PM Structural Component award for a driving flange (Courtesy EPMA)

Fig. 2 Rosswag GmbH received the Additive Manufacturing award for its Forgebrid® component (Courtesy EPMA)

Fig. 3 An award was presented for this near-net shape reactor coolant pump impeller (Courtesy EPMA)

Fig. 4 AMT PTE Ltd received the MIM award for its one piece nozzle for automotive applications (Courtesy EPMA)

Hot Isostatic Pressing award

The development of a near-net shape component for use in the nuclear power sector was the winner in the Hot Isostatic Pressing (HIP) category. The component, a reactor coolant pump impeller (Fig. 3), has a large dimension and complex geometry, which both pose significant production challenges.

Such components with large, complex shapes, were traditionally manufactured by casting, but the lifetime of these products is limited due to the ageing of the material. Alternative approaches, consisting of machining impellers from forged ingots, offer an improvement of the mechanical characteristics. However, in the case of a reactor coolant pump impeller (RCP) produced in this way, it is necessary to start with a 4000 kg ingot to finish with a 600 kg impeller, resulting in 85% material wastage.

On the basis of this, a consortiu- composed of Framatome, Aubert & Duval, Ventana Group, Metalscan and institutional laboratories (Université de Bourgogne, ARTS and CEA) established the manufacturing sequence for a large-dimension impeller in 316L austenitic stainless steel by means of PM HIP processes with a near-net shape (NNS) approach.

The tooling of this impeller has been designed by 2D/3D simulation and then is machined in low carbon steel elements. Once assembled and welded, the low-carbon steel container is filled with 316L powder and HIPed. After the HIP cycle, a rough machining is performed to open hydraulic channels and facilitate the chemical pickling. This approach aims at reducing the machining and finishing operations after HIP as much as possible, in particular on the blades of the impeller, thereby limiting the final cost of the part and reducing the production time.

The part produced exhibited the expected geometric features (+/- 2 mm), fine grain size (around 50 µm) and isotropic microstructure and excellent mechanical properties (R_p0.2=290 MPa, R_m=580 MPa, A%=57).

Metal Injection Moulding award

The award for a metal injection moulded component was presented to AMT PTE Ltd, Singapore, for its one piece nozzle for automotive applications (Fig. 4). The judges stated that the MIM nozzle featured a good finish with complex internal channels and was manufactured in a sustainable and economical way. The product was said to have opened up an entirely new application for MIM process capability, and AMT stated that it was the most complex part that it has produced to date.

Development efforts for the component focused on controlling the distortion of the plastic inserts during MIM, as the high injection pressure and temperature could greatly affect the insert integrity. The challenge was to maintain a high packing pressure in the inner core channel, as any loss in pressure could lead to weakness and result in cracks.

Identifying the ideal injection parameters for a good overall part was said to be highly challenging. In addition, the tip of the nozzle, the diameter of the hole and the gap surrounding it were all controlled in the micron range, and produced using MIM without secondary operations. These critical features were achieved to a high definition.

The one piece nozzle is applied in a Selective Catalytic Reduction (SCR) system for commercial vehicles in Europe to comply with the Euro 5 and Euro 6 standards. The undercut internal channel of the part can reportedly only be produced using AMT's patented In-Coring™ technology and is thus specially designed for MIM processing. Compared to the production of a similar part of a corresponding quality and finish by conventional machining and brazing, AMT reported a reduction in costs of up to one third.

www.epma.com

EPMA PM Thesis Competition 2019 now open for submissions

The European Powder Metallurgy Association has launched its 2019 Powder Metallurgy Thesis Competition, sponsored by Högänas AB, and is accepting entries via its website. The deadline for submissions is April 24, 2019.

This competition is open to all graduates of a European University whose theses have been officially accepted or approved by the applicant's teaching establishment during the previous three years. Theses, which must be classified under the topic of Powder Metallurgy, are judged by an international panel of PM experts drawn from both academia and industry.

The aim of the competition is to develop interest in and promote PM among young scientists at European academic institutions, and to encourage research at undergraduate and postgraduate levels.

The PM Thesis competition winners will be awarded prizes of €750 and €1,000 for Masters and Doctorate levels respectively, sponsored by Högänas AB, complimentary registration to the Euro PM2019 Congress & Exhibition courtesy of the EPMA, and the opportunity of to have their work published in the scientific journal *Powder Metallurgy*

www.epma.com

Freeman Technology releases revised ebooks on powder tester selection

Freeman Technology, Tewkesbury, UK, has issued revised versions of two of its eBooks on powder tester selection. 'Choosing a Powder Tester' reviews the technology available on the market and has been updated to include recent innovations such as uniaxial powder testing, while 'The Value of Powder Testing' considers how test data can deliver an economic return, and now extends to an assessment of the benefits of real-time measurement.

Powder testing techniques range from the simple to the sophisticated, with the cost of a tester running up to tens of thousands of pounds. Understanding the strengths and limitations of different techniques and testers is therefore essential when it comes to choosing one that cost-effectively meets requirements, states Freeman.

Powder testers vary significantly in terms of their ability to deliver data that is relevant and sufficiently sensitive to solve regularly encountered problems, whether in R&D or manufacturing.'Choosing a Powder Tester' covers the majority of testing techniques in routine use, including all USP methods. The latest edition also includes avalanche methods and uniaxial testing, a technique that ranks powder flowability in an analogous way to shear cell testing, but using a simpler and more direct method.

The results of powder testing can include faster progress in R&D, secure identification of a cheaper raw material, effective troubleshooting of a process problem and/or higher product quality, all of which are associated with tangible economic benefits. Freeman's 'The Value of Powder Testing' explains how to estimate the payback on testing, with the latest edition also including a case study based on the use of in-line powder flow monitoring.

Both eBooks are available to download free of charge via Freeman's website, along with the company's introductory guide, 'An Introduction to Powders'.

www.freemantech.co.uk

AMRC training courses highlight fundamentals of metallurgy

The Advanced Manufacturing Research Centre (AMRC) Training Centre, Rotheram, Yorkshire, UK, is set to run two training courses on the fundamentals of metallurgy for professionals with little or no background in metals or materials science. The courses, 'Fundamentals of Metallurgy' and 'Metallurgy for Non-Metallurgists' are to be offered on multiple dates for the year ahead.

Metallurgy for Non-Metallurgists

This two-day course aims to provide a sound understanding of the scientific principles of metallurgy and how to apply them to specify and process metals in an industrial context. The next courses take place:

- February 26–27, 2019, at the AMRC Training Centre
- March 26–27, 2019, at the MTC
- June 11–12, 2019, at the AMRC

Fundamentals of Metallurgy

This one-day course provides an introduction to the principle alloy categories and their applications. It also explains the properties of metals, how they are tested, how metal products are made and where they are used.

The course forms one module of the 'QCF Level 3 Certificate in Metallurgy' qualification. The next courses take place:

- January 8, 2019, at the AMRC Training Centre
- March 13, 2019, at ImechE, London, UK
- May 14, 2019, at the AMRC
- May 16, 2019 at the MTC
- October 9, 2019, at the ImechE

www.amrctraining.co.uk

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EPMA reflects on a successful Euro PM2018

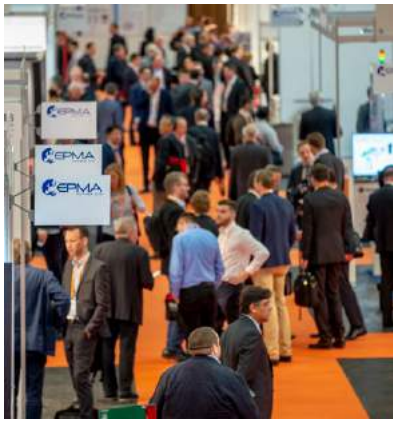
The European Powder Metallurgy Association (EPMA)'s Euro PM2018 Congress & Exhibition was held in Bilbao, Spain, from October 14–18, 2018. The event once again attracted a wide range of participants from the international Powder Metallurgy industry to discuss the latest industry trends and technological innovations. According to the EPMA, this year's event drew participants from more than fifty countries around the world. Over three-hundred oral and poster presentations were given during the event, and more than 1,100 participants attended the conference and exhibition, where over one-hundred booths hosted exhibitors from across the PM supply chain.

Speaking on the event's success, Dr Olivier Coube, EPMA Technical Director, stated, "Euro PM2018 represents a turning point of our annual congress and exhibition in terms of size, with 50% more presentations versus 2017, including a 40% increase in metal Additive Manufacturing content, and at the same time an enlarged programme for conventional PM technologies, which remain the backbone of our industry."

Lionel Aboussouan, EPMA Executive Director, added, "Bilbao was a great location and made for a thriving event. The enlarged technical programme and extended exhibition opening times helped to attract a diverse range of companies and sectors that want to learn more about what PM can do for their applications and industries."

For the fifth year, Euro PM2018 hosted the EPMA's Young Engineers Day, which enabled students from five universities to attend the event for an intensive two-day programme and gain an understanding of what a career in the PM industry can offer. Euro PM2018 gave the opportunity for each of the EPMA's Sectoral Groups to hold their meetings alongside the technical sessions. The metal Additive Manufacturing group, EuroAM, celebrated its five-year anniversary during the event, with a well-attended session on new and innovative AM-related processes, a review of the past and future works and challenges for the group, and the third Metal AM Trends Survey.

The hardmetals group, EuroHM, invited keynote speakers to give an update of the growing Spanish hardmetals community, while the press & sinter group, EuroPress&Sinter, used its session for a discussion on possible ways to improve the technology and the relationship between industry and academia. The Hot Isostatic Pressing group, EuroHIP, and Metal Injection Moulding group, EuroMIM, also met during the event.



The Euro PM2018 exhibition (Courtesy EPMA)

In addition, a new functional materials group, EuroFM, was established with the aim of representing materials that are used in functional applications such as electric cars and battery systems.

www.epma.com

Atlas Pressed Metals showcases Powder Metallurgy during National Manufacturing Day

Atlas Pressed Metals, a producer of Powder Metallurgy parts based in DuBois, Pennsylvania, USA, has been working to promote job awareness in manufacturing through participation in this year's US National Manufacturing Day, held on October 5. Atlas was one of ten manufacturers on-hand at Penn State DuBois, offering an insight into Powder Metallurgy process and the skills needed for a career in PM to around two-hundred visiting university and high school students.

Sponsored by the Manufacturers Extension Partnership (MEP), a US federal programme offered through the National Institute of Standards and Technologies, Manufacturing Day is an opportunity for manufacturers to showcase how things are made, and the various jobs available in manufacturing; it is intended to "energise the future pipeline" of skilled workers, according to the MEP's website.

Craig Stringer, PhD. Materials Science, and Senior Metallurgical Engineer at Atlas, along with Marty Timm, Atlas Manufacturing Manager, discussed the Powder Metallurgy manufacturing process with the students. They also brought along a collaborative robot to show the students how humans and machines work together in an automated manufacturing setting.

"We always try to build some excitement into our display to draw attention to our booth, but our message is aimed to get students to think about careers in manufacturing," stated Erin Heath, Business Development Manager at Atlas Pressed Metals. "Skilled laborers, technicians, engineers, and specialised and experienced operators are in high demand. The work is rewarding, and the pay is competitive in this region. There are great jobs available in manufacturing."

www.atlaspressedmetals.com

Fritsch launches new Pulverisette 5 premium line planetary mill

Fritsch GmbH's Milling and Sizing division, Idar-Oberstein, Germany, has introduced its new planetary mill, the Pulverisette 5 'premium line'. The new planetary mill is the next size up from the company's previous Pulverisette 7 'premium line', and features two grinding stations for bowls between 125–500 ml volume. It offers 2.2 kW drive power and centrifugal acceleration up to 64 g at 800 rpm, with a rotational speed of 1600 rpm for the grinding bowl.

The Pulverisette 5 is capable of grinding sample quantities of up to 450 ml at a maximum feed size of 10 mm, and is said to be ideal for wet and dry grinding of hard, medium-hard, soft, brittle and moist samples, as well as for mechanical alloying, mixing and homogenising. According to the company, it produces reliable results down to the 'nano range'.

Fritsch's new Pulverisette 5 'premium line' planetary mill enables safe and easy insertion of grinding bowls into the mill (Courtesy Fritsch GmbH)

The new planetary mill has been designed to make small-scale grinding operations easy and safe. It incorporates a guided insertion mechanism to ensure the correct insertion of grinding bowls, and incorporates a safety mechanism for secure automatic clamping of grinding bowls within the mill. ServoLOCK is a user-independent, motor-driven locking mechanism designed to ensure that both the mill, the member of staff using it and the plant are protected during grinding.

In addition, if the machine detects an operating state not permitted for safety or quality, it will block grinding operations from beginning, and if an imbalance is detected during grinding it will shut off automatically. Depending on the material of the grinding bowl itself, which is detected via RFID chip, it is also said to automatically prevent users from setting grinding speeds which are too high for safety or for good results.

www.fritsche.de

MPIF and APMI award-winning papers announced

The Metal Powder Industries Federation (MPIF) has announced the winner of its 2018 Howard I Sanderow Outstanding Technical Paper Award, selected from manuscripts presented at POWDERMET2018 in San Antonio, Texas, June 17-20, 2018. This year's winning paper is 'Monitoring of Powder Homogeneity During Double-Cone Blending', by Alex Wartenberg, Sierra Mirtes, and Chris Schade, GKN Hoeganaes, and Sarah Ackermann, C-Therm Technologies Incorporated.

The paper is published in the conference proceedings, Advances in Powder Metallurgy & Particulate Materials–2018, which can be found by visiting the MPIF Publications portal. The paper itself is available on the Outstanding Technical Paper Award page on the MPIF site.

The Howard I Sanderow Outstanding Technical Paper Award (renamed in 2009), was established in 1993 to recognise authors of manuscripts for excellence in scientific and technical written communications. The authors will receive their award plaques during POWDERMET2019, June 23–26 in Phoenix, Arizona, USA.

APMI International, the American Powder Metallurgy Institute, has named the winner of its Excellence in Metallography Award. For this award, APMI International selects a winning technical paper to recognise individuals responsible for excellence in the metallography used in scientific and technical written communications.

This year's winning paper is 'Comparison of Binder Jetting Additive Manufacturing to Press and Sinter 316L Stainless Steel' by Alexander Zwiren, Thomas F Murphy, GKN Hoeganaes. The winning paper is available to read on the APMI International website.

www.mpif.org | www.apmiinternational.org

The effect of nitrogen content and cubic phase composition on the structure of cemented carbides

The influence of nitrogen content and total cubic phase content on the thickness of the gradient layer, as well as the chemical composition of surface layers, of cemented carbides was discussed by Shequan Wang and colleagues in a presentation [1] at the WorldPM2018 Congress in Beijing, China, September 16-20, 2018.

Outlining the presentation, it was stated that functionally graded hardmetal WC-Co-(Ti, Ta, Nb)CN, with a cobalt enriched and cubic phase depleted gradient layer, has been researched extensively by many scientists over the years. Due to the improved toughness of Chemical Vapour Deposition (CVD) coated inserts, and the prevention of cracks from propagating into substrates, the gradient tough surface zone enhances cutting tool lifetime greatly during metal working.

The author added that much work has also been published on the core mechanism of fcc-free layer formation. It has been shown that strong thermodynamic coupling between nitrogen and titanium promotes titanium diffusing in the direction opposite to the nitrogen concentration gradient. Nitrogen diffuses out from the material surface and titanium, along with other elements (Ta, Nb, etc), diffuses towards the interior of the alloy where higher nitrogen potential is kept. This results in liquid cobalt filling the vacancies.

However, much more complicated factors during the actual production are said to significantly impact the formation of fcc-free layer structures. These include, for example, C and Co content, WC grain size, volume of cubic phase, Ti, N and other elements (such as Ta, Nb, Cr, Zr), concentrations of cubic phase, temperature and time of sintering procedures, atmosphere (Ar or N_2) and pressure level, and so on. It was stated that, to develop a fundamental theory model, an enormous amount of research is still necessary.

No.	Element content (wt.%)							Ti/(Ta+Nb) atomic ratio	fcc phase fraction (vol.%)
	Co	Ti	Ta	Nb	C	N	W		
1	7.50	2.00	1.38	0.40	5.97	0.09	3.50	13.3	Balance
2	7.50	2.00	2.15	0.62	5.98	0.09	2.25	14.8	Balance
3	7.50	2.00	3.23	0.93	6.00	0.09	1.50	16.8	Balance
4	7.50	2.00	2.15	0.62	5.95	0.12	2.25	14.8	Balance
5	7.50	2.00	2.15	0.62	5.93	0.15	2.25	14.8	Balance

Table 1 Powder mixture composition (mass %)

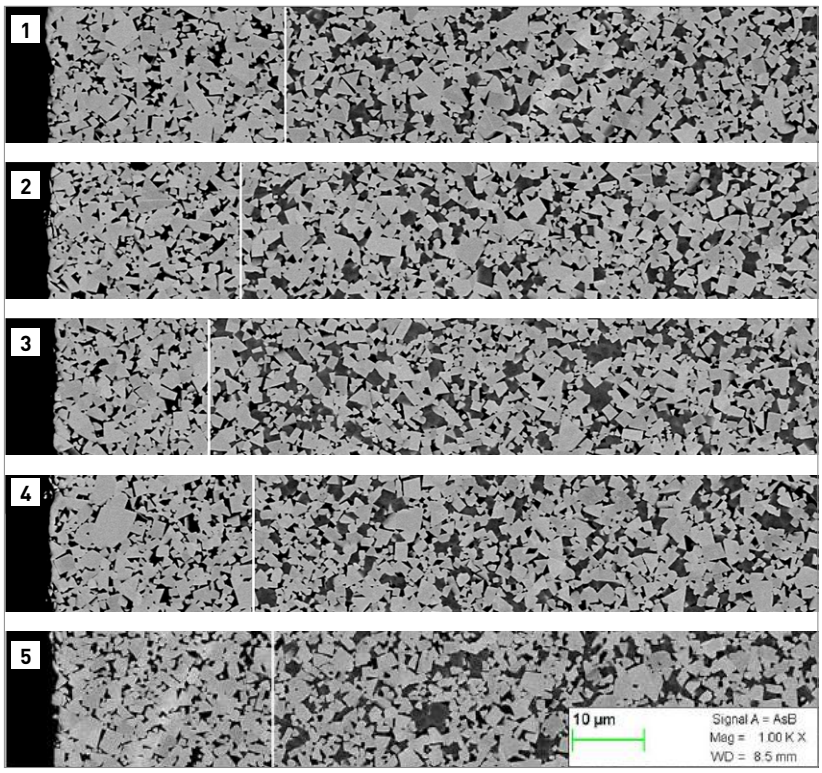


Fig. 1 Micromorphology of alloy 1-5. White lines show the fcc-free layer boundaries

Investigations

The author presented work to investigate the effect of nitrogen content and cubic composition (raising Ta+Nb volume with Ta/Nb ratio and Ti content kept constant) on the fcc-free layer structure by computer simulation and simultaneous experiment. Several findings were discussed in order to explain internal mechanisms, including the nitrogen decomposition process, fcc-free layer thickness and formation rate on nitrogen content and (Ta+Nb) concentration.

The investigated FG WC-Co hardmetal materials in this work were prepared by mixing powders of WC, pure Co, NbC, (Ta, Nb)C, (Ti, W)C, TiCN and C (when needed). Details of hardmetal composition

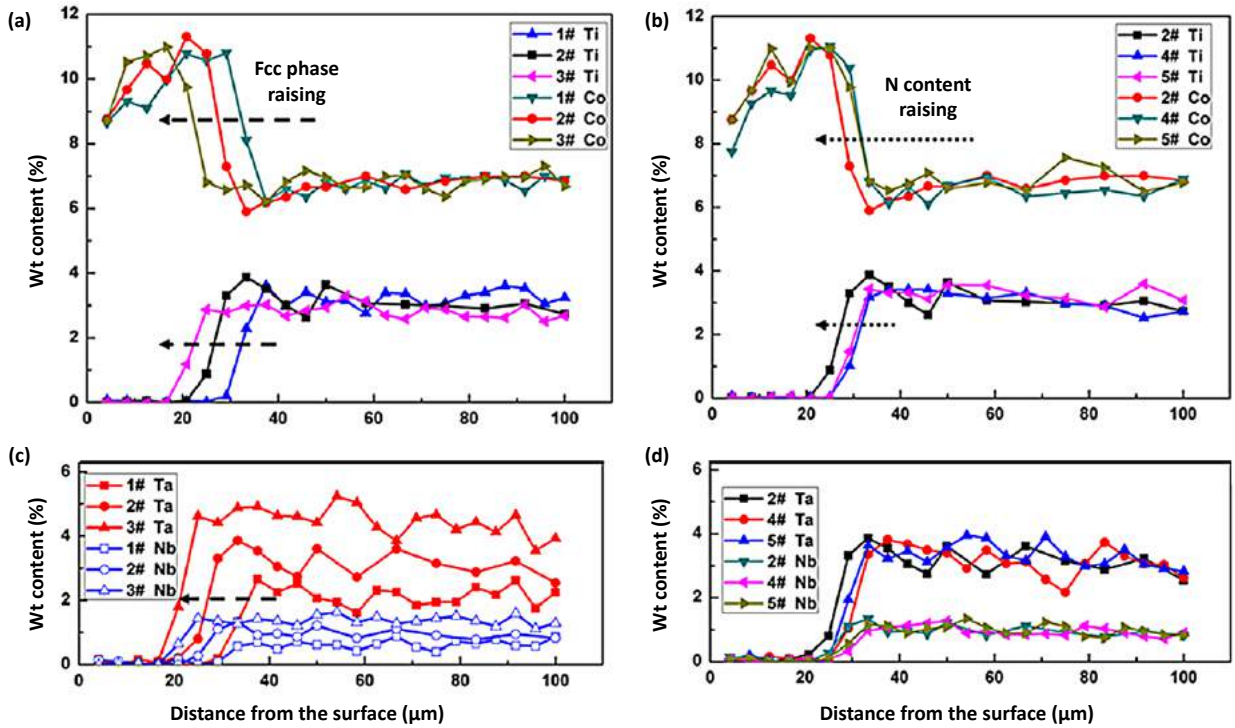


Fig. 2 Co and Ti, Ta and Nb elements distribution of sintered alloy in fcc-free layer from surface to 100 μm: (a) (c) 1, 2 and 3, and (b) (d) 2, 4 and 5. Dashed arrows show nitrogen content or cubic phase volume increasing

are listed in Table 1. All five grades were said to have the same Co and Ti contents. Cubic phase fraction of samples 1, 2 and 3 increases from 13.3% to 16.8% (vol.%) by adding more (Ta, Nb)C and fixing Ta/Nb ratio, while maintaining equivalent titanium and nitrogen content. Nitrogen content of samples 2, 4 and 5 increase (0.09%, 0.12%, 0.15%, respectively), while holding the same cubic phase fraction. In order to exclude the effect of carbon activity on fcc-free layer structure, this work balanced C contents of all five alloys to keep identical C activity (calculated by Thermo-Calc software).

The five powder mixtures were ball milled for twenty-four hours, with a ball and powder ratio of 5:1, and then dried at 80°C in flowing Ar atmosphere for two hours. PS21 samples of 25 x 75 x 6.5 mm were compacted on a TPA machine. Subsequently, pressed PS21 samples were sintered in vacuum at 1350°C. Further heating steps were undertaken in 50 mbar Ar atmosphere at 1450°C for one hour. Finally, the samples were naturally cooled to 1200°C and then rapidly cooled to room temperature in hydrogen.

The densified hardmetal microstructure and chemical composition of the surface fcc-free layer were investigated using SEM (Zeiss Supra55) and EDS (Oxford Instruments). The grain size of the WC and fcc phase of samples 1-3 were examined by EBSD (Oxford Nordlys). Before being placed in the SEM system equipped with a EBSD detector, the surface was vibration polished. High voltage was set as 20 kV and a high current mode was selected. The nitrogen content (wt.%) of the sintered hardmetals was analysed by the Chemical Volumetric Method. In addition, several magnetic and mechanical properties of all alloys were measured. To further understand the gradient zone formation and predict features of cemented hardmetal, DICTRA computer simulations were performed based on the thermodynamic and diffusion database.

Micromorphology

The micromorphologies of the samples were examined by SEM with back-scattered electrons, as shown in Fig. 1. The different shades (white, grey and black) display each phase (WC, cubic phase and binder phase, respectively) in the alloy. White longitudinal lines highlight the boundaries of fcc-free layers and the thickness of each gradient layer was measured. In Fig. 1, a gradually heavier cubic phase is seen in alloy 1-3, which correlates with the designed increasing ingredient (13.3%, 14.8% and 16.8%, respectively). Meanwhile, the thickness of fcc-free layer declines from 31.1 μm to 19.2 μm.

Chemical distribution

The chemical distribution of each component (Ti, Co, Ta and Nb) in the surface zone (from the surface to a depth of 100 μm) was measured at three positions by EDS, and the mean results of samples 1-5 are shown in Fig. 2. Fig. 2a and Fig. 2b plot wt content of Co and Ti in the fcc-free layer from the surface to

100 μm depth. Wt contents of Ta and Nb are displayed in Fig. 2c and Fig. 2d, respectively. It was stated that Co-enriched and cubic phase depleted gradient layer thickness decreases as cubic phase fraction increases, which is in accordance with the backscattering images seen in Fig. 1. At the same time, Ta and Nb contents rise, while Ti concentration drops slightly. Secondly, as nitrogen content increases from 0.09% to 0.15%, the thickness of gradient layer expands 3-5 μm (25.6 μm, 28.6 μm and 30.3 μm, data from Fig. 1). Ti, Ta and Nb concentrations present equivalent levels. It was found that there is no significant variation of the maximum Co content in the Co-enriched zone among alloys 1-5 (Max Co wt.%:10.78%-11.3%).

Simulation results

Based on the thermodynamic multi-component database of W-Co-Ti-Ta-Nb-C-N, this work calculated the thickness of fcc-free layers, showing element distribution in the gradient layer from surface to centre, and nitrogen activity after sintering at 1450°C for one hour.

Differences between experimental results and simulation results indicate that some other factors, or interaction, affect the microstructure, the author stated. Simulation profiles highlighted the effect of cubic phase and nitrogen content on chemical distribution (Ti, Co, Ta and Nb). As the cubic phase volume increases, the thickness of the fcc-free layer becomes thinner. Ta and Nb contents rise, whilst Ti concentration declines at the same time. In the gradient layer, Co content increases rapidly towards a maximum. Meanwhile, the mean Co content and maximum Co content gradually increase the cubic phase volume. Thereafter, Co content falls quickly to a minimum, resulting in a low Co and cubic phase enriched region (35-40μm). The results also showed that the concentrations of Ti, Ta and Nb increased in the low Co zone.

Mechanical properties

The magnetic and mechanical properties of alloys 1 to 5 were tested. After sintering at 1450°C for one hour, it was seen that nitrogen content had no distinct effect on Hc, and Hv. A small reduction in fracture toughness, with the increase of (Ta+Nb), was attributed to the increasing total volume fraction of the hard phase.

No.	N content of ingredient (wt.%)	N content 1450°C/5min (wt.%)	N content 1450°C/1h (wt.%)	Calculated Act-N	Experimented fcc-free layer thickness (μm)	Calculated fcc-free layer thickness (μm)
1	0.09	0.085	0.084	2.245E-07	31.1	31.2
2	0.09	0.078	0.075	2.966E-07	25.6	28.3
3	0.09	0.076	0.069	3.705E-07	19.2	23.2
4	0.12	0.103	0.098	4.055E-07	28.6	31.2
5	0.15	0.124	0.113	4.827E-07	30.3	32.8

Table 2 Nitrogen content and gradient thickness of the fcc-free layer

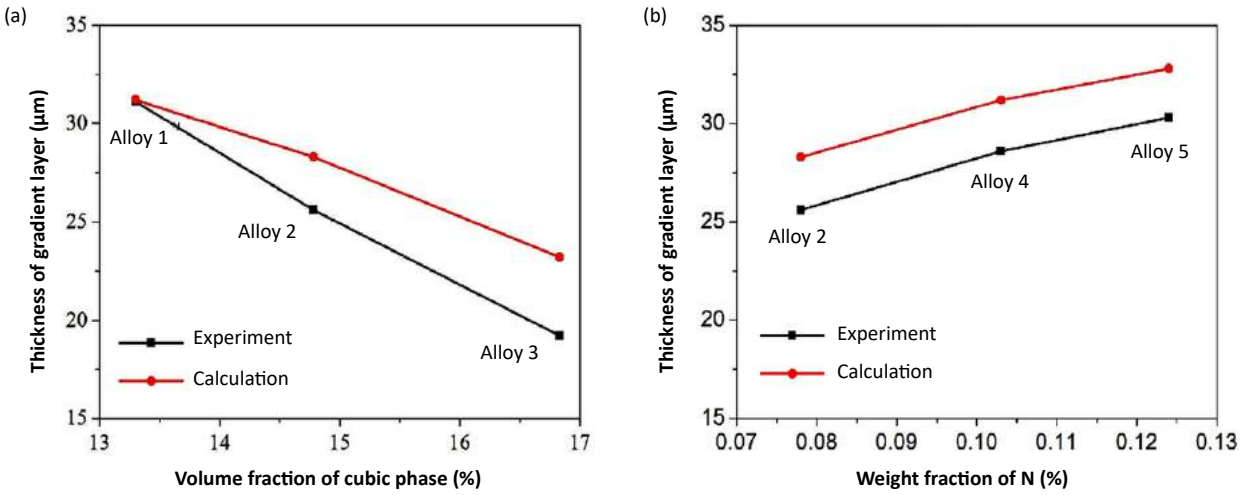


Fig. 3 Influence of cubic phase fraction and N content on fcc-free gradient layer thickness by simulation and experiment

Chemical distribution
The author displayed the simulation and experimental results plotted together for each alloy 1 to 5. The experimental results closely matched the calculated curves, especially for Ti content in the fcc-free layer and Co/Ti /Nb in the range from 60 μm to 100 μm. However, several differences were noted and illustrated. Firstly, the simulated maximum Co content was shown to be higher than that of the experimental value, declining more sharply near the fcc-free layer boundaries than the experimental results showed. Secondly, the experimental Co contents in the low- Co zone are higher than those of the simulation result. Finally, it was stated that Ta seems to be more dispersive than Co, Ti and Nb.

Thickness of the fcc-free layer
The experimental and calculated results were said to show consistency in the effect of the cubic phase fraction and nitrogen content on the fcc-free layer thickness.

The nitrogen content and the thickness of the fcc-free layer thickness can be seen in Table 2. Fig. 3 shows the influence of cubic phase fraction and nitrogen content on fcc-free layer thickness by simulation and experiment. In Fig. 3a, it can be seen that the fcc-free layer thickness gap between experiment and calculation is increasing as the cubic phase volume increases. In contrast, the gap between experiment and calculation results remains almost constant when changing the nitrogen content, as shown in Fig. 3b.

Summary and conclusion
Summarising the work, the authors concluded that the multi-component hardmetal WC-Co-(Ti,Ta,Nb)(C,N) undergoing simulation based on a thermodynamic database, agreed with their experimental data. Fcc-free layer thickness was shown to decrease as the cubic phase volume fraction increased, but to increase when increasing the nitrogen content. The cubic phase volume fraction was said to show a more efficient effect on controlling fcc-free layer structure.

The authors stated that as nitrogen content and (Ta+Nb) concentration in the cubic phase increases, nitrogen activity increases and nitrogen decomposition becomes faster.

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Rio Tinto Metal Powders: Celebrating fifty years of metal powder production

This year, Rio Tinto Metal Powders celebrated the 50th anniversary of the opening of its metal powder manufacturing facility in Sorel-Tracy, Quebec, Canada. Today, the company offers a full range of ferrous powder grades for almost all Powder Metallurgy applications, and is strongly committed to a programme of research and development. The following article provides a brief history of the company, as well as highlighting the importance of working with PM part makers as it looks to the future.

This year marks the 50th anniversary of the opening of Rio Tinto Metal Powders (RTMP), at the time known as Quebec Metal Powders Ltd (QMP). Located in Sorel-Tracy, Quebec, Canada, construction of the company's $10 million, 55,000 ft^2, iron powder plant was completed in October 1968. However, the history of QMP began well before the first workers started building the plant. It was the discovery of a massive ilmenite deposit in Northern Quebec that initially attracted investors. A mine and associated processing plant to extract the ilmenite ore from the ground, and transform it into titanium dioxide and iron, were first established on the site in 1948.

Under the leadership of William L Walsh, President of the Quebec Iron and Titanium Company (QIT), construction of a powder plant began in 1967. The modern facility was unique, being the first in the world to use molten metal and to be part of an integrated complex. It was also the largest plant of its kind, and when production began the new facility had a capacity of 70,000 tons and employed 150 workers.

In 1984, with the implementation of Statistical Process Control, quality assurance was rapidly established as one of the powder plant's strengths. Over the years, the powder plant has retained its reputation as one of the first in the PM industry to achieve each of the quality standards:

Fig. 1 Rio Tinto Metal Powders is the only major ferrous powder producer in the world to manufacture powder from iron entirely sourced from low residual ore

Fig. 2 The company has been producing metal powders at its facility in Sorel-Tracy for fifty years

Fig. 3 Rio Tinto Metal Powders opened its China facility in 2005

ISO 9001,QS-9000, ISO 14001 and ISO/TS 16949. Another major milestone in the powder business's history was reached in 1987, with the construction of a steel powder plant. An important step forward, the addition of the steel plant opened the door to a myriad of new PM applications.

In the late 1980s, QMP became a wholly owned subsidiary of Rio Tinto, one of the world's largest international mining and metallurgical companies. Today, the Rio Tinto group employs over 45,000 workers in thirty-five countries, operating numerous mines around the world and processing key metals and minerals. In 2007, QMP merged with Rio Tinto Fer et Titane (parent company) and was renamed Rio Tinto Metal Powders (RTMP), but maintained its QMP branding. The integration of its powder manufacturing plant with its molten iron and steel suppliers enabled the company to benefit from operational synergies between the facilities, and also opened the way for the powder business to take full advantage of Rio Tinto's global assets.

In 2005, RTMP established a blending facility with comprehensive customer support and distribution capabilities in Suzhou, China. To meet growing demand in the ever-expanding Asian market, the company installed two powder annealing furnaces at the Suzhou facility (in 2014 and 2016), expanding its metal powder production capacity by over 12,000 tonnes per year.

In 2011, an investment of around $30 million was announced to increase the capacity of its primary facility in Canada by 20%. A year later, Rio Tinto Metal Powders established a full service sales office in Mumbai to focus on the growing Indian powder market and recently installed a blending facility in India.

Today, RTMP's world headquarters are still located in Sorel-Tracy, Canada, but the company has numerous sales offices, technical representatives and agents around the globe. The company is currently increasing its plant capacity in Canada through continuous improve-

Fig. 4 An employee checking process parameters at the Suzhou powder plant

ment initiatives. "By strategically locating warehouses in Europe, Asia and the USA, we are aiming to further improve and optimise our delivery lead-times and offer customers increased flexibility," stated Carlo Coscia, RTIT's Director of Sales Development & Performance.

Rio Tinto Metal Powders is the only major ferrous powder producer in the world to manufacture powder from iron that is entirely sourced from low residual ore. As little to no scrap material is used in the process, its powders are said to offer exceptional cleanliness and consistency, resulting in improved compressibility and reduced part-to-part variation.

The company offers a full range of ferrous powder grades for virtually all Powder Metallurgy applications. Iron, pre-alloyed, diffusion and organic bonded grades are all supplied under the ATOMET range of metal powders.

In-house expertise and external collaboration driving R&D

The Rio Tinto Metal Powders R&D Group is composed of around twenty scientists, engineers, professionals and highly skilled technicians. The team is a department within Rio Tinto Iron & Titanium (RTIT)'s Technology Group, which is comprised of close to 150 staff in total. The Technology group's activities include product development for metallic materials (metal powder, steel billet, pig iron), titanium dioxide products and zircon.

In addition to product development, the Technology group is also responsible for process development at plants located in Sorel-Tracy, and in Richard's Bay, South Africa.

Having product and process development teams under the Technology group, is seen as a significant advantage for product development as it eases interaction between the various experts across the business.

An automotive focus

The RTMP R&D Group is currently conducting research in various sectors of the Powder Metallurgy industry, including press and sinter, consumables, chemicals, Additive Manufacturing, etc. However, the current and future needs of the automotive industry define the priorities of a number of the group's projects.

While the cost of PM parts needs to remain low, the engineering requirements of PM parts increase. For instance, the performance/weight ratio of every new

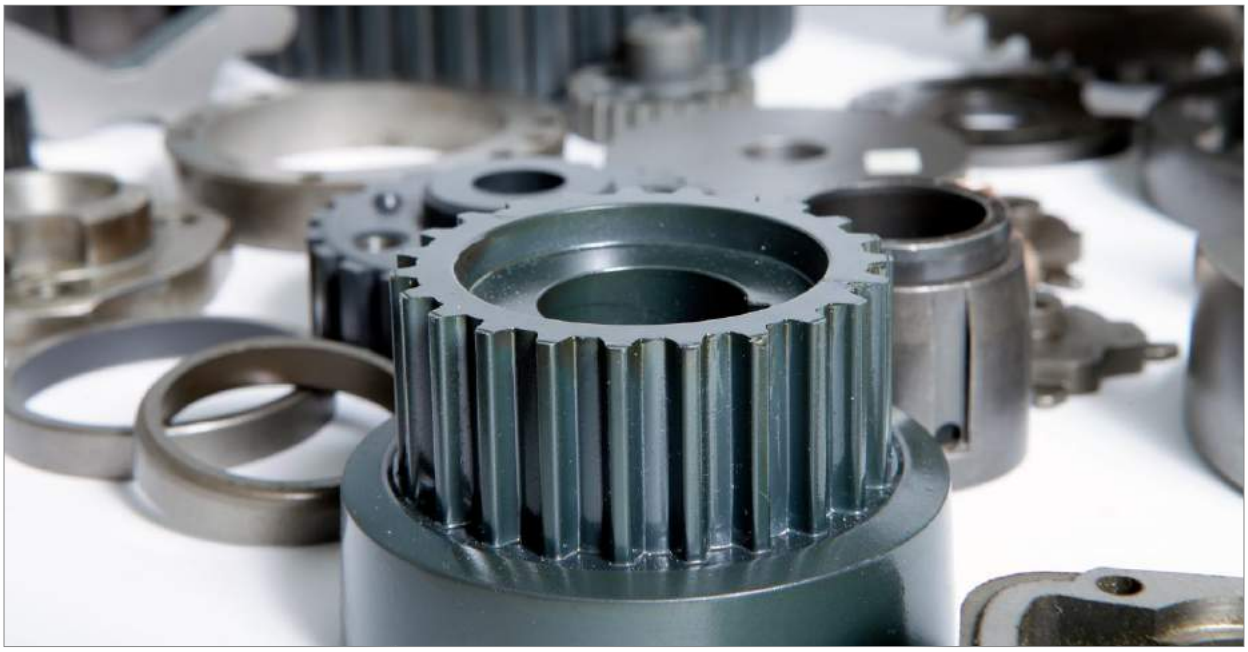

Fig. 5 Rio Tinto Metal Powders works closely with Powder Metallurgy parts makers to offer high-quality powders specifically designed for a wide range of applications

part is expected to improve when compared to the previous generation. In order to achieve this challenging target, powder producers such as RTMP have to improve the performance of base powders and mixes. Projects such as the development of a new lubricant and DB10Cu are currently underway in line with this requirement, and are discussed in more detail on the following pages.

Reducing time to market

The company's approach to reduce the time to market for new product development is to establish collaborations. This successful format has included partnerships with customers, suppliers, universities and research institutes. "Having these connections brings diversity, complementarity and resources to our R&D efforts," stated Chantal Labrecque, Director, Technology Centre - Ferrous Products.

Currently, four Canadian universities are working with RTMP: Université Laval (Québec) on improving the machinability of sintered parts, University of Waterloo (Toronto) to explore the potential of water atomised powders in Additive Manufacturing, École de Technology Supérieure (Montréal) for advanced powder characterisation, and University of Toronto in the field of water atomisation modelling.

"In 2018, we celebrated RTMP's 50th anniversary but also ten years of partnership with PMC Tec GmbH and twenty-five years with one of our most fruitful collaboration partners; NRCC (National Research Council Canada). With their support, several technologies were developed including Flomet binder technology (to improve part to part stability) and RTMP's new proprietary lubricant for complex-shaped PM parts," added Labrecque.

RTMP is also developing options for the future automotive market where lower CO_2 emission regulations are driving car electrification. It is likely that soft magnetic composites (SMC), will be used in high performance low cost electric motors, and the company recently launched a development programme to expand its SMC product portfolio.

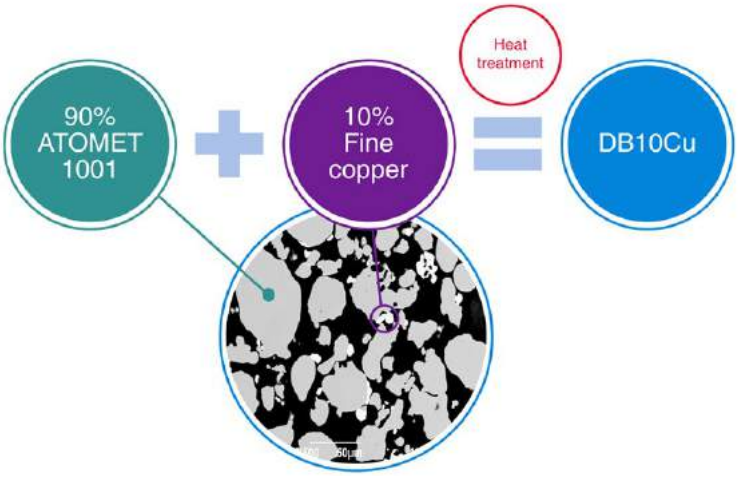

Fig. 6 Powder characteristics of DB10Cu

Improving powder mix stability

Improving die filling performance and part-to-part stability leads to higher quality Powder Metallurgy components. A powder grade currently under development at RTMP is expected to meet these needs through the use of a diffusion bonded fine copper powder, allowing better powder mix stability. The grade, DB10Cu, is based on the company's ATOMET 1001 powder and contains 10% fine copper that is diffusion bonded to the surface of the iron particles following a heat treatment (Fig. 6).

"When using diffusion bonded copper powders, finer additives can be used," stated Julie Campbell-Tremblay, Senior Researcher Powder Metallurgy – R&D Ferrous Products. "This results in a more homogeneous distribution but also finer residual porosities where the original copper particles were present. The bonded copper will also be less prone to segregation."

In order to evaluate this, mixes following the MPIF FC-0205 composition (2% copper and 0.5% carbon) were produced using elemental copper as well as diffusion bonded copper. Green and sintered properties were evaluated, as well as segregation resistance (Fig. 7) and die filling capability. The mixes were also evaluated on an industrial press to compare part-to-part stability (Fig. 8).

"The use of diffusion bonded copper has no impact on sintered properties, strength and hardness are unaffected by the change in copper source. However, segregation resistance and part-to-part stability are greatly improved," added Campbell-Tremblay.

The evaluation of segregation resistance following ASTM standard D6940 is reported to show that mixes containing elemental coarse copper are more susceptible to segregate than mixes produced with finer diffusion bonded copper. This is said to translate to a much better weight and dimensional stability when introduced on an industrial press (Fig. 9).

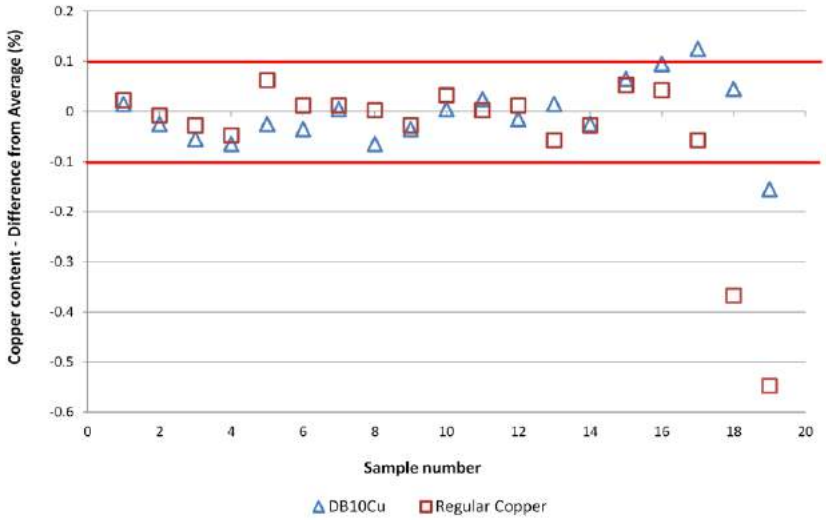

Fig. 7 The results show that bonded copper is less prone to segregation (J. Campbell-Tremblay, R. Guo, O. Wang, M. Nie, "Use of Diffusion Bonded Copper Powder for Better Powder Mix Stability", World PM 2018, Beijing, China, 2018)

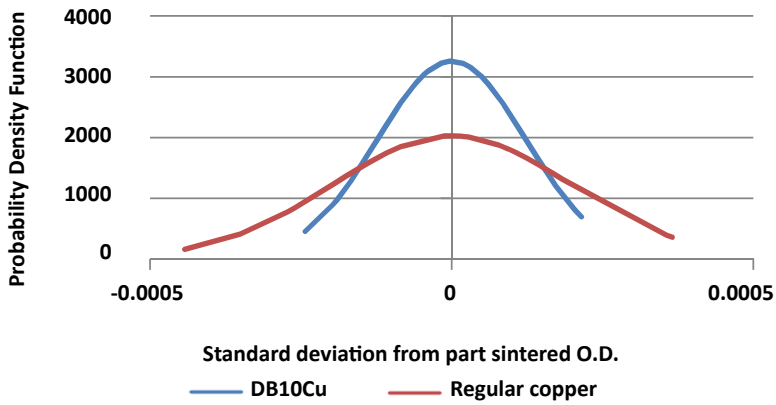

Fig. 8 Comparison of part sintered dimension distribution of DB10Cu vs standard copper

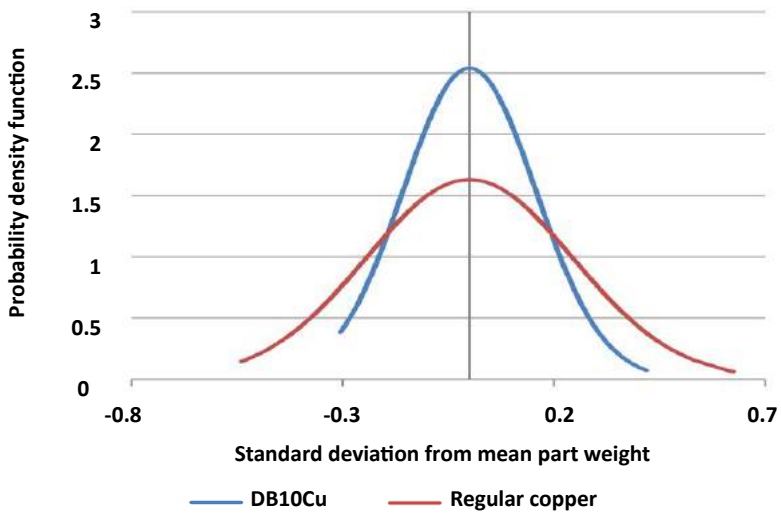

Fig. 9 Comparison of the part weight distribution of DB10Cu and standard copper

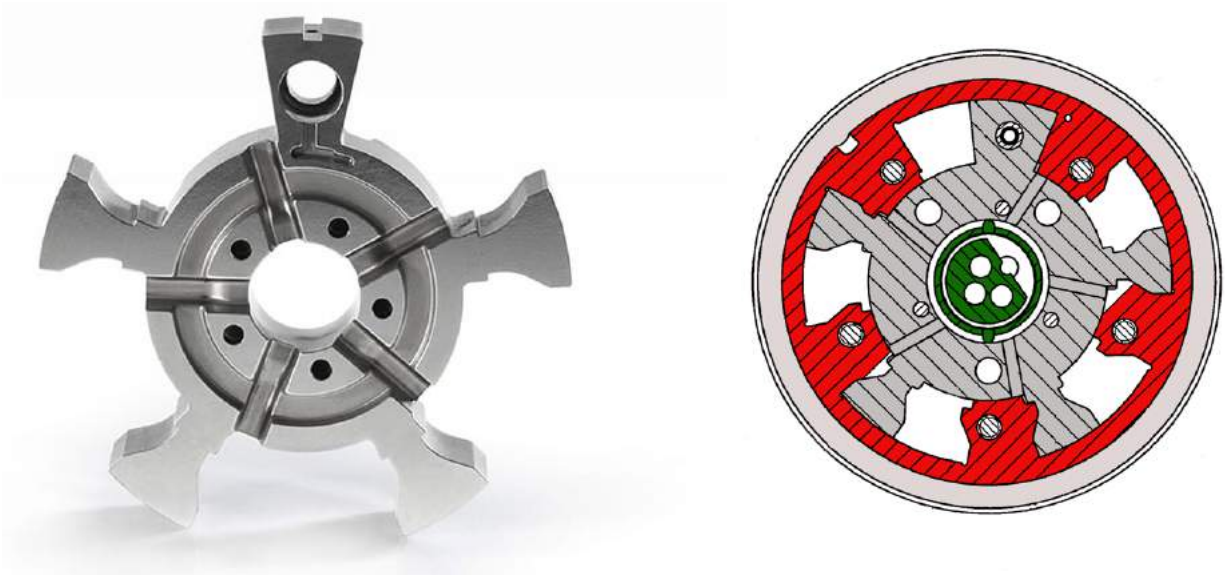

Fig. 10 This VVT rotor (left) is part of a camshaft adjuster assembly. The schematic of a VVT rotor (in dark gray) and stator (in red) assembly (adapted from Hutcheson et al. (2009), J. D. Hutcheson, A. Knecht, D. Pohl, G. A. Barton, S. L. Nance and J. S. Cole, "Variable Valve Timing Device". United States of America Patent US 2009/0173297 A1, 9 July 2009. Photo courtesy Schunk Sintermetalltechnik GmbH)

Working with part makers to meet auto industry demands

Powder Metallurgy is a proven technology for the manufacturing of many automotive parts and its capacity to produce precise components has been proven several times over. However, some critical system parts must meet increasingly tighter dimensional tolerances. This is certainly the case for Variable Valve Timing (VVT) components such as rotors and stators.

Variable Valve Timing is a technology introduced in the late 1960s that enables optimised combustion and reduced fuel consumption in internal combustion engines. This is achieved by adjusting the timing of the cylinder valves opening and closing throughout the engine combustion cycle. Powder Metallurgy offers a more economic production process then conventional machining operations for VVT components, due to its high material usage.

Today, these parts are being used in very precise hydraulically-driven systems for which tolerances are extremely severe. The production of hydraulically-activated VVT components, such as rotors and stators, requires high levels of dimensional precision. This represents an additional challenge for parts manufacturers relying on the Powder Metallurgy process.

"Given the high expected growth in demand for VVT parts, driven by increasingly stringent fuel economy standards, parts manufacturers can expect such complex processes to become more prevalent at their operations," explained Vincent Paris, Director Market Development Powder Metallurgy – R&D Ferrous Product.

To reach this level of precision in the compaction of stators, several production steps must be carefully controlled to avoid problems such as part deformation during sintering and out-of-tolerance inner or outer diameters. "The production of consistent

Process step	Variables evaluated	Measurements
1. Compaction	Process stability	Height on 50 consecutive parts
		Weight on 50 consecutive parts
	Green distortion and springback	Inner and outer diameters Zeiss CMM
2. Sintering	Sintering warpage	Inner and outer diameters Zeiss CMM
3. Sizing	Process stability	Height on 50 consecutive parts
	Adequacy to targeted size	Inner and outer diameters Zeiss CMM
4. Finishing	Density gradient	Density (water immersion) DIN EN ISO2738
	Microstructure	Metallography
	Hardness	Indentation of 5 parts, top and bottom DIN EN ISO6506-1

Table 1 The experimental procedure investigated numerous process steps

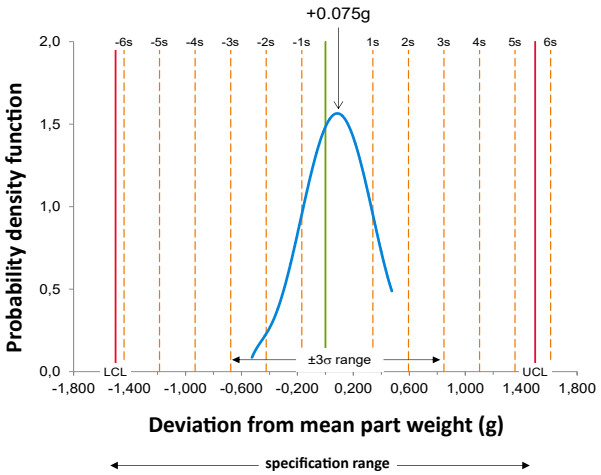

Fig. 11 In the compaction of the VVT stator, a C_p value of 1.97 for part weight was reported

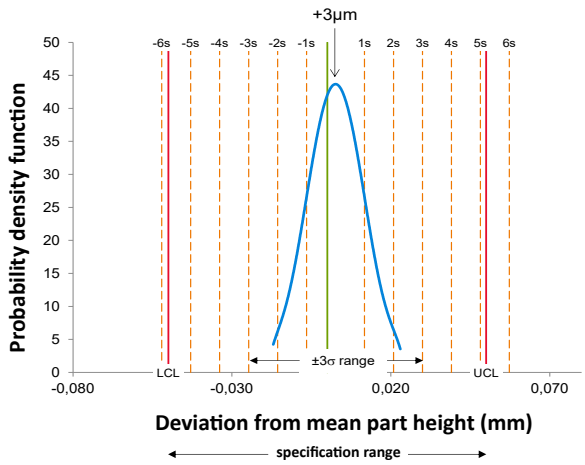

Fig. 12 In the compaction of the VVT stator, a C_p value of 1.83 for part height was reported

and precise parts is largely impacted by the first step in Powder Metallurgy - compaction of a green component. Using advanced premixes prepared with innovative lubricants allows the compaction of parts to be undertaken in a very predictable and repeatable manner," continued Paris.

The ring-like shape of a the VVT stator, with its thin-walled structure, makes it difficult to properly fill with the metal powder mixture (Fig. 10). Uneven powder fill can cause some areas of the part to contain less material than others, leading to green density gradients.

As was highlighted in a paper presented at the 2018 Powder Metallurgy World Congress, Beijing, China, jointly authored by Rio Tinto Metal Powders and Schunk Sintermetalltechnik, enhanced process control begins at the raw material level. The analysis of the process stability for the production of the VVT stator demonstrated that high process stability metrics are achievable with a premix lubricant developed by RTMP.

The peculiar geometry of a VVT stator renders this part more difficult to lubricate, as several sections have high height-to-width ratios. In such tall and narrow sections, the lubricant pool available to lubricate the die walls is smaller than what would be available in a bulkier section. Hence, the more the lubricant can be effective at lubricating the die walls and part interface, the better the premix should perform under industrial compaction conditions. The C_p metric measures the capability of a process to meet its specified tolerances and the higher its value, the more the process is in control. In the compaction of the VVT stator, C_p values of 1.97 and 1.83 were obtained for the green part weight (Fig. 11) and green part height (Fig. 12), respectively. In later process steps, VVT parts are sintered and sized to dimensions. This ensures that the final parts are achieving the tight dimensional tolerances required by the application. In this case, the variance in the diameter corresponding to the critical surface of the VVT rotors produced was shown to be contained within 5 µm over a specification allowing for a 60 µm range.

"Results like those are possible when two key ingredients are combined: the manufacturing expertise of a part supplier and exceptionally stable Powder Metallurgy premixes," added Paris. "Additional value can be derived from the Powder Metallurgy process when the development of such premixes is jointly performed by the powder and parts manufacturers."

Meeting the needs of a changing market

Rio Tinto Metal Powders sees its future as a committed long term global business and technical partner. With fifty years' experience in the manufacturing of metal powders, and being part of one of the largest mining and metals companies in the world, it is in a strong position to continue to offer the PM industry a wide range of high quality metal powders. As markets change and the demand for increased material properties grows, the company's strong commitment to R&D, both internally and collaborativley, will see it further improve its products and perfect new applications.

"We strongly believe R&D is at the front and centre of our business. It has been so in the past, and will continue for the foreseeable future. We are positioning ourselves to align our business with the needs of our customers while remaining agile to adapt to a fast changing technological environment," Paris concluded.

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Catalus Corporation enters a new era of Powder Metallurgy manufacturing

Catalus Corporation is an international supplier of custom Powder Metallurgy parts to a diverse range of markets and applications. Headquartered in St. Marys, Pennsylvania, USA, the family-owned business was, until recently, known as SMC Powder Metallurgy. With almost 70 years in the PM industry, Catalus has recently opened a new state of the art production facility, as well as establishing dedicated R&D operations.

SMC Powder Metallurgy Inc. became Catalus Corporation on October 1, 2018. Quoting the often referenced mantra, "Change is inevitable. Growth is optional," the rebranding is one part of a move to grow the business in ever more challenging times. In late 2017, the company broke ground on its second facility. A new plant and office complex is now located in St. Marys, Pennsylvania, at the St. Marys Airport Industrial Park. Along with the decision to build a second manufacturing site, the management team also decided to invest in a new research and development facility, creating the Catalus Research Facility, at the company's site in Galeton, Pennsylvania.

"Our new name conveys the catalytic impact we will have on the improvement of existing products, and the development of innovative products that meet new market demands," Stephen Lanzel, President and CEO of Catalus told *PM Review*. "Applying more focus to research and development, and changing the name to Catalus, demonstrates that the company has taken the time to understand the needs of the market."

Catalus was originally founded as a carbon plant in 1939 in St. Mary's by Jerome E Lanzel and Louis W Eberl. The company turned its attention to Powder Metallurgy in the early 1950s when it began producing powder metal components. Three generations later, the family-owned and operated business believes it has now entered a new era.

Fig. 1 Catalus has been located in Galeton, Pennsylvania, USA, since 1965

Fig. 2 Thanks to a wide range of compacting presses, Catalus is capable of manufacturing a large number of different sized Powder Metallurgy components for many market segments

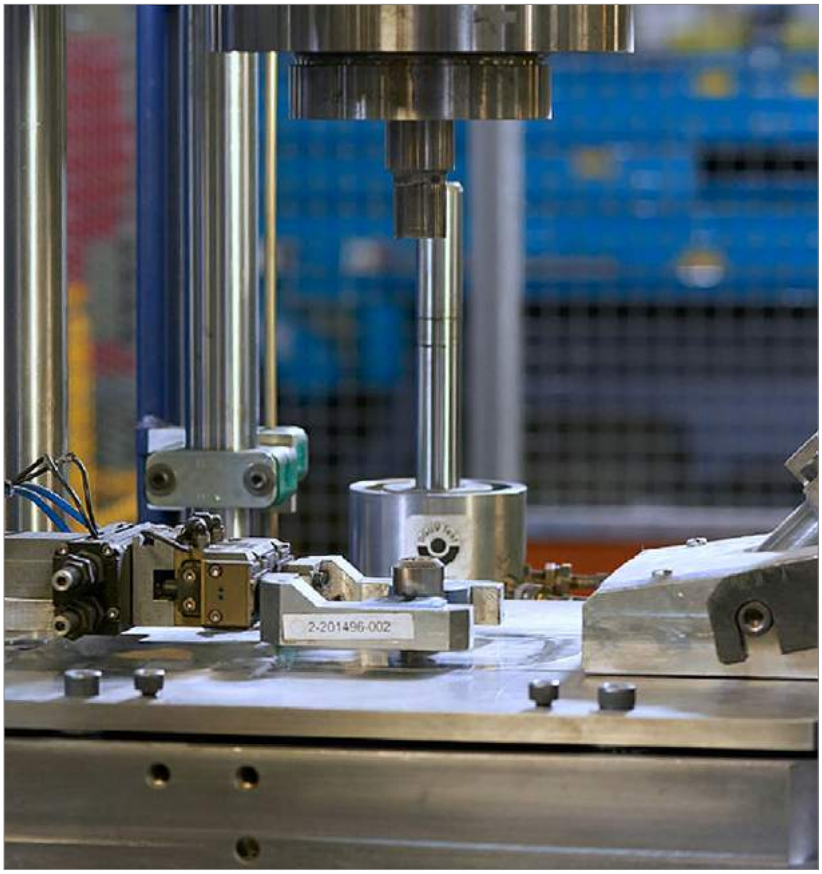

Fig. 3 Catalus has a wide range of mechanical and hydraulic presses, between 45 and 825 tons, with multiple cavity tooling possible in many cases

A growing company

Today, Catalus is a growing company, active in many market segments (Fig. 2). In the automotive sector, Catalus manufactures parts for steering columns, transfer cases, oil systems, engine components and more. Catalus is also active in the recreation and hobby sector, working with the marine industry, ATV manufacturers, snowmobile producers and others. The company also produces components for outdoor power equipment applications, such as lawn mowers, zero turn mowers, and generators. Most recently, Catalus has expanded into the hardware and hand tool markets. The company works closely with OEM's, as well as the second and third tier suppliers that make assemblies for the OEM market.

The success that Catalus has had across such varied applications can be tied to the fact that it has a wide range of mechanical and hydraulic presses, with tonnages between 45 and 825 tons (Fig. 3). Catalus performs cold

Fig. 4 The Catalus sales team is supported by a group of applications engineers and metallurgical engineers back at the plants

compaction, warm die compaction or warm compaction, with multiple cavities possible in many cases. This allows it to produce large and small components effectively.

The types of sintering offered by Catalus include de-lube, conventional, high temperature and sinter-hardening. The sinter-hardening process, often used as an alternative to secondary heat treatments, involves loading the part into the furnace where it undergoes preheating, high heat, then gaseous nitrogen cooling before exiting the furnace to be tempered.

Secondary operations include plating (in trivalent zinc chromates, nickel, nickel zinc or chrome), as well as coatings, resin/oil impregnation and machining, which can include drilling, tapping, honing, milling, lapping, grinding, turning, hard turning and reaming. Thermal treatments are also available, both with steam treat and with heat treat. Other secondary capabilities include welding and assembly, resonant testing, specialised packaging, sizing and repressing, along with deburring.

Materials can be admixed, pre-alloyed, partially alloyed or a hybrid alloy (which allows pre-alloyed or partially-alloyed powders to be blended with elemental or ferralloy additions). The company works with a wide range of iron and stainless-steel materials and that, coupled with its sintering capabilities, further expands the range of products it can produce.

"The sales team is made up of sales engineers supported by a group of applications engineers and metallurgical engineers..."

Engineering support is at the forefront of how Catalus goes to market. The sales team is made up of sales engineers supported by a group of applications engineers and metallurgical engineers in its plants (Fig. 4).

Award winning components

Catalus is not adverse to tackling challenging products. The first Metal Powder Industries Federation (MPIF) award received by the company was for a fuel system valve used in the automotive industry (Fig. 5). Made for Kendrion FAS Controls, the valve was specifically designed for gasoline direct injection technology, facilitating lower fuel consumption and higher efficiency. Replacing a wrought part that required heavy machining, the PM flange is fabricated from a proprietary premix developed in order to achieve the required dimensional stability. The part has a perpendicularity require-

Fig. 5 A fuel system component for gasoline direct engine technology won Catalus an Award of Distinction in the MPIF's 2015 Powder Metallurgy Design Excellence Awards. The component connects and seals a spill valve operating in an automotive fuel system and to date, over 1.6 million flanges have been made and shipped to the customer (Courtesy MPIF)

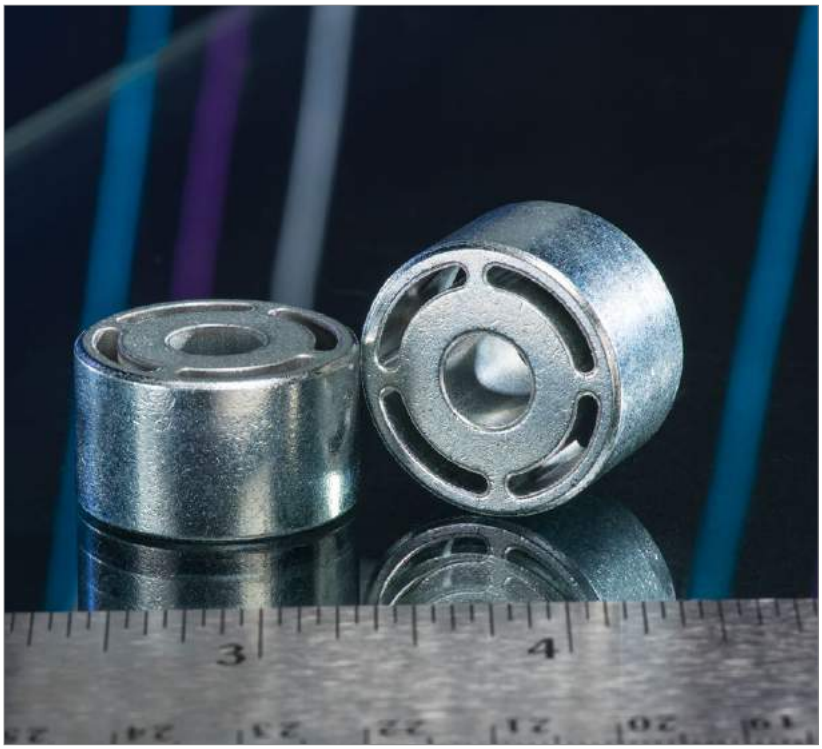

Fig 6 The company received an Award of Distinction in the MPIF's 2018 Powder Metallurgy Design Excellence Awards for this spacer component, used in a tilt steering mechanism. The part is over-moulded with plastic and sees very little stress in the application (Courtesy MPIF)

ment relating to the machined counterbores and O-ring groove.

The component is made with a two-level flange die with the pin in the bottom. The compaction tools had to be specially designed to accommodate the significant dimensional change realised in the process due to the stainless-steel powder used to make the part. After compaction, the parts are delubed and then placed on specially designed slates for high-temperature sintering in 100% hydrogen. To further complicate things, the part requires some precision machining after compaction and sintering.

Surface finish is key in the application, along with some very tight tolerances. In order to make the part viable for production, Catalus worked with one of its material suppliers to develop a mix that made the part easier to machine while still achieving the material characteristics required for the application. The fact that this part has had a long successful run in a demanding application can be attributed to the collaborative efforts between Catalus, the customer, the material source, and the machining house.

In 2018 Catalus received a second award in the MPIF design excellence competition (Fig. 6). Up front engineering with the customer turned a costly wrought part into a successful and much more economical PM part. "While on the surface the PM part appears fairly simple, it required a good bit of back and forth with the customer to come up with a part that had uniform density throughout and allowed for a tool design that would be robust enough withstand to compaction pressures," explained Lanzel. "By opening some tolerances, Catalus was able to eliminate some costly secondary operations, making the part more financially attractive."

Working with the customer

The strong engineering support that Catalus offers has allowed it to work with customers to combine two or three parts into one. This often starts

with a line walk, wherein the Catalus sales engineer does a walk through of the customer's assembly line to identify components that are not currently PM components, but could be. Recently, Catalus had the opportunity to walk the production line at a facility that makes road trucks; during the tour the sales engineer came across a part used as an oil plug. The part consisted of a stamping and a screw machine part that were welded together, painted, and had a rubber seal added to one portion (Fig. 7a).

The design of the welded assembly was such that Catalus could produce it to net shape without any secondary machining, immediately combining two parts into one. After learning that the part needed special corrosion protection, Catalus worked with a secondary shop to develop a plating that not only met, but exceeded the corrosion protection of the welded assembly (Fig. 7b). With the proposal submitted by Catalus, the customer was able to achieve cost savings that allowed it to pay for the cost of the tools in less than one year. It also allowed the customer to buy in a finished component, rather than sourcing two parts, welding them, and having them painted.

"When working on new projects, it is not unusual for Catalus to be awarded more than one component in a specific application," added Lanzel. "This has been the case for steering systems, transfer cases, and a marine throttle-shift mechanism."

It is also common for Catalus to work on mating gears or other items that function together when used in the application. "When products are used together, each part has its own criteria for strength, form, corrosion resistance and durability. In some instances, the parts that are used together must interact in such a way that 'feel' becomes one of the most important criteria, albeit somewhat hard to quantify."

This was the case in the marine shift/throttle application shown in Fig. 9. Initially, the challenges were durability and corrosion resistance. The challenge came when the customer started evaluating the 'feel'

Fig. 7 This automotive oil plug was originally made from two stamped and machined parts welded together (a). Catalus identified that it could be produced net shape using Powder Metallurgy without any secondary machining (b)

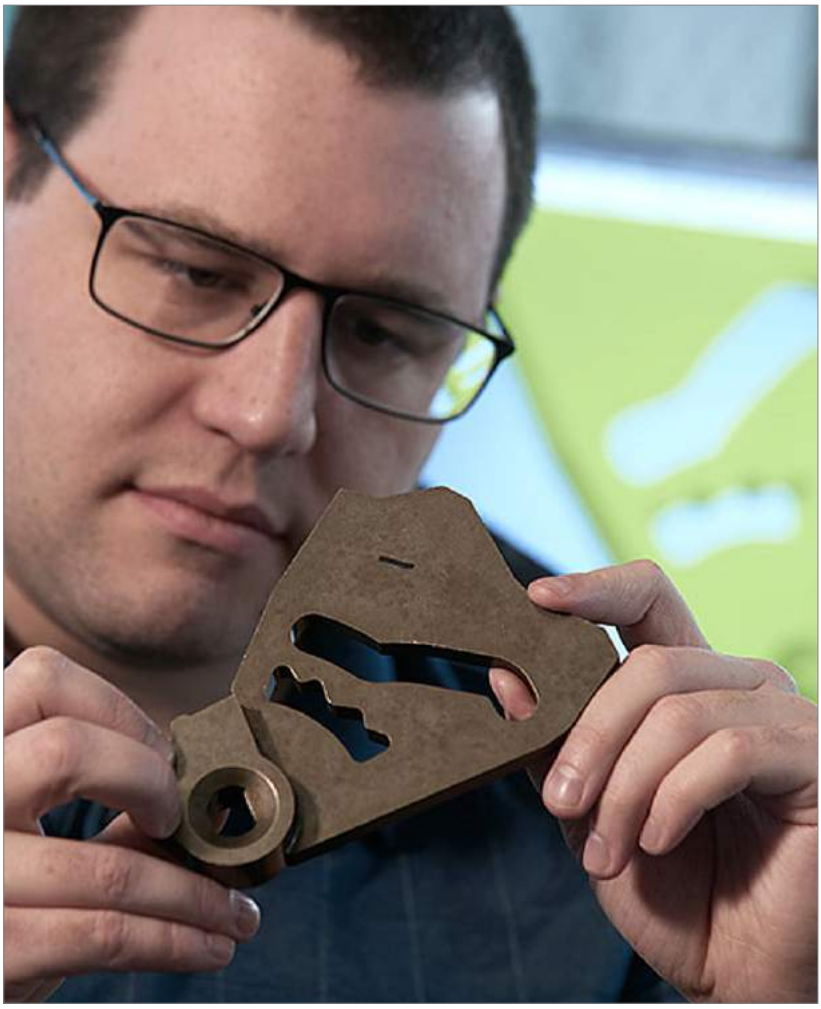

Fig. 8 Engineers at Catalus identify components that would be suited to PM production, often combining multiple components into one near-net shape part

Fig. 9 This marine shift/throttle application offered specific challenges. In addition to improved durability and corrosion resistance, the customer required a quiet and smooth operation

an operator gets when moving the throttle. It had to be equally smooth whether moving the throttle forward or into the reverse position and it had to be quiet with no clicking sound. 'Feel' and 'sound' can be a challenge because there are hard to quantify. Through a series of tests, Catalus worked with the customer to achieve the desired results. Because of the product design, the gear teeth ended up having slightly different shapes (tool controlled) and different corrosion protection was applied to the mating components. The net result of the development efforts was a successful project launch on a platform that has been in service for several years.

Fig. 10 Catalus is expanding production as well as adding dedicated R&D facility at its Galeton site

Educating the end-user

The companies that supply powders to the PM industry are constantly making big strides in what the materials can do. At the same time, the companies that develop pressing technologies are continually enhancing their ability to compact more complicated components with more and more levels. While this technology is improving, Catalus has found that customers often don't have a good understanding of what can be made with metal powders and how the material properties have improved over the years.

For this reason, Catalus has developed a seminar that can be presented to the engineering communities at customer sites. The presentation is designed to give an overview of what can be done with metal powder technology today, and how to design parts in a way that they are PM-friendly. The seminar covers materials, processes, tooling, part features and more.

R&D expansion

Catalus is working to take this to the next level by adding research and development capabilities at its site in Galeton, Pennsylvania (Fig. 10). The plan is to have customers come in and work on new or conversion products on site, with engineers, tool designers, material scientists, and production capabilities all under one roof. By working with 3D models of parts and systems, Catalus and its customers can evaluate just what can be done to accomplish the goals assigned (Fig. 11).

"Working on the engineering end up front allows for best cost practices early on, and can help to eliminate waste or the need for secondary operations. The fact that PM technology is often presented as an afterthought to engineering students today means there is a gap to fill when it comes to understanding what Catalus can do," added Lanzel.

Fig. 11 By working with 3D models of parts and systems, Catalus and their customers can evaluate what can be done to accomplish the goals assigned

Meeting industry standards

Catalus is an active member of the MPIF. The MPIF through its standards committee, establishes and publishes material standards and test methods that are used throughout the PM industry. MPIF Standard 35 provides the chemical and physical properties for materials used throughout the industry. The Standard Test Methods for Metal Powders and Powder Metallurgy Products provides the details of how specific tests are to be conducted throughout the industry.

Catalus has invested heavily in an on-site materials laboratory so that it can conduct detailed metallurgical and physical property tests on the powders it purchases, and in parts produced by Catalus and its competitors. In order to verify that its lab is up to standard in terms of providing accurate results, Catalus participates in the MPIF Test Methods Assurance Program (TMAP). This programme began in 1994, and Catalus has participated each year since 2000. The objective of TMAP is to demonstrate that Catalus can follow test method standard procedures to get reliable consistent data.

To participate, Catalus receives materials from the MPIF and has to report results back to TMAP. Because of the equipment and time investment required, not all PM parts manufacturers choose or can afford to participate in this programme. Catalus believes that accurate metallurgical properties are key to being able to provide quality parts to its customers. With the emphasis Catalus is placing on research and development, it now views this as more important than ever.

The future at Catalus

So, what does the future hold for Catalus? "The new facility in St. Marys was designed specifically for powder metal product flow. The market will dictate what types of equipment will be used for production based on the part requirements and volumes," stated Lanzel. "Engineering parts up front using the research and development capabilities, and then putting things in place to begin making tomorrow's parts today is the plan. Coupling this with the fact that powder metal part making is a 'green technology' where the powders used come from recycled and processed scrap metal suggests a bright future for Catalus," he concluded.

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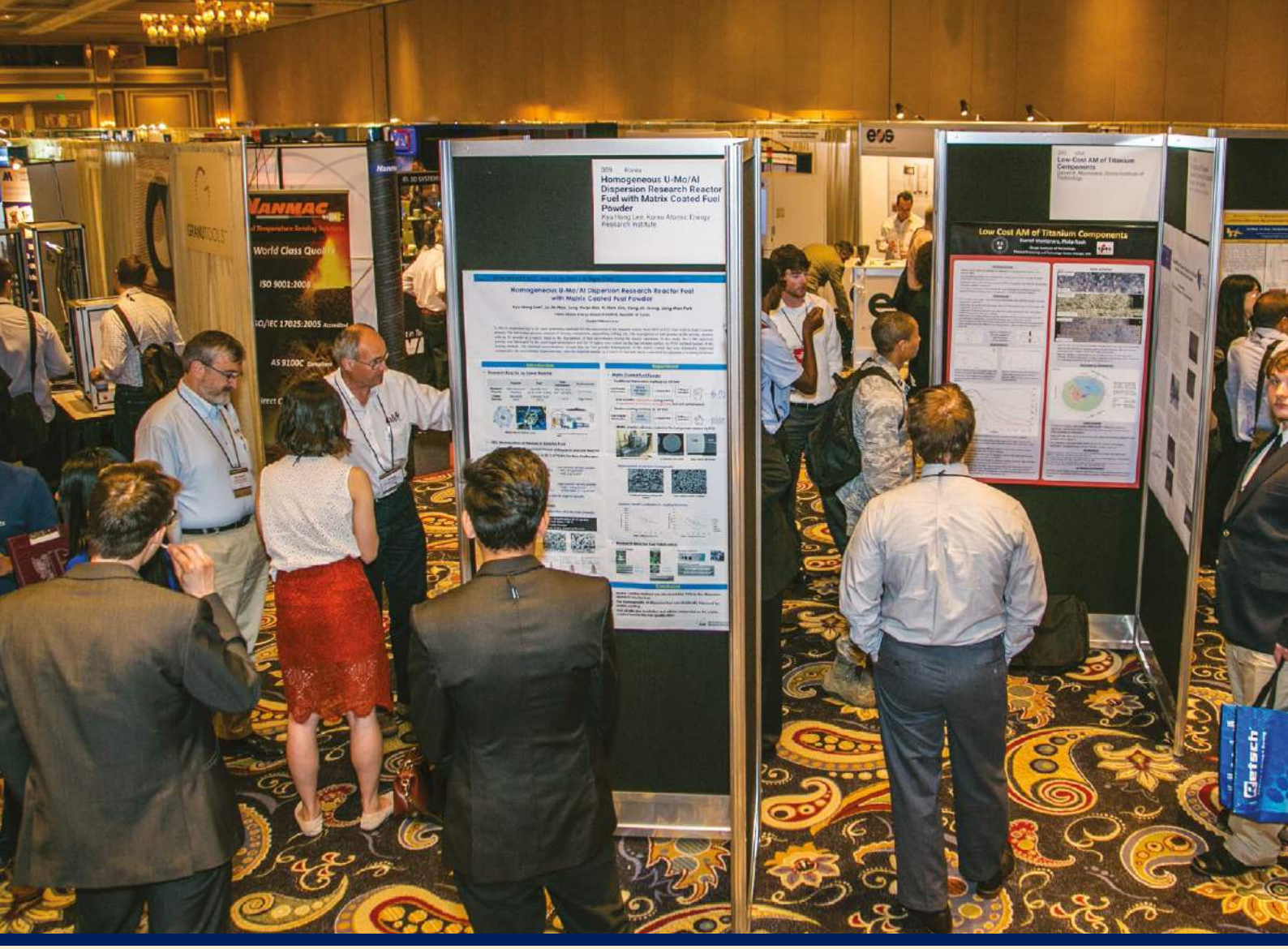

WORLDPM2018: Ferrous PM materials and processes for demanding automotive applications

A number of developments in new materials and processes to improve the performance of PM components were presented at the 2018 World Congress on Powder Metallurgy (WORLDPM2018) in Beijing, China, September 16–20, 2018. In this article, Dr Yoshinobu Takeda reports on work underway to meet the increasing demands of the automotive industry, highlighting specific applications and advances in processing technology.

Development of matrix reinforced valve seat materials with improved adhesive wear resistance

Automotive valve seat inserts (VSI) are exposed to harsh combustion environments and require high wear resistance. Changes in engine performance, and particularly the recent trend of high efficiency engines, require a more durable material. A paper presented at WORLDPM2018 reported on work by researchers at Japan's Fine Sinter Co., Ltd. and Toyota Motor Corporation on the development of valve seat materials with improved adhesive wear resistance [1].

In order for valve seat inserts to have high wear resistance, hard particles are homogeneously distributed throughout the matrix. This results in a reduction in surface pressure between the sliding valve and matrix, known as the cobblestone effect (CE). In addition, as a result of the heat generated during combustion, iron oxides are formed on the valve seat surface, leading to further increased adhesive wear resistance.

However, recent improvement in engine efficiency has resulted in difficulty for Fe oxides to form. There is a need, therefore, for a material that is strengthened with more effective hard particles. In this paper, the cobblestone effect of hard particles against the surface pressure was investigated using a computer simulation (CAE).

The basic structure of the material comprises coarse hard particles of Mo-Co based alloy and the ferrous matrix strengthened with fine hard particles of Fe-Mo based alloy. The amounts of coarse and fine hard particles were optimised by the CAE. Along with the CAE, the raw powder mixtures with various amounts of hard

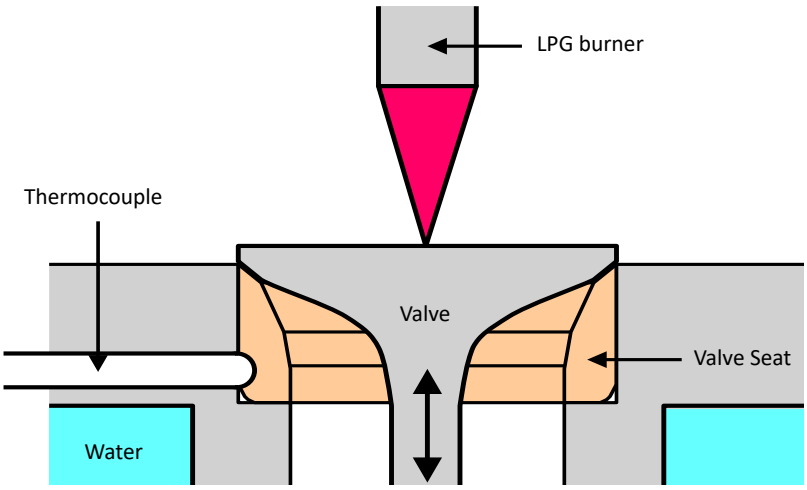

Fig. 1 Testing equipment for valve seat inserts [1]

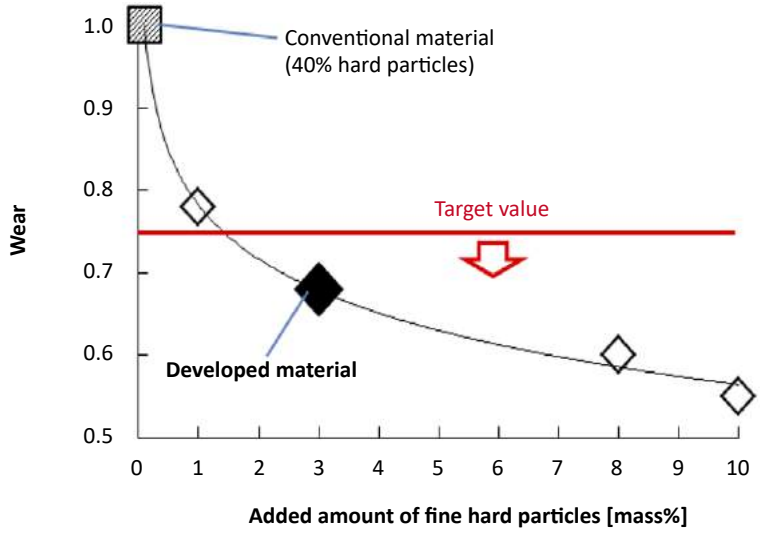

Fig. 2 Relationship between the amount of hard particles and wear [1]

particles were compacted at 784 MPa and sintered at 1100–1150°C in H_2+N_2 atmosphere for 60 min. The wear test was performed using the tester shown in Fig. 1, under the condition of VSI surface temperature of 200°C, mating valve material JIS SUH35 (Fe-21Cr-4Ni-9Mn-0.5C-0.35N), cam rotating rate of 3250 rpm and for 8 h. The surface of the VSI was heated by an LPG burner and the VSI was exposed to shock and sliding by moving the rotating valve up and down, simulating the actual engine operation.

At first, the effect of coarse hard particles was investigated in terms of the wear, but even with a 40% addition, the wear resistance did not reach the target. Then, CAE analysis of the surface pressure to the matrix was conducted and confirmed the exact correlation to the wear. Instead of increasing the coarse hard particle content further, strengthening of the matrix was investigated. The same methodology was applied to strengthen the matrix with fine hard particles. A CAE analysis of the matrix was conducted for different quantities of fine hard particles. Based on the results, a wear test was conducted with additions of up to 10% of fine particles and 40% coarse hard particles (Fig. 2).

The desired amount of the fine hard particles was determined to be 3%, considering the fluctuation during mass production and the economics. Subsequently, the optimised VSI was tested in the actual engine and was confirmed to fulfil the target requirements.

Finally, the machinability of the new VSI was evaluated through a turning test. VSIs must have good machinability because of the requirement for air tightness in the combustion chamber. Poor machinability of the VSI increases machining time and tool cost significantly. The machining test was conducted using a carbide tool at the speed of 80 m/min, feed of 0.08 mm/rev with water soluble coolant for the cutting distance of 300 m. Cutting tool wear was shown to be less than 0.8 mm, a reduction of more than 30% compared to the conventional material.

Fig. 3 shows the microstructure of the new VSI, consisting of the coarse hard particles of 100 µm diameter and the fine hard particles of 25 µm diameter homogeneously distributed in the matrix. The development also contributed to an improvement in the economics of the VSI by 35%.

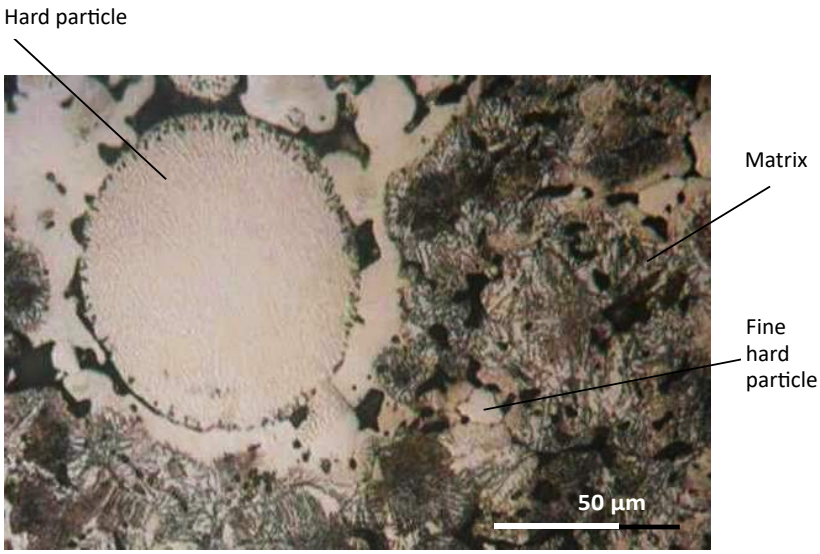

Fig. 3 Relationship between the amount of hard particles and wear [1]

Development of heat-resistant sintered alloy having high wear resistance and salt damage resistance

Currently, many automotive engines use exhaust gas recirculation (EGR) and/or turbocharger systems to achieve improved performance along with better emission control. In order to compete against high-Cr cast steels, for example, the PM components used in these systems need to offer high wear resistance, heat resistance and salt damage resistance (when the components are exposed to external conditions). Work undertaken at Japan's Diamet Corporation highlighted the develop-

ment of a sintered alloy that offers heat resistance, high wear resistance and salt damage resistance (2).

PM stainless steel is used in the exhaust system of automobiles for components such as the HEGO (Hot Exhaust Gas Oxygen) sensor boss, exhaust flange and ABS sensor ring. These examples are also exposed to the harsh outside environment, but not in a high temperature environment, while the components of the EGR or turbocharger are exposed to high heat. Ordinary press and sintered stainless steels contain a certain level of porosity, which induces corrosion. In order to increase corrosion resistance, it is common practice to increase the Cr content and/or add Mo. However, in order to achieve high wear resistance at elevated temperature, certain hard phases also need to be added.

Initially, Fe-30 mass% Cr pre-alloy powder was selected to control the Cr content of the matrix mixed with a plain iron powder. The mixes, having Cr contents of 28–36 mass%, were prepared and compacted at 784 MPa into cylindrical specimen of 20 mm diameter and 6 mm height. Sintering was conducted at 1200–1300°C for 90 min in vacuum. Sintered specimens were evaluated by the salt spray test, using a 5 mass% NaCl solution at 35°C for 24 hours, and areas of rust were then measured by quantitative image analysis. Fig. 4 shows that Cr content of 32 mass% is required in order to ensure sufficiently high corrosion resistance.

Next, the addition of 1–4 mass% Mo by means of mixing Fe-60 mass% Mo powder was studied. As shown in Fig. 5, additions beyond 2 mass% of Mo did not improve the corrosion resistance. As the sintered densities of these specimens were 6.81–6.89 g/cc, porosity was close to 10%. As porosity is also an important parameter for corrosion resistance, an attempt to increase density by liquid phase sintering was conducted. 1 mass% FeB powder was added and the density was increased to 7.53 in the case of Fe-32 mass%Cr-2 mass% Mo. The porosity was decreased from around 10% to 1%. The corrosion resistance of the developed alloy was evaluated as shown in Fig. 6. The new alloy was shown to have better corrosion resistance than that of the cast high-Cr steel.

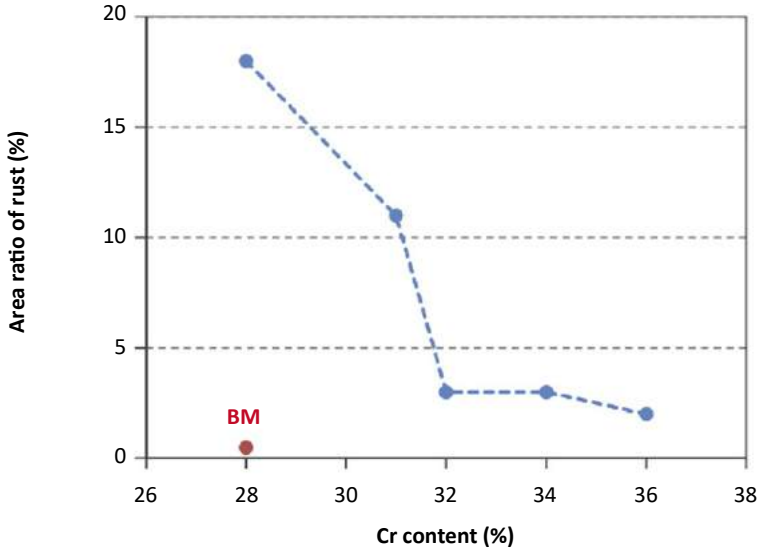

Fig. 4 The effect of Cr content on area ratio of rusting (BM is reference cast Cr steel) [2]

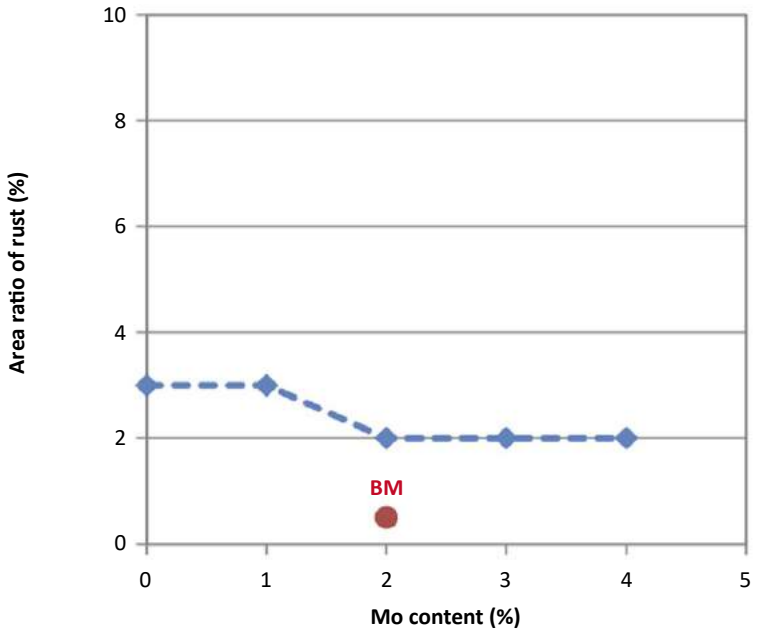

Fig. 5 The effect of Mo on area ratio of rust (BM is the reference high Cr cast steel) [2]

As the material requires good wear resistance, hard particles also need to be added. Among various candidate hard materials, CrB and Cr2B were selected because of their minimal negative effect on the corrosion resistance experimentally confirmed. Unexpectedly, the corrosion resistance was shown to be lower than that without hard particles. The sintered microstructure showed significant growth of Cr2B from 10 μm to several tens of microns, which means that Cr in the matrix was consumed to change CrB to Cr2B, in the case of a CrB addition. Therefore, the depletion of Cr in the matrix was considered to

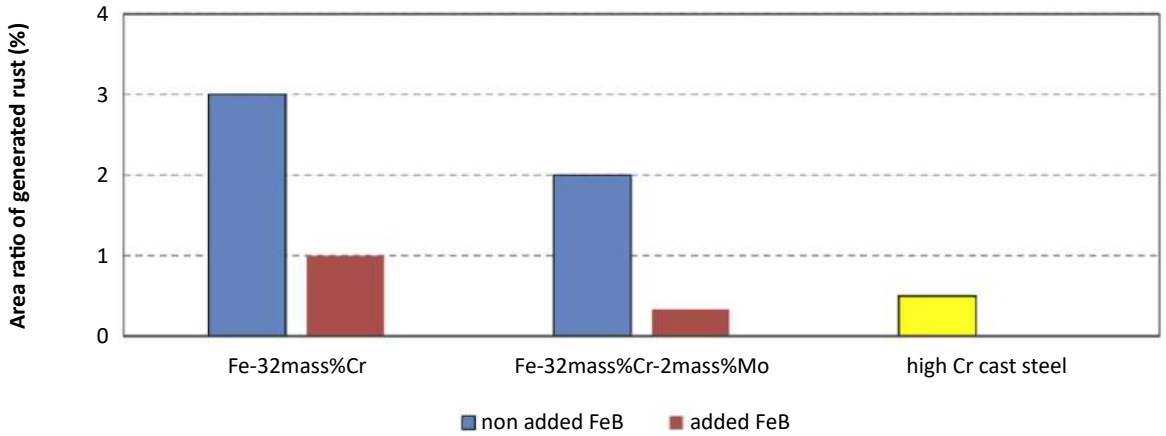

Fig. 6 Corrosion resistance of Fe-32Cr and Fe-32Cr-2Mo added with and without FeB compared with the reference high Cr cast steel [2]

have deteriorated the corrosion resistance. In order to compensate for this depletion of Cr in the matrix, more Cr needed to be added. Finally, the new material with a 15 mass% addition of CrB showed good corrosion resistance and wear resistance at 600°C. The wear test method is shown in Fig. 7.

The wear test result is expressed as the sum of the wear in the specimen and mating shaft, as shown in Fig. 8. Although the new material showed slightly higher wear of the specimen overall, wear to the shaft was much smaller, resulting in better wear properties than those of the cast high-Cr steel.

The oxidation resistance is also important for the application of the new material. The specimens were exposed to hot air at 800°C for 75 h. There was no peeling off of oxide scale, and the weight gain per unit area was equivalent to that of the high-Cr cast steel.

This successful development of heat and corrosion resistant material is expected to be more widely used, expanding the market for PM components.

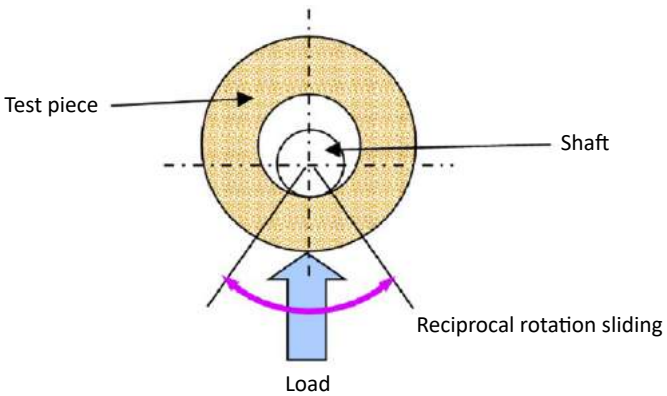

Fig. 7 Schematic presentation of wear test method [2]

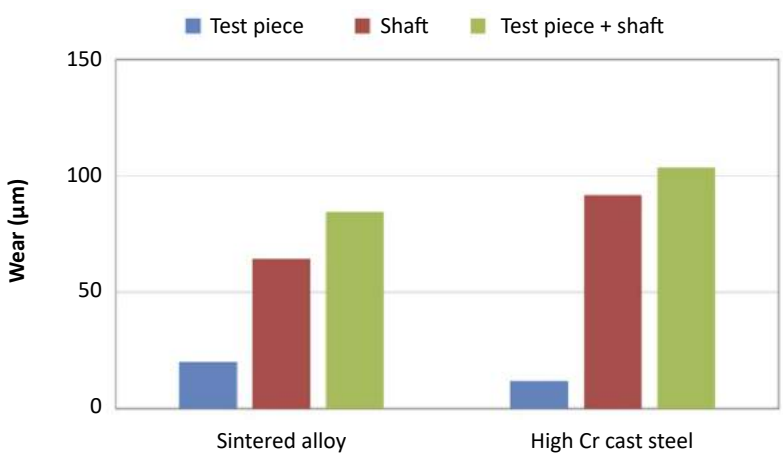

Fig. 8 Wear test results at 873°C in air [2]

Development of a high-efficiency oil pump for automobiles

The internal gear oil pump (gerotor) is used in number of automobile applications, including systems for engine lubrication, hydraulic systems for automatic transmissions (AT/CVT), direct injection diesel fuel pumps, etc. In general, the gerotor needs to offer high efficiency for the purpose of improving fuel efficiency. In a presentation from Sumitomo Electric Sintered Alloy Ltd. (SESA), Japan, the development of high-efficiency automotive oil pumps was discussed. The approach used by the researchers to improve efficiency combined a proprietary warm sizing process with

low friction inserts made of PTFE (FEX) along with their proprietary tooth design.

The gerotor has a long history, dating back to the early 20th century, and there have been various designs of tooth profile throughout its history. Sumitomo has developed various types which improve volumetric efficiency, noise, driving torque and size.

Fig. 9 shows the typical structure of an oil pump with internal gear pump rotors, while Fig. 10 shows its cross section, where the clearances in the system are visible. The development of high-efficiency oil pumps is realised by reducing the amount of oil leakage at each part of the oil pump in order to improve the volumetric efficiency, as well as reducing sliding loss generated between the rotor and the pump in order to reduce driving torque. However, there is a trade-off between these two solutions: reducing tip-clearance (tip CL) and side-clearance (side CL) improves the volumetric efficiency significantly, but leads to an increase of driving torque caused by the increase of sliding loss at the side CL and may, in the worst cases, result in pump seizure. For this reason, the lower limit of side CL is approximately 0.02 mm, which causes a certain amount of oil leakage even if the side CL is at its minimum. Hence, the degree of improvement in oil pump efficiency achievable by reducing the side CL is limited. In addition, the tolerance range of tip CL is usually determined at around 0.10 mm by taking manufacturing variations in sintering into account, making it hard to narrow the tolerance range greatly. This is one of the issues relating to the improvement of oil pump efficiency.

Accordingly, the following methodology for improving the efficiency of the oil pump was devised: adopting 'warm sizing' (WS), SESA's proprietary technology for manufacturing high-precision gears in order to reduce production variations, and applying high-performance polymers ('FEX (cross-linked PTFE resin)') at the oil pump in order to dramatically reduce sliding loss generated at the side CL. This methodology enables the lower limit of side CL to be close to zero,

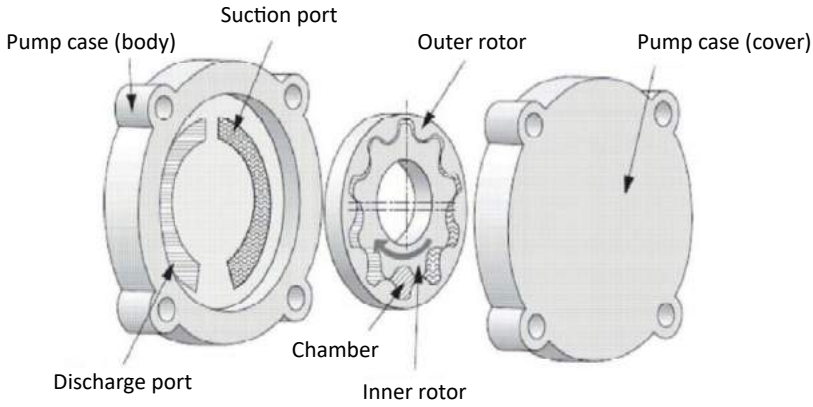

Fig. 9 Structure of internal gear oil pump [3]

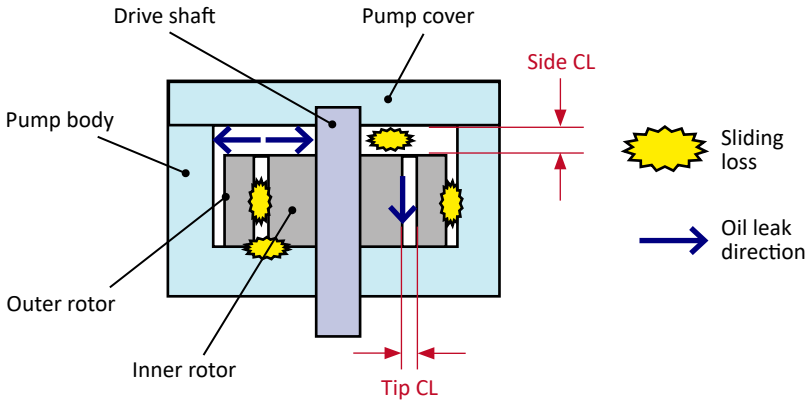

Fig. 10 Cross-section of oil rotor set [3]

which improves the efficiency of oil pumps significantly compared to that of conventional pumps.

Warm sizing is a process used to achieve high precision after heat treatment. This technology received an award from the JPMA in 2002 as a new process development, and has been used for the commercial production of high-strength, high-precision gerotors.

Fig. 11 shows the principle of the process, which is similar to 'press quenching (PQ)', used for the heat treatment of wrought ring gears and bearing races. PQ is the quench process conducted in the tool with quench oil, in order to minimise the distortion of ring shapes by Martensite transformation and thermal stress. WS exploits the repressing of under-cooled austenite during PQ in order to enable a calibration effect by sizing, and eliminates the distortion caused by quenching. As Martensite transformation occurs simultaneously with sizing in the repressing (sizing) tools, significant reduction of tip CL, even after heat treatment, was realised.

The advantages of the high-performance polymer FEX (cross-linked PTFE resin) are its excellent wear resistance and adhesive properties with the base material, which were issues with conventional PTFE resin. Its coefficient of dynamic friction is at the minimum level as solid. FEX was developed by SESA's mother company, Sumitomo Electric Industries Ltd., which calls it Electron Beam Radiation Grafted PTFE (FEX). Therefore, adopting FEX for the oil pump allows the side CL to be reduced without increasing sliding loss compared to that of conventional specifications and also without causing pump seizure. In other words, the amount of oil leakage is minimised without increasing driving torque, leading to further improved oil pump efficiency.

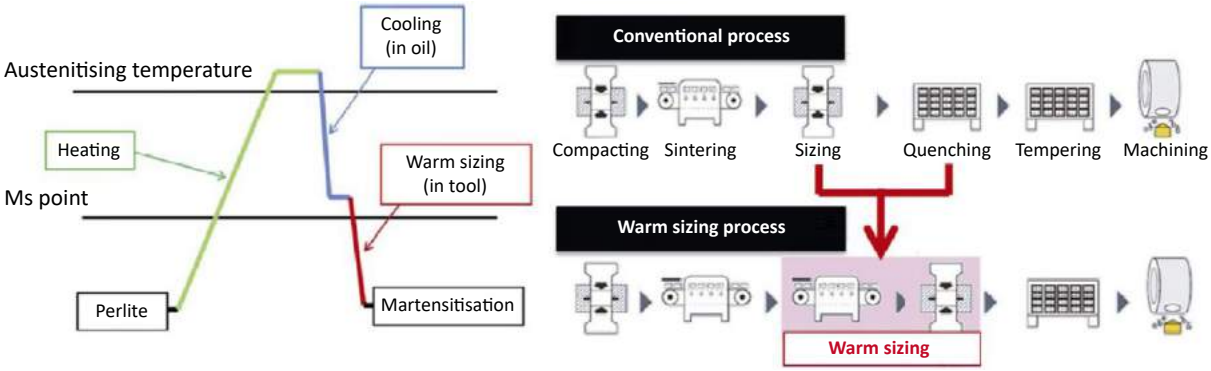

Fig. 11 Process and thermal history of "Warm Sizing" process [3]

Fig. 12 shows the oil pump with FEX plate inserts. Table 1 shows the comparison of specifications between the existing oil pump and the new one with FEX. Side CL was reduced from 30 µm to 15 µm and tip CL was reduced from 50 µm to 30 µm. As a result, the discharge volume was increased by 10% at 500 rpm and driving torque was decreased by 20% at 1000 rpm. The pump efficiency, which is the product of the efficiency of the discharge volume (volumetric efficiency) and the efficiency of driving torque (mechanical efficiency), was improved by around 15% at 1000 rpm.

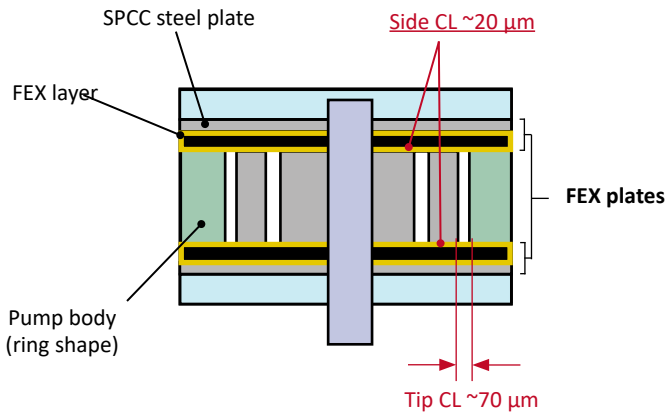

Fig. 12 Oil pump rotor set with FEX plates [3]

Contents	Existing oil pump	FEX oil pump
Theoretical discharge volume (cm^3/rev)	8.5	
Size of oil pump rotor (mm)	Ø 51 x 17 (outer diameter x thickness)	
FEX plates	-	Applied
Side CL (mm)	0.030	0.015
Tip CL (mm)	0.050	0.030

Table 1 Comparison of specifications between the existing oil pump and the FEX oil pump [3]

Process prototyping for production scale sinter (Bainite) hardening of PM parts by gas quenching

The microstructure of sintered PM parts is generally ferrite and pearlite, with the pearlite content in proportion to the carbon content. This can be changed to martensite by a hardening process wherein, after parts are heated, they are rapidly cooled in either oil or under-pressurised and recirculated gas. PM parts can also be sinter hardened in a mesh belt sintering furnace within a module placed immediately after the furnace.

To further improve the fatigue properties of forged and machined or stamped spring steel parts, as well as ductile iron cast parts, a bainite structure (instead of a martensite structure) can be obtained. This is done by austenitising the parts, quenching them to 280–400°C and holding them until the complete transformation to bainite is achieved. This process is called 'Bainite Hardening' or 'Austempering'.

India's Fluidtherm Technology reported on its work to establish a prototype furnace equipped with the function of austempering PM parts [4]. Continuous Cooling Transformation (CCT) diagrams of the typical PM steels Astaloy CrM (Fig. 13) and Astaloy Mo provided by Höganäs AB were investigated in order to estimate the process parameters, and study the different types of Bainite.

As can be seen in Fig. 13, rapid cooling at >2°C/sec gives a marten-

sitic structure, and slower cooling between 0.5°C/sec to 2°C/sec gives Bainite with Martensitic patches, but rapid cooling at above 8°C/sec to a temperature between 380°C/sec to 470°C/sec followed by isothermal holding (at chosen temperature for required time) gives 100% Bainite transformation.

The concept of the furnace is that, after debinding and sintering, the parts are transported into a gas quench module for rapid cooling, and then to a low-temperature furnace for isothermal holding, as shown in Fig. 14. During trials the sintering atmosphere used was 90%N_2+10%H_2 and the sintering condition was 1120°C for 25 min, then hot gas quenched down to, and held at, 310°C for 30 min and cooled to ambient temperature. The furnace structure was a roller hearth type, which enables the use of shutter doors and flexible feeding or holding time as can be seen in the figure. In order to design the quenching chamber and effective convection cooling system, furnace modelling of the quenching chamber was conducted using ANSYS. Assuming sintering of gears made from Astaloy Mo 0.6%C, transient cooling curves of the gears depending on the convection gas speed of 2 to 6 m/s were superimposed on CCT curves, as shown in Fig. 15.

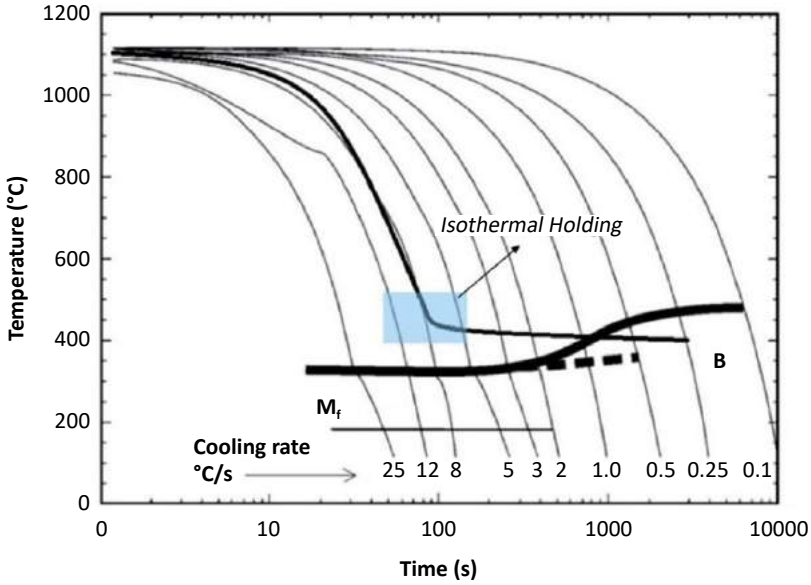

Fig. 13 CCT curve of Astaloy CrM with superimposed curve for rapid cooling and isothermal holding [4]

The hardness and ultimate tensile strength of Astaloy CrM 0.5%C is shown in Fig. 16. The hardness is considerably lower than that for the Martensitic case and UTS is 20% lower due to the Bainitic microstructure. Fatigue strength and impact energy are still to be measured.

While this concept is not applicable to mesh belt type furnaces, high volume production can be achieved in roller hearth or pusher hybrid furnaces.

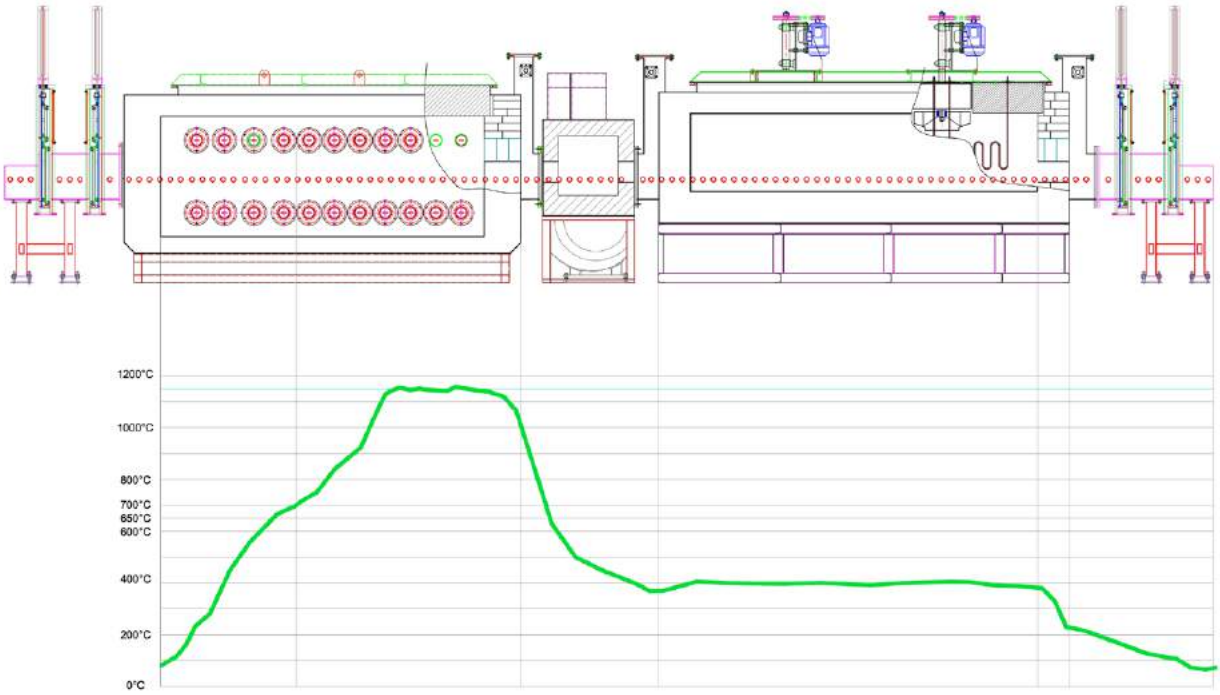

Fig. 14 Structure and temperature profile of the furnace [4]

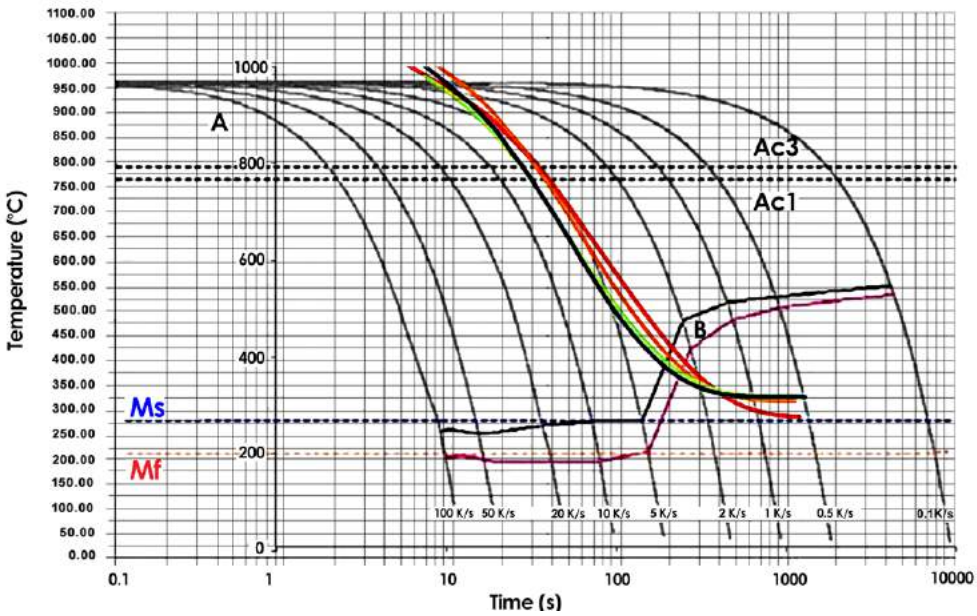

Fig. 15 CCT of Astaloy Mo+0.6C with simulated cooling rates of gas quenching [4]

Fluidtherm added that the possibility exists, in such furnaces, of carbo-austempering, where low carbon alloy parts are carburised after sintering and then hardened in the manner described above, to obtain a Bainitic surface backed by a softer substrate.

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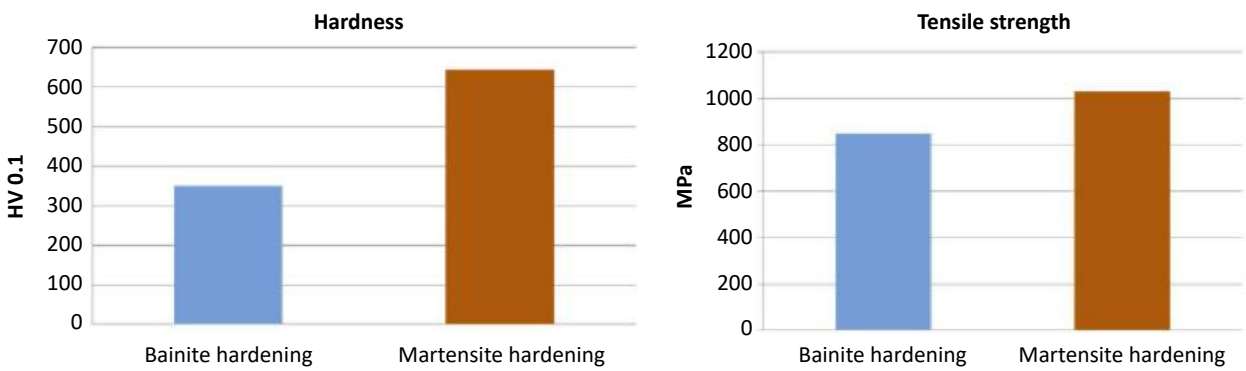

Fig. 16 Hardness and tensile strength of Astaloy CrM+0.5%C with Bainite Hardening and Martensite Hardening [4]

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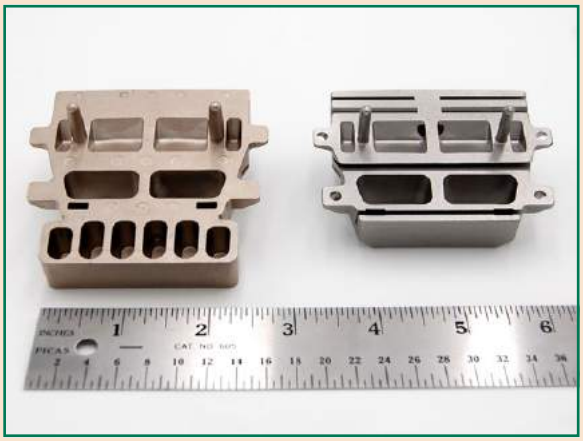

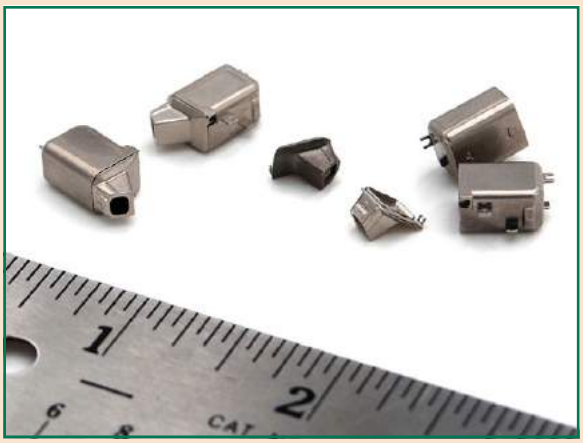

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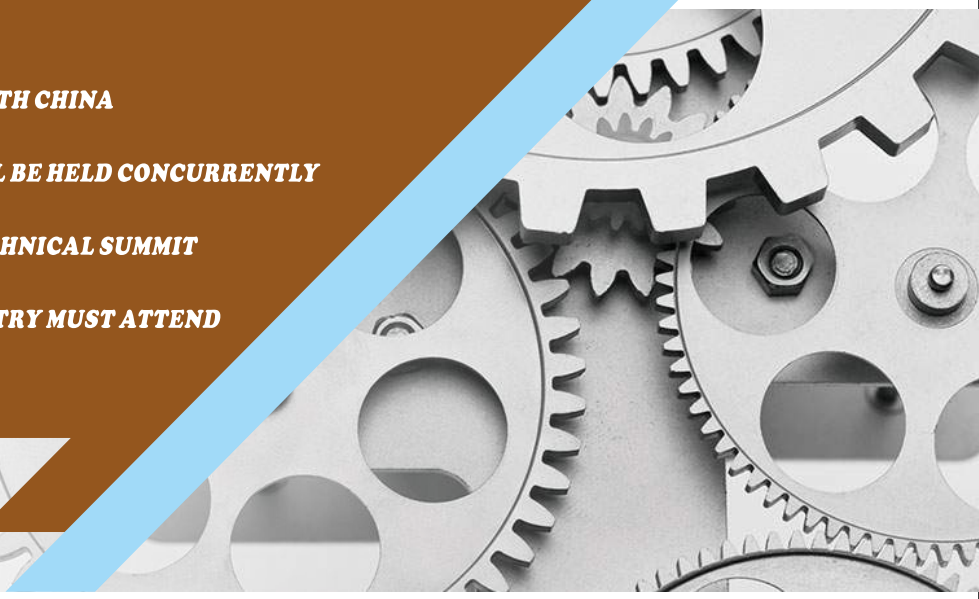

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Manufacturing Equipment of Cemented Carbide and Powder Metallurgy

Cemented Carbide Products

Powder Metallurgy Products

Detection Equipment and Technologies

Additive Manufacturing (3D Printing)

CONCURRENT EVENTS

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2. International Powder Metallurgy New Product and Technology Promotion Conference
3. The 17th Shenzhen (China) International Small Motor & Magnetic Materials Exhibition
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WORLDPM2018: Plenary sessions highlight continued growth for global Powder Metallurgy

The reviews of the status of the PM industries in Asia, Europe, and North America, as presented during the Plenary Sessions at the WORLDPM2018 Congress in Beijing, China, September 16-20, again served to highlight positive market trends in the various sectors of Powder Metallurgy as well as technological developments. Bernard Williams, Consulting Editor, reports on the industry status presentations, including the rapid development of PM in China over the past decade.

The global Powder Metallurgy community gathered at the China National Convention Centre in Beijing, September 16-20, 2018, to attend the first World PM Congress and Exhibition to be held in China. The event, which was organised by the Chinese Society of Metals and the China Powder Metallurgy Alliance in cooperation with the Asian Powder Metallurgy Association and other regional PM trade associations, provided more than 1,000 delegates from over 40 countries around the world the opportunity to learn about the latest technological developments in the various sectors of PM. Over 400 technical papers were presented and the large accompanying exhibition underlined the latest developments and offerings from metal powder producers and equipment suppliers.

The opening Plenary Session included presentations by leaders of trade associations on the state of trade and technology in their respective regions, and as this was the first World PM Congress to be held in China, there was an additional Plenary presentation which focused on the rapid growth experienced in PM in China over the past decade.

Status of PM in Asia

Yoichi Inoue, President of the Japan Powder Metallurgy Association (JPMA), reviewed production trends for PM ferrous and copper-based materials in Asia. He stated that there were positive trends in nearly all Asian countries with PM industries in 2017, with the exception of Malaysia and Thailand (Table 1). Structural PM part production in China was shown to have increased by 9.4% in 2017, with the ferrous PM sector increasing by 8.4% to 169,636

Fig. 1 More than 1,000 delegates from over 30 countries attended the World PM2018 Congress in Beijing, September 16-20, 2018.

Area		2015	2016	2017	17/16(%)
Japan	Iron-base	89,123	88,145	92,166	104.6
	Copper-base	3,449	3,121	3,059	98.0
	Total	92,572	91,266	95,225	104.3
China	Iron-base	146,153	156,525	169,636	108.4
	Copper-base	12,457	12,669	15,535	122.6
	Total	158,610	169,194	185,171	109.4
Korea	*Iron-base	67,617	64,086	68,917	107.5
	Copper-base	640	633	435	68.7
	Total	68,257	64,719	69,352	107.2
Taiwan	Iron-base	30,680	30,000	32,637	108.8
	Copper-base	2,100	2,000	2,070	103.5
	Total	32,780	32,000	34,707	108.6
India	Iron-base	30,500	30,000	33,600	112.0
	Copper-base	10,000	6,000	7,200	120.0
	Total	40,500	36,000	40,800	113.3
Malaysia	Iron-base	4,186	3,810	3,744	98.3
	Copper-base	136	116	85	73.3
	Total	4,322	3,926	3,829	97.5
Singapore	Iron-base	1,452	1,486	1,542	103.8
	Copper-base	498	438	404	92.2
	Total	1,950	1,924	1,946	101.1
Thailand	Iron-base	16,074	17,141	16,498	96.2
	Copper-base	7	8	66	825.0
	Total	16,081	17,149	16,564	96.6
Indonesia	Iron-base	3,992	5,444	6,134	112.7
	Copper-base	83	68	96	141.2
	Total	4,075	5,512	6,230	113.0
Total	Iron-base	389,777	396,637	424,874	107.1
	Copper-base	29,370	25,053	28,950	115.5
	Total	419,147	421,690	453,824	107.6

** includes other applications*

Table 1 Production trends for iron-and copper-based PM products in Asia 2015-2017

tonnes and Cu-based parts, including bearings, by 22.6% to 15,535 tonnes. Japan recorded an increase of 4.3% in combined ferrous and Cu-based PM production to 95,225 tonnes.

Korean PM production increased by 7.2% to 69,352 tonnes, Taiwan was up 8.6% to 34,707 tonnes, and India recorded a gain of 13.3% to 40,800 tonnes, which included a 12% increase in ferrous PM and a 20% increase in Cu-based PM products.

Total ferrous and Cu-base PM production in all Asian countries reached 453,824 tonnes in 2017 which Inoue stated was a healthy 7.6% increase on the previous year. A key reason for the continuing growth of PM in Asia is the dominance of the production of ferrous and non-ferrous structural parts for the growing automobile sector. As can be seen in Table 2, the percentage of automotive applications for PM is 94% or over in Japan, Korea, Thailand and Indonesia and 80% and 62% in India and China respectively.

Inoue then focused on production trends for PM parts and bearings in Japan. He stated that there has been little growth in PM production in Japan since 2010, when the industry recovered from the economic crisis in 2009. Production of structural PM parts in 2017 was said to be 88,484 tonnes - up 4% on the previous year, and PM bearing production was up 8.3% to 6,741 tonnes. Inoue stated that the increases were the result of growing domestic production of vehicles, which saw a rise of 5.3% from the previous year. However, he reported that the average weight of PM parts per car is estimated to have fallen from 9.7 kg in 2010 to 8.5 kg in 2017. As can be seen in Fig. 2, Japanese production of structural PM parts reached 104,000 tonnes in 2008 but fell significantly in 2009 as a result of the international economic crisis.

Inoue stated that the JPMA is undertaking a number of initiatives to promote the application of PM parts including annual awards for new PM designs and new materials. He cited the development of a new PM planetary carrier and a complex-shaped PM pulley having non-circular gear teeth which won Design awards in 2017. In the new Materials category were included awards for a sintered current collector used on high-speed trains and PM Fe-Cu bearings for high sliding load applications. He further stated that the JPMA will publish a Roadmap in 2020 outlining projections for the Japanese PM industry up to 2030.

Status and trends in Europe

Philippe Gunderman, President of the European Powder Metallurgy Association (EPMA), reported on the continuing healthy state of all sectors in the European PM industry, which he said was supported by a strong supply chain for metal powders and

AREA	For Transportation Machines	For Industrial Machines	For Electrical Machines	For Others
Japan	94.3	4.8	0.6	0.3
China	62.0	2.0	25.0	11.0
Korea	94.0	0.0	3.0	3.0
Taiwan	44.0	26.0	7.0	20.0
India	80.0	5.0	8.0	7.0
Malaysia	56.1	1.9	42.0	0.0
Singapore	52.5	3.2	42.9	1.4
Thailand	91.8	1.1	7.1	0.0
Indonesia	100.0	0.0	0.0	0.0

Table 2 Main application areas for PM products in Asia

production equipment as well as more than seventy active R&D centres involved in PM across Europe. Gunderman stated that metal powder shipments for all PM sectors increased to around 250,000 tonnes in 2017, which represents an increase of 2% by volume compared with 2016 (Fig. 3). Of this total, the ferrous PM part sector was said to make up around 80%. In terms of sales value Gunderman put the total in Europe at €11.6 billion in 2017 for all PM sectors, which he said was a 3% increase over the previous year (Fig. 4).

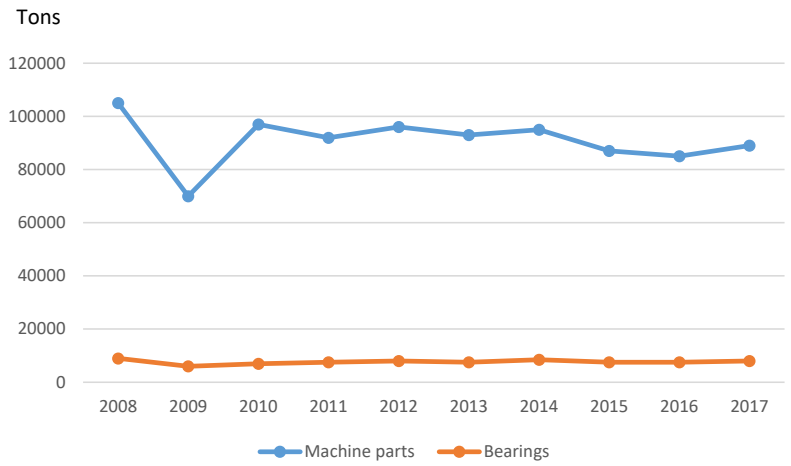

Fig. 2 Production of structural PM parts and PM bearings in Japan 2008-2017

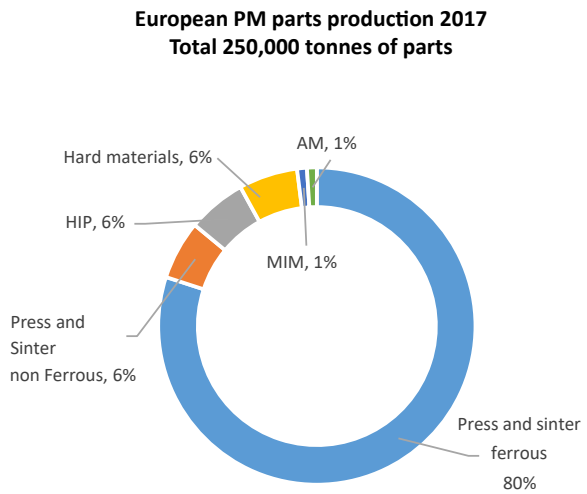

Fig. 3 Powder production for all PM sectors increased 2% by volume In Europe in 2017

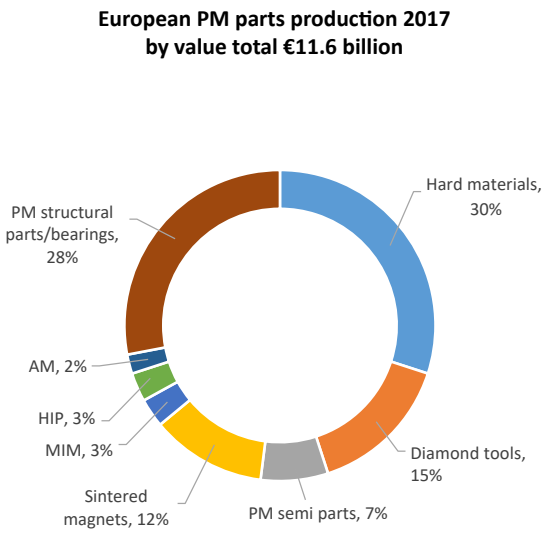

Fig. 4 Breakdown of European PM production by sales value in 2017

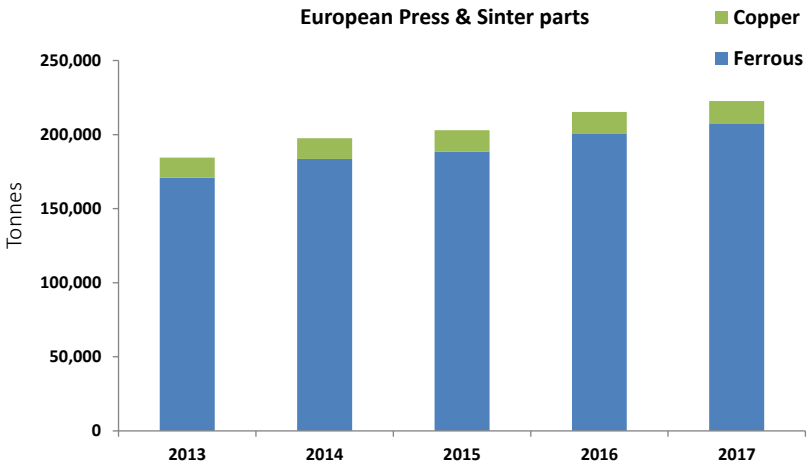

Fig. 5 Production of ferrous and copper-based PM grade powders in Europe 2013-2017

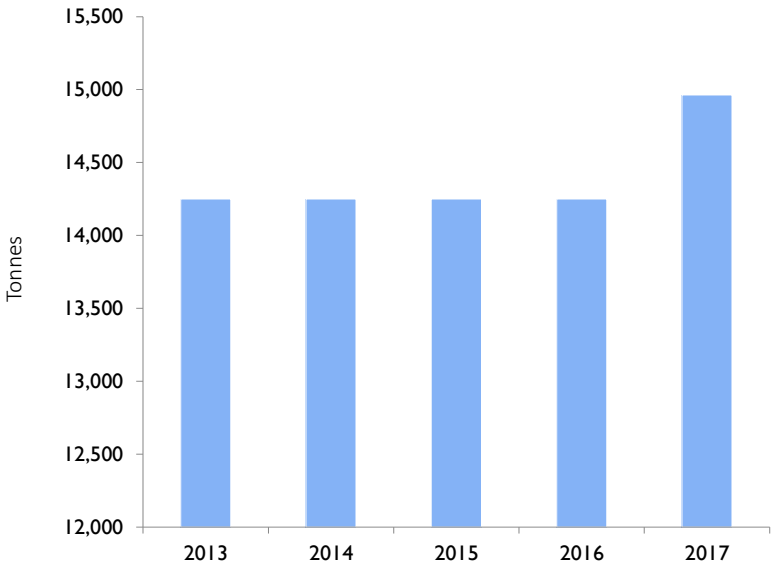

Fig. 6 Production of hardmetal (cemented carbide) cutting tools and wear parts showed significant gains in Europe 2017

Fig. 5 shows the steady growth in ferrous and Cu-base PM production in Europe over the past five years. Much of this growth is attributed to the application of PM parts in the automotive industry, with an average of 8 kg of PM parts being used per vehicle. The gradual increase in production of pure electric (ECV) or hybrid electric vehicles (HEV) could impact on the European PM parts industry, stated Gunderman. In 2017 around 4.4% of the 17 million cars produced in Europe were either EVC or HEV, and the production of these vehicles is expected to accelerate in the years ahead.

Although hard materials, comprising cutting tools and wear resistant parts, made up only around 15,000 tonnes of the volume of PM parts produced in Europe in 2017, hard materials is the largest sector in terms of sales value, representing 30% of the total of €11.6 billion in Europe. Hard materials are followed by structural PM parts at 28%, and diamond tools at 15%. Fig. 6 shows that hard materials production made a significant gain in 2017 after four years of essentially no growth.

Gunderman stated that the Metal Injection Moulding (MIM) sector was also performing well, with an 8% increase in sales in 2017 to exceed €400 million. Hot Isostatic Pressing is another sector doing well, particularly in the aerospace sector, and new functional PM materials are emerging in Europe for applications such as energy storage, high efficiency motors, heat

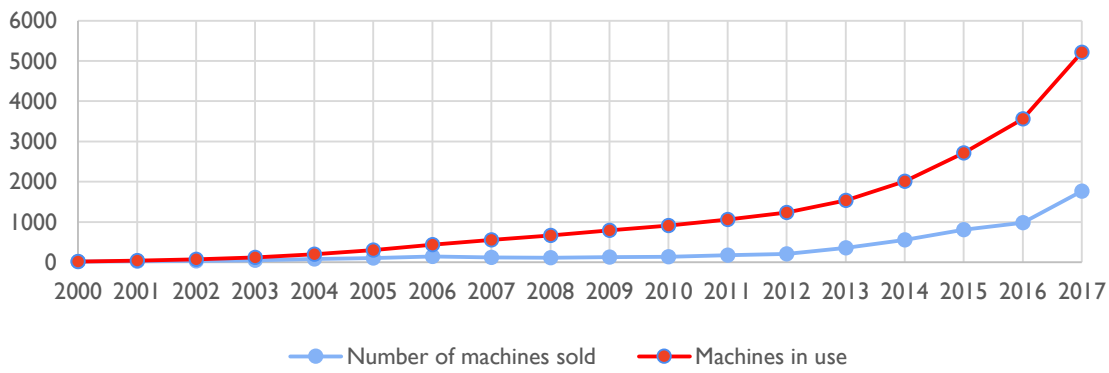

Fig. 7 Number of AM machines sold and in use in Europe 2000-2017

transfer and heat recovery. Additive Manufacturing (AM) is certain to have an impact on the European PM industry, said Gunderman, who reported that around 2,000 metal AM machines were sold in Europe in 2017 for production and/or part development. This takes the total to over 5,000 metal AM machines now in use in Europe compared with 1,000 in 2010 (Fig. 7). The metal AM market is expected to double in Europe over the next ten years.

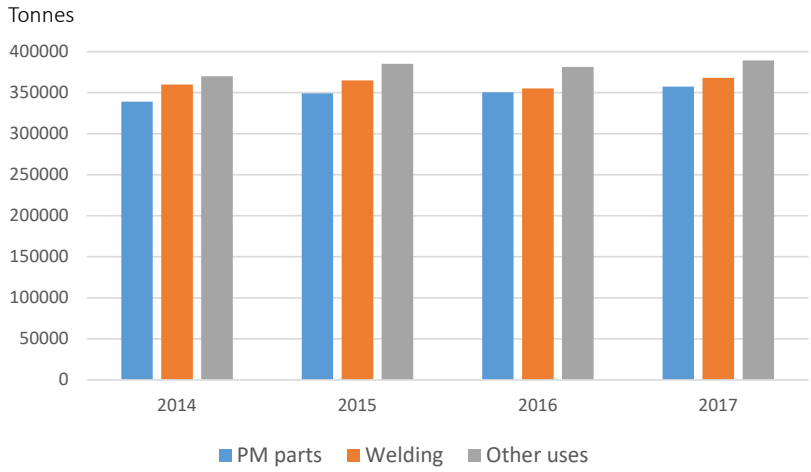

Fig. 8 North American iron powder shipments - 2014 to 2017

State of the North American PM industry

John Sweet, president of the Metal Powder Industries Federation (MPIF) reported that North American metal powder shipments grew modestly in 2017, and that powder producers are optimistic for 2018. Iron and steel powders for the structural PM part sector increased by just 2% to 357,399 tonnes with a further 32,000 tonnes of iron powder shipped for welding and other uses (Fig. 8). Estimated stainless steel powder shipments increased by 3% to 7,936 tonnes, with copper and Cu-based powders increasing by 2% to 16,462 tonnes. According to the MPIF, tungsten and tungsten carbide powder shipments rose by around 50% in 2017 to 1,125 tonnes and 7,916 tonnes respectively. The increase in oil drilling activities in the USA was a factor contributing to the higher tungsten carbide powder shipments.

Sweet further reported that whilst conventional PM part production will ease into a maturing mode in the coming years, PM manufacturers state that mid-range designs of PM parts are still profitable and growing. They are forecasting 5-10% growth across the market and some PM part producers expect to see double digit growth in 2019-2020. The average size North American sedan car currently contains an average of 12.7 kg/car whilst a mid-range crossover uses 20 kg/car of PM parts and a large SUV uses around 34 kg/car. The production of aluminium PM parts is expected to increase as automobile manufacturers seek to lighten vehicles and powertrains. Sweet gave the example of a new PM aluminium transmission planetary carrier developed by GKN Powder Metallurgy.

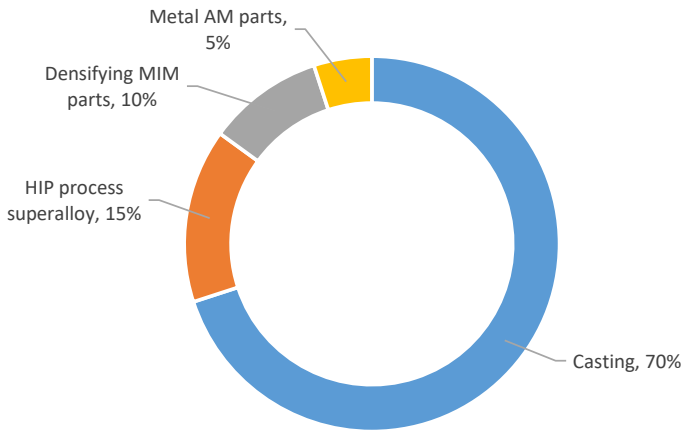

Fig. 9 Breakdown of the North American hot isostatic pressing market

Metal Injection Moulding (MIM) sales in North America are said to have increased by 5% in 2017 to exceed $400 million, despite US firearm manufacturers facing reduced sales during the year. Sweet said that the metal AM business seems to be changing almost monthly, and the new Association for Metal Additive Manufacturing (AMAM) established by the MPIF is forecasting significant increases in sales for this sector in 2018. Metal AM is attracting significant investments from large international corporations, and the sector is hopeful that AM will be adopted into commercial production relatively quickly. Both metal powder and equipment sales for metal AM are strong in North America. The Hot Isostatic Pressing (HIP) market in North America is dominated by the castings sector (70%) but applications such as the HIPing of PM superalloys, and densifcation of MIM and metal AM parts, are also significant and growing (Fig. 9).

Sweet stated that the MPIF is working to establish a new Digital Library for Powder Metallurgy through a repository of technical PM papers dating back to 1945.

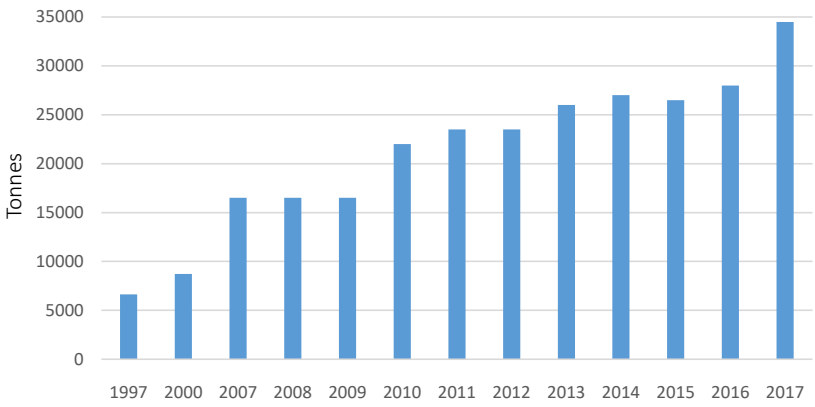

Fig. 10 Production of cemented carbides in China 1997-2019

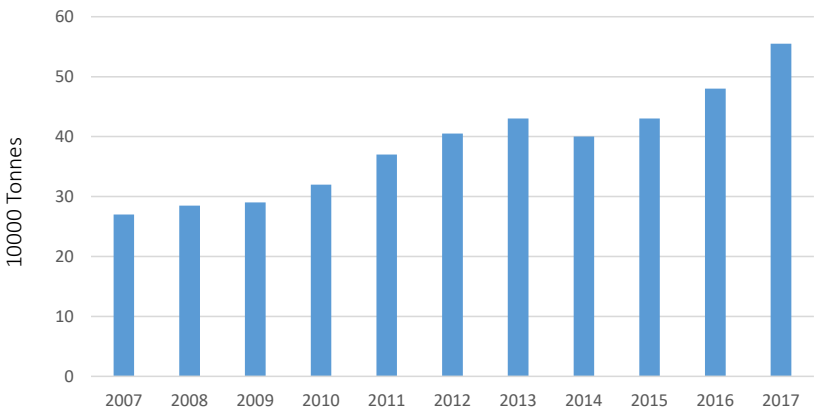

Fig. 11 Shipments of iron and steel powders in China for all applications 2007-2017. PM grade iron powders shipments were reported at 221,000 tonnes in 2017

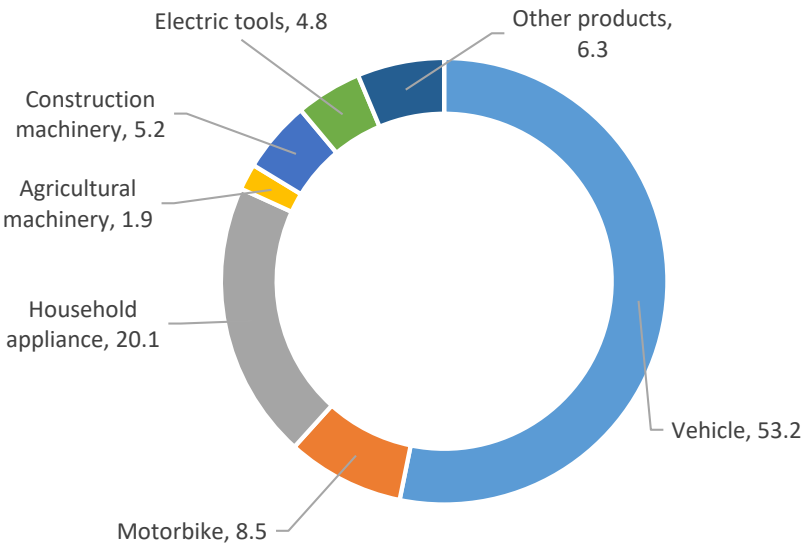

Fig. 12 Breakdown of PM-grade iron powder applications in China in 2017

China's rapidly growing PM industry

As this was the first occasion for China to host a World PM Congress, it was appropriate to include a presentation which reviewed how PM has progressed in the country in recent years. Professor Huang Boyun, Director of the Expert Committee at the China Powder Metallurgy Alliance (CPMA), covered China's key PM interests which include cemented carbides, ferrous and non-ferrous Powder Metallurgy products, PM rare earth magnets, PM friction materials, PM superalloys and the development of metal powders for Additive Manufacturing.

Prof Huang stated that much of the success and expansion of China's PM industry has been due to the establishment of a group of research institutes which are cooperating with and supporting industry in key areas of PM research to assure future growth. Universities are also offering a complete training system to prepare PM professionals to work in the various sectors of PM.

China has seen a rapid expansion of its infrastructure over the past decade or so, and this has also been one of the driving forces for the rapid growth in cemented carbide production in the country. Prof Huang stated that by 2017 China had built 24,000 km of high-speed railways, 126,000 km of conventional railways, and 130,000 km of highways. In addition around 5,000 km of subway (metro) lines have been constructed in 34 cities with a further 6,300 km under construction in some 56 cities in China. Cemented carbide tools have played a key part in construction projects and together with advances in cutting and forming tools for manufacturing industries, production reached 34,500 tonnes in 2017 - an increase of 23% compared with the previous year (Fig. 10). Exports of cemented carbide products accounted for 22.4% of production in 2017, and

China today makes up 39% of global cemented carbide production. However, Prof Huang stated that the country will in future focus more on quality of carbide products rather than quantity. To achieve this China is establishing multi-component property databases for cemented carbides including cutting test data to optimise carbide substrates and coatings in the production of cutting tool inserts.

Another key area of PM in China is the production of ferrous PM parts. Prof Huang reported that iron and steel powder shipments in China reached 553,000 tonnes in 2017, achieving an annual growth rate of 10% over the past ten years (Fig. 11). Of this total, 221,000 tonnes was for ferrous PM parts used in a variety of sectors but mainly for automobile and motorcycle applications (Fig. 12). He stated that 90% of the sales of ferrous PM parts in China was dominated by just nine enterprises.

Powder producers are working to develop improved grades of iron and steel powders including meeting the demand for higher compressibility to achieve green density of 7.24 g/ cm^3 at a compacting pressure of 600 MPa, diffusion alloyed Fe-Ni-Mo-Cu powders having less segregation, and premixed steel powders with reduced dusting and improved dimensional stability in structural parts. Prof Huang stated that one Chinese producer has recently built an automatic production line having a capacity of 90,000 tonnes/year of water atomised iron and steel powder.

PM rare earth (NdFeB) magnets are another sector in which China has built a world leading position thanks to the huge resources of rare earth minerals in the country. 148,000 tonnes of NdFeB magnets were produced in China in 2016, of which around 25,000 tonnes were exported (Fig. 13). China now accounts for around 85% of the global market for NdFeB magnets.

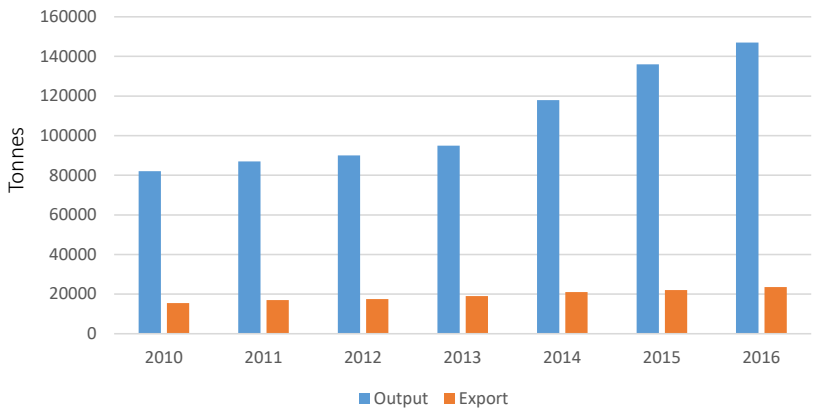

Fig. 13 Production of NdFeB rare earth permanent magnets in China 2010- 2016

Fig. 14 Production of sintered brake blocks for high speed trains now exceeds 300 million pieces/year

Prof Huang stated that sintered friction materials are supporting the rapid growth of China's high-speed rail network. The market for the sintered brake blocks used on high speed trains travelling at up to 350 km/h and other vehicles (Fig. 14) now exceeds 300 million pieces/year, and this sector is expected to have sales exceeding Yuan 10 billion ($1.44 billion) by 2020. Further examples of the advanced level of PM technology achieved in China are the production of high-performance PM superalloy components such as turbine disks for aero engines, and the development of high quality metal powders for Additive Manufacturing.

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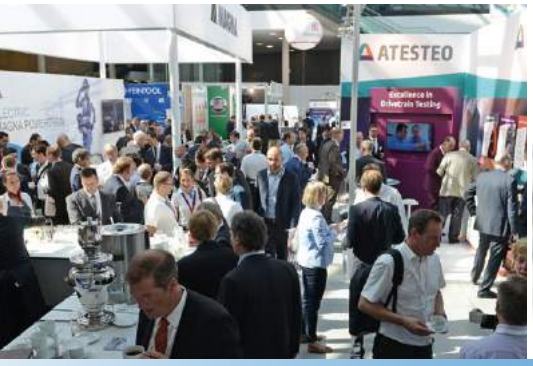

JPMA Awards 2018 recognise innovations within Japan's PM industry

The winners of the Japan Powder Metallurgy Association 2018 Powder Metallurgy Awards once again served to highlight the ongoing developments being made to further expand the range of PM applications. The winners included innovations in component design and processing, demonstrating the continued potential for new applications in the automotive sector, as well as other high-volume application areas.

Development prizes

Oil impregnated sintered bearing with 1 µm inner dimensional tolerance

A prize was awarded to Porite Corporation for the development of an oil impregnated sintered bearing. The part has a 1 µm inner dimensional tolerance, with an inner diameter of φ 2.5 mm and a length of 11 mm (four times the inner diameter). The bearing is applied to a polygon scanner motor, which requires very high operating speed levels and high precision.

In recent years, higher operating speeds have required miniaturised motors to have higher outputs. However, at these high speeds, if the clearance between the motor shaft and the inner diameter bearing is too wide, noise and vibration will occur. On the other hand, if the clearance is too narrow, the motor current value increases and it takes more time to reach specified revolutions. In order to solve these problems, the clearance between the bearing and the shaft must be optimised by reaming the bearing inner diameter after the normal sizing operation. However, in this method, management of the rotating sizing tools was reported to be expensive and not easy.

The part's developers succeeded in reducing the inner diameter variation by one third, compared with conventional sizing, by improving the bearing material, tooling and the processes of compaction, sintering and sizing. As a result, a 1 µm inner dimensional tolerance was achieved using only the sizing process, negating the need for a reaming process.

Fig. 1 Porite Corporation received an award for its development of an oil impregnated sintered bearing (Courtesy JPMA)

Fig. 2 Fine Sinter Co. Ltd received an award for its development of a transmission part for hybrid vehicles (Courtesy JPMA)

Fig. 3 Porite Corporation achieved a second award for its development of a bush used in a motorcycle ABS hydraulic control unit (Courtesy JPMA)

Transmission parts for new-generation hybrid vehicles

Fine Sinter Co. Ltd received an award for the development of an important functional transmission part for the next generation of hybrid automobiles. The part supports the whole weight of a vehicle when the parking lock is on. High reliability is critical for this part, as any damage could lead to physical injury.

As the fuel efficiency of hybrid automobiles is particularly important, this part is required to be designed differently from earlier versions, requiring a reduction in part weight as well as a reduction in the number of components in the unit.

In the original design, it was difficult to compact the shape of the part. Working with the customer, Fine Sinter optimised the part geometry, including the peripheral parts inside the unit, after making a review of the design. Further improvements, for example in restructuring of the die, were also carried out.

The two-step shape, which the old product did not have, was achieved with minimal and simple machining. Through this process, Fine Sinter was able to maintain the functionality required in the customer's initial design, and succeeded in removing two components from the original part design. The effect of this was a reduction in the cost of a unit by about 40%, and reduction in weight by about 10%, contributing to an improvement in the customer's competitiveness.

Sintered eccentric bush used in a motorcycle ABS hydraulic control unit

Porite Corporation received a second award for its development of an eccentric bush used in a motorcycle's anti-locking brake system's hydraulic control unit. The unit is used for the conversion of the rotary motion of the shaft into a linear reciprocating motion of the hydraulic driving piston.

ABS is widely used in cars, but not in motorcycles. However, in recent years, motorcycle ABS has been becoming mandatory worldwide. Accordingly, production volumes for this device are expected to be increased significantly.

At the first stage of the development, the customer chose to use an integrated camshaft manufactured by a machining process. In order to reduce the cost, the design was then changed to the combination of the sintered eccentric bush and the straight shaft.

In general, ferrous material is selected when this type of machine part is designed. However, a copper-based material was selected for three reasons; corrosion resistance, an elongation level that can allow easy deformation in a sizing process to fulfil the very thin wall thickness requirement of 0.7 mm and ease of sizing to achieve a dimensional tolerance of 6 μm in the inner and outer dimensions. As a result, around 50% cost reduction was successfully achieved.

Sintered screw nut used in a medical syringe pump

A further Porite Corporation award was for a non-circular sintered screw nut used in a medical syringe pump, equipment that provides small amounts of liquid medicines continuously. The nut is required to transmit the lead screw rotation to the plunger accurately. It is also required to support the lead screw while rotating at low speed with low friction and high accuracy.

This part was originally a molybdenum-coated material, manufactured by a machining process and needed to use grease. The adoption of the sintered bearing material, selected for the condition of high-load and low-speed, met the required smoothness and durability without needing to use grease.

In addition, this product's design was required to prevent tooth jumping. This requirement was met by the adoption of the serration tooth shape, after discussion with the customer. As a result, cost is reduced to one third of the original. Also, as this is a grease-free product, the former problem of scattered grease was solved.

High-density sprocket with low cost and compaction without a die lubricant

Fine Sinter Co. Ltd. secured a second award for a two-step engine sprocket with a high density of 7.35 g/cm^3 achieved by normal compaction and mesh-belt sintering.

In order to produce high-strength products, various methods (such as warm die compaction, die-wall lubricated warm compaction and high temperature sintering) have been adopted that require the addition of nickel, an expensive alloying element. In contrast, for the purpose of cost reduction, this development used the hybrid Mo steel powder (pre-alloy with Mo and diffusion bonded with Mo fine powder) that does not contain nickel. Although this raw material powder has relatively good compressibility, it is necessary to apply high compaction pressure in order to achieve a density of over 7.35 g/cm^3. This required the optimisation of tool breakage by using CAE analysis.

In addition, the achievement of green density levels over 7.35 g/ cm^3 also contributed to cost reduction through the ability to employ inexpensive mesh belt sintering, because expensive high temperature sintering is no longer necessary to achieve the high density.

By this development, compared with the conventional die-wall lubrication compaction method, a cost reduction of around 22% was achieved.

Fig. 4 An award was presented to Porite Corporation for this non-circular sintered screw nut used in a medical syringe pump (Courtesy JPMA)

Fig. 5 Fine Sinter Co. Ltd. received an award for a high density two-step engine sprocket (Courtesy JPMA)

Fig. 6 An Effort Prize was presented to Sumitomo Electric Industries Ltd. for a gear set for use in a turbocharged engine component (Courtesy JPMA)

Effort prizes

Development of gears for a wastegate valve in a turbocharged engine

The first of the Effort prizes went to Sumitomo Electric Industries Ltd. for a gear set for a decelerating mechanism in a turbocharged engine, used for opening and closing a wastegate valve.

The use of sintering technology for the manufacture of the gears was investigated as an alternative to adopting high strength resin. Although high strength resin was initially chosen, it was replaced due to its insufficient strength in this application.

The predicted drawback, caused by replacing light weight resin with sintered materials, was a considerable increase in gear weight. However, this issue was eliminated by optimising the gear design by introducing holes for reduced gear weight.

Although forming large holes in the gear contributes to weight reduction, the thickness of tools to form the holes in the gear inevitably becomes thin and breakable. As a measure to combat this, the shape of tooth profile of the gear was improved to avoid stress concentration in the gear.

This development has succeeded in the mass production of gears for a wastegate valve, while meeting characteristics required by customers.

Fig. 7 Sumitomo Electric Industries Ltd. received a prize for a sensor holder for an automotive application (Courtesy JPMA)

Development of a pressure sensor holder in a gasoline direct injection system

Sumitomo Electric Industries Ltd. secured a second Effort prize for a component used to fix a pressure sensor onto a delivery pipe in a gasoline direct injection system. The pressure sensor is a critical device for improving fuel efficiency and is used to measure pressure inside the engine, controlling the injection timing and pressure.

Sensor holders have previously been manufactured by forging and machining, which can be costly in high volume production. The required characteristics of the sensor holder include airtightness, strength, corrosion resistance and high dimensional accuracy. The component also has thin walls in part.

The use of PM was investigated primarily to reduce cost. The production method included compaction and sintering of a high strength material, machining, heat treatment, resin impregnation and plating. In most cases, the blank/material cost of sintered parts can be more expensive than that of forged parts. However, the machining cost of the sintered part was successfully reduced, compared with conventional forged parts, by optimising the shape of blank/material.

This takes advantage of PM's capability to offer a high degree of design freedom, and a 20% reduction in manufacturing cost for sintered sensor holder was achieved. This enabled the replacement of conventional forged parts with sintered ones, while maintaining all the necessary functions for required by the customers.

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www.pmccexpo.com/pmcc2.html

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