VOL. 9 NO. 3
AUTUMN/FALL 2020

POWDER METALLURGY REVIEW

STATE OF THE NORTH AMERICAN PM INDUSTRY

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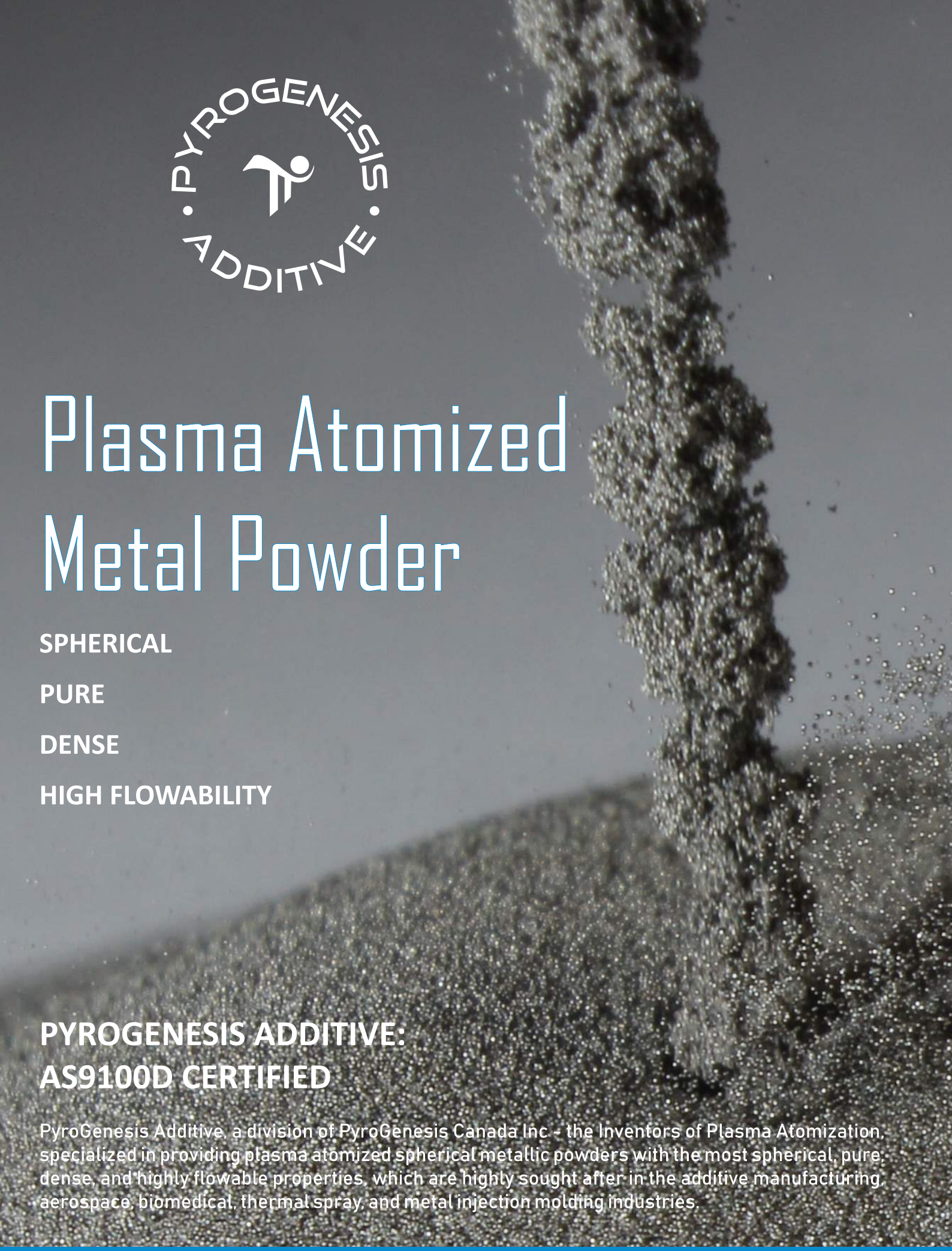
www.pm-review.com



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

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A brave new world for PM events

This year, the European Powder Metallurgy Association will hold its first-ever virtual congress, replacing the annual Euro PM event which was set to take place in Portugal. With three full days of technical presentations and special interest seminars, scheduled to take place October 5–7, the web-based conference is set to cover all aspects of Powder Metallurgy.

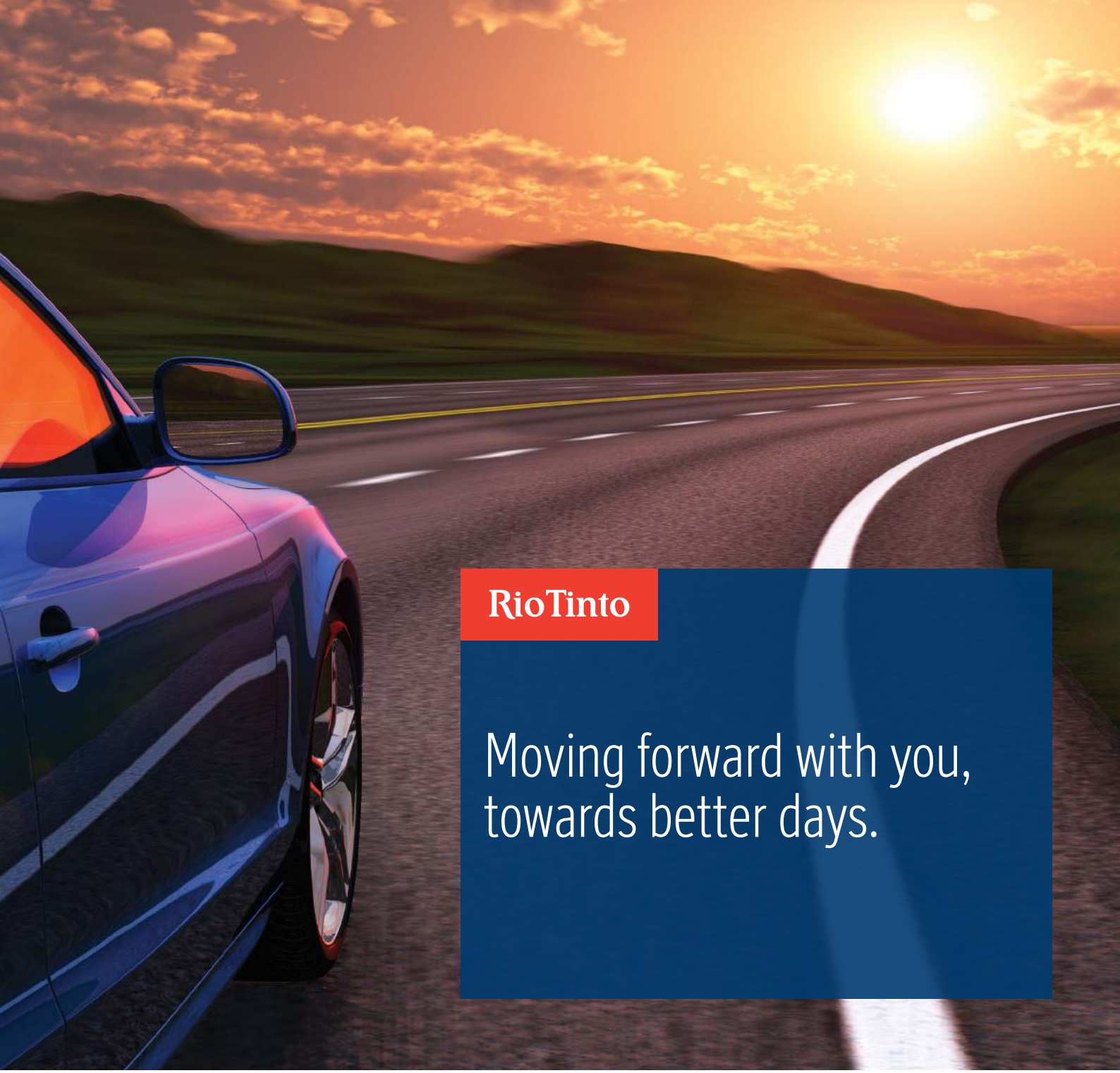
The concept of the virtual event will be new to most of us, and will be very different to the normal conference experience on many different levels. The basic interactions that author and delegate enjoy will be difficult to replicate. The networking and social aspects pretty impossible to achieve. However, don't let that be a barrier. We need to embrace the format as best we can, and take the opportunity for what it is – a chance to discover the latest advancements in the Powder Metallurgy process and applications, from the comfort of our own desks.

It has also been announced that Formnext, the largest Additive Manufacturing exhibition, will also run virtually this year. Being predominantly an exhibition, realising this as a fully digital event will be a challenge for the organisers. However, with such a committed team working closely with its core exhibitors, we can be sure that the best will be made of the current situation. Albeit without a beer or two at the infamous exhibitor party!

Looking ahead to next year's schedule, the MPIF has already announced that its annual MIM conference will take place as a virtual event in February. How the rest of the year's events will pan out remains to be seen, but whatever the situation, you can be assured you will still find the latest news and developments from the PM industry in *PM Review* magazine.

Paul Whittaker
Editor, *Powder Metallurgy Review*

Cover image
The MPIF PM Design Excellence Award winners in the Automotive category (Courtesy MPIF)



We are in unprecedented times. However, these are the times when agility, resilience and innovation of our people define our businesses.

At Rio Tinto Metal Powders we have implemented social distancing measures, promoted good hygiene habits and applied new site access requirements including body temperature measurements. Furthermore, at our Technology Centre in Sorel-Tracy, we produced hand sanitizer to keep our employees and communities' safe – even supplying paramedics. We also donated hundreds of N95 (FFP2) masks to the local hospital.

These initiatives make Rio Tinto a part of the solution in the fight against COVID-19. If you are proud of your initiatives, share with us and we will publish them in our next Customer Bulletin. We are all in this together, and it is through teamwork and innovation that we will rise to the challenge. Please feel free to contact your regional sales representative should you have any concerns during the COVID-19 crisis or email us at **info.qmp@riotinto.com**

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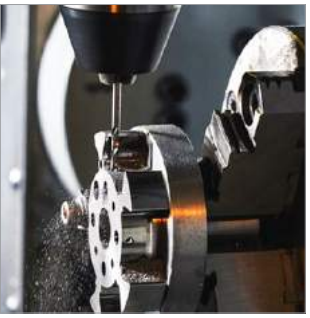
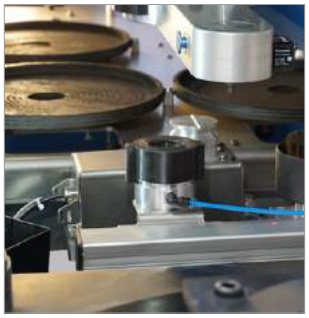
POWDER METALLURGY REVIEW





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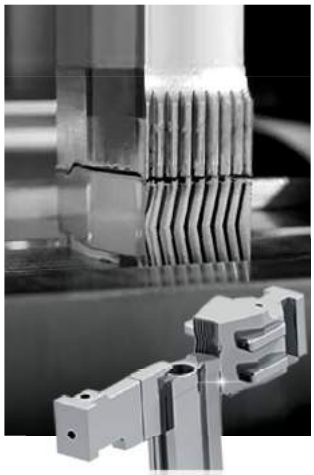

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- **Ceramic Powder** – hard working, long lasting tools.

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- → Validate Metal Printed Parts — metallurgical evaluations, mechanical testing, microstructure and failure analysis
- → Powder Studies — alloy development and powder re-use

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industry news

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

Sacmi's new MPH250 hydraulic metal powder press offers high productivity

The Sacmi Group, headquartered in Imola, Italy, has announced the launch of its latest metal powder press, the MPH250. The new 250-tonne multilevel CNC hydraulic press is equipped with three upper axes and three lower axes, and is said to offer a reduced footprint and low energy consumption.

The MPH250 multilevel CNC hydraulic press (Courtesy Sacmi)

The MPH250 follows on from Sacmi's popular MPH200 and features an innovative hydraulic circuit, which is reported to result in lower energy consumption thanks to its variable pressure lines. The press is also said to be capable of a speed increase of up to 50%, whatever the production field.

A high level of operational efficiency is also reported to be a feature of the new press, due to the use of a user-friendly API (Assisted Programming Interface) that drastically reduces the programming and tuning times.

"By keeping the design of the MPH200 and performing accurate hands-on tests, SACMI has come to the new MPH250 project, which takes advantage of all features developed by Sacmi in the last years and which have been widely appreciated on the PM market," the company stated.

"This machine brings several advantages, from high productivity to limited footprint, as well as the absence of a foundation pit and energy saving. In other words, a press that will be surely appreciated by our customers for the numerous benefits it is able to offer."

Sacmi manufactures a wide range of fully automatic hydraulic metal powder compaction presses from 80 to 1000 tonnes, as well as a 20-tonne electric press.

www.sacmi.com

Höganäs launches Intralube GS powder offering improved green strength

Sweden's Höganäs AB unveiled its new powder mix, Intralube® GS, during a webinar on June 17, 2020. The webinar was hosted by Fredrik Vinnerborg, Competence Technology Leader, who discussed the benefits of Intralube GS with Höganäs' product experts Åsa Ahlin and Per Knutsson.

The company explained that, with so many exhibitions and conferences in the metal powder industry being cancelled due to the coronavirus (COVID-19), Höganäs decided to launch its new powder mix virtually.

"As a leading company in our business, we choose to be proactive and work in new ways to serve our customers in these trying times," stated Henrik Jarl, who heads the marketing communications team.

The new powder mix is reported to improve the green strength of compacted parts by up to 80% compared to other powder mixes. Thanks to this green strength, the company says that Intralube GS increases customers' production efficiency, reduces scrap rates and helps them work in a more sustainable way.

"We have seen a need for improved green strength of compacted parts," commented Åsa Ahlin, Manager for Organic Material development. "Intralube GS enables green machining, which saves a lot of time and drastically reduces production cost. At the same time, we have been able to keep all other properties at a high level, for instance compressibility and lubrication."

Intralube GS enables green machining (Courtesy Höganäs AB)

www.hoganas.com

Sandvik's Dormer Pramet to acquire Miranda Tools

Sandvik AB, Stockholm, Sweden, reports that Dormer Pramet, a division within Sandvik Machining Solutions, is to acquire the entire business of India-based Miranda Tools, a manufacturer of High-Speed Steel and solid carbide round tools.
The acquisition is said to enhance Dormer Pramet's product offering and facilitate an improved presence in key markets such as India, China and Southeast Asia.

In 2019, Miranda Tools reported revenues of approximately 200 million SEK with around 580 employees.

"The acquisition is aligned with Sandvik Machining Solutions' focus on strengthening our round tools offer whilst also adding greater production capacity and flexibility to support long-term growth," stated Lars Bergström, president of Sandvik Machining Solutions.

Stefan Steenstrup, president of Dormer Pramet, commented, "I am very pleased that we have reached an agreement to acquire the business of Miranda Tools, which will further enhance Dormer Pramet's position as one of the leading suppliers of cutting tools for the general engineering and component manufacturing industries."

The transaction is expected to close during the third quarter of 2020, subject to relevant regulatory approvals. According to Sandvik, the parties have agreed not to disclose the purchase price.

www.home.sandvik
www.mirandatools.in

H.C. Starck Tungsten Powders sold to Masan Resources

H.C. Starck Tungsten Powders, Goslar, Germany, a leading global provider of customer-specific tungsten powder, and part of H.C. Starck Group GmbH, has been acquired by Vietnamese-based Masan Resources. A subsidiary of Masan Group, Masan Resources is a supplier of critical minerals including tungsten, fluorspar and bismuth.

H.C. Starck Tungsten Powders develops and produces high-performance powders made from the refractory metal tungsten and its compounds. It has a patented recycling process with which it extracts tungsten in what it states as the highest quality from secondary raw materials. The business has approximately 540 employees across three production sites in Germany, Canada and China, as well as sales offices in the USA and Japan. Masan Resources is reported to have one of the world's largest tungsten deposits and associated refining facilities outside of China.

"The entry of a strategic owner on time for the hundredth anniversary we are celebrating this year marks the beginning of a new era for our company," stated Dr Hady Seyeda, CEO of H.C. Starck Tungsten Powders. "Direct access to primary raw materials as a complement to our recycling expertise means even more flexibility and security for our customers all over the world."

Craig Bradshaw, CEO of Masan Resources, commented, "The competencies of both companies in the field of raw materials on the one hand and the highly specialised processing on the other complement each other perfectly. For us, this transaction is the next strategic step in executing on our vision to become a leading global vertically integrated high-tech industrial materials platform."

https://www.masangroup.com/
www.hcstarck.com

Melrose announces financial results for first half 2020

Melrose Industries PLC, UK, has announced its interim results for the six months ended June 30, 2020. The group, which includes GKN Powder Metallurgy, GKN Aerospace and GKN Automotive, reported an adjusted operating profit of £56 million in the period, compared to £541 million for the first half 2019.

The group made a statutory operating loss of £581 million. However, it was reported that trading over the summer months had been at the higher end of the board's expectations, particularly in automotive and key Nortek Air Management markets.

Automotive and Powder Metallurgy sales were said to have been down 36% in the period, but Melrose stated that it saw a number of encouraging signs of recovery in these segments, with recent trading in China ahead of 2019's results. North America was also said to be improving quickly, and there were some positive signs in Europe, although the speed and shape of improvements remains uncertain.

Restructuring projects were said to be underway at Melrose that will improve the group's trading performance by over £100 million next year. In particular, substantial margin improvement opportunities are said to be available across GKN businesses.

The group reported that its investment in advanced and energy-efficient technologies has continued throughout the period. Among those technologies, it continues to invest in its Additive Manufacturing capabilities.

Justin Dowley, chairman of Melrose Industries PLC, commented, "These are extraordinary times which we have addressed with rigorous cash management and decisive restructuring actions; recently, and encouragingly, we have started to see trading improving in some key end markets."

www.melroseplc.net

Euro PM2020 Virtual Congress programme launched

The European Powder Metallurgy Association (EPMA) has published the programme for its Euro PM2020 Virtual Congress. The Virtual Congress, the first online edition of the EPMA's annual Powder Metallurgy Congress, will take place from October 5–7, 2020.

The online event will cover the latest developments in Powder Metallurgy, with over 150 technical papers to be presented over three full days. The programme of plenary, keynote, oral and poster presentations will focus on the following aspects of PM:

- Additive Manufacturing
- Environment and sustainability
- Functional materials
- Hard materials and diamond tools
- Hot Isostatic Pressing
- Metal Injection Moulding
- Materials and processes for specific applications
- Press & sinter

The EPMA states that live Q&As will also follow all oral presentations to provide the opportunity to further enhance participant knowledge.

The full Virtual Congress programme and registration details are available via the EPMA.

www.europm2020.com

H.C. Starck Tantalum & Niobium changes name to Taniobis

H.C. Starck Tantalum & Niobium has announced that it is now operating under the Taniobis brand name. Taniobis will continue to offer a wide range of materials, powders, and alloys based on tantalum and niobium.

Taniobis uses rare ores and refractory metals to produce high-performance powders on an individual basis for its customers. These materials are important in a range of industries, including automotive, energy, aviation, electronics, the chemical industry and the medical technology industry. The supply and development of Ta and Nb materials also supports global trends in areas including the Internet of Things (IoT), big data, smart cities, and connectivity, where current developments are heavily dependent on tantalum and niobium.

Taniobis spherical tantalum powder is suitable for a range of applications (Courtesy Taniobis)

Additive Manufacturing is another important area of application. Taniobis is a leader in the development of biocompatible alloys for the production of patient-specific implants made using AM. The company's AMtrinsic pre-alloyed, high-performance powders are developed specifically for Additive Manufacturing.

The properties of tantalum and niobium include high melting points, high resistance to corrosion, extremely high resistance to chemicals, and high thermal and electrical conductivity. Alloys containing these elements are suitable for a wide range of applications.

www.taniobis.com

Plansee reports fiscal results for 2019/2020

The Plansee Group, Reutte, Austria, has reported its financial results for the fiscal year 2019/2020. The company stated that the recession in key industries, as well as trade disputes, led to a decline in demand causing sales in the group to drop 10% over the fiscal year.

Over the year, the group's portfolio as a whole was said to have proved robust. The group companies reported revenue of €2.9 billion, while production sales in Breitenwang/Reutte were reported at €635 million.

The group states that it feels well prepared to cope with the economic consequences of the coronavirus (COVID-19) crisis. Over 2019/2020, its investment volume was €206 million, and expenditures on research and development amounted to €68 million. "In addition to the trade conflict between the USA and China, declining orders from the European automotive and the mechanical engineering industry in particular resulted in the slump in sales in the 2019/2020 fiscal year," explained Karlheinz Wex, spokesman of the executive board of the Plansee Group, during its annual press conference in Reutte.

Overall sales fell from €1.52 billion to €1.38 billion in 2019/2020. Despite this development, the Plansee Group continued to invest heavily in equipment and infrastructure and research and development, and states that this decision has paid off: new products accounted for 31% of sales in the past fiscal year, up from 29%. The equity ratio rose from 58–61%, reaching what the company states is a peak level.

Despite temporary closures of individual plants, the group was able to maintain almost all deliveries to its international customers between the months of March and May.

www.plansee.com

Praxair changes name to Linde

Linde plc, Guildford, UK, reports that its subsidiary, Praxair, Inc., located in Danbury, Connecticut, USA, will begin operating under the Linde name, effective September 1, 2020.

This name change reflects the company's evolution following the merger of Praxair, Inc., and Linde AG. The combined product and service portfolios of the new Linde offer customers more options to improve operational efficiency and plan for future growth, explains the company.

Linde states that it remains committed to providing the same products and services that its US-based customers have come to expect. The primary customer contacts for products and services will remain the same.

www.linde.com
www.lindeUS.com

JSJW brings its metal powders to the US market

JiangSu JinWu New Material Co., Ltd., (JSJW), headquartered in Taizhou City, Jiangsu Province, China, is introducing its range of metal powders, suitable for AM, MIM and thermal spray coating, to the US market under its Superflow brand. The metal powders will be distributed by Kuzma Industrial Corp, located in Brooklyn, New York, USA.

Having over ten years experience in metal powder manufacturing, JSJW specialises in titanium powder manufacturing. It has two production facilities and 100 tons annual production capacity.

With its advanced R&D and manufacturing facility, the company states that it provides high-quality metal powders at highly competitive prices.

"Our customers rely on our powder products because of high trust in JSJW's superior technology, reliable equipment and process management. JSJW's unique IPCA technology produces the powder with very good sphericity, very few satellites, and very low porosity," the company stated.

www.kuzmaindustrial.com
www.jsjinwu.com

PM China 2020 reports 14% visitor growth

The 13th International Exhibition for Powder Metallurgy, Cemented Carbides and Advanced Ceramics (PM China 2020) which was held August 12–14, 2020, welcomed over 25,793 visitors on-site, an increase of 14% on last year's show, reports the organiser, Uniris Exhibition Shanghai Co., Ltd.

The 30,000 m^2 exhibition represented an increase of 20% on the previous year, with a total of 494 exhibitors from China and the rest of the world. According to the organiser, the exhibition made headway in bringing more cutting-edge technologies and products to its visitors.

In addition to the exhibition, the event comprised five summits featuring sixty-two academics, professors and business executives in the fields of Powder Metallurgy, cemented carbide and advanced ceramics to share new trends and development with more than 1,200 participants.

The 14th International Exhibition for Powder Metallurgy, Cemented Carbides and Advanced Ceramics (PM China 2021) is scheduled to take place from May 23–25, 2021.

www.pmexchina.com

Carpenter Technology reports Q4 and full year 2020 results

Carpenter Technology Corporation, Philadelphia, Pennsylvania, USA, has announced financial results for its fiscal fourth quarter and year ended June 30, 2020. Over the quarter, the company reported a net loss of $118.4 million, with a net profit of $1.5 million reported over the full fiscal year 2020.

Net sales for the group's fiscal year 2020 were reported to be $2,181.1 million, down from FY2019 which had net sales of $2,380.2 million. The company's reported operating income for the fiscal year 2020 of $25.3 million was a considerable drop from 2019's figure of $241.4 million. Net sales for the fourth quarter were $437.3 million compared with $641.4 million in the fourth quarter of fiscal year 2019, a decrease of $204.1 million (32%), on 32% lower volume. The group made an operating loss of $148.2 million, compared to operating income of $67.9 million in the same period last year.

"The strategic decision to accelerate our inventory reduction plan to drive cash flow negatively impacted our operating results in the quarter," explained Tony R Thene, president and CEO of Carpenter Technology.

In the fourth quarter, Carpenter's Specialty Alloys Operations (SAO), which manufactures premium alloys and stainless steel saw net sales of $369.4 million (2019: $532 million) and $1,831.6 million for the full year (2019: $1,967.3 million).

Carpenter's Performance Engineered Products segment, including the Dynamet titanium business and the Carpenter Powder Products (CPP) business, achieved net sales for the fourth quarter 2020 of $77.1 million, down from $126.4 million in the fourth quarter of fiscal year 2019. For the full year 2020, the segment reported net sales of $401.1 million, down from $479.8 million in 2019.

www.carpentertechnology.com

Metal powder development company Alloyed receives start-up award

Alloyed, a UK-based company formed from the merger of OxMet Technologies and Betatype in late 2019, reports that it has won the Institute of Physics' Business Start-up Award 2020.

The award, which was entered by OxMet prior to the merger, recognises the scientific work of the team that led to the formation of its innovative Alloys By Design (ABD™) system. The company explained that the ABD digital platform is enabling new standards to be set for the development of metal materials for advanced manufacturing applications in a broad range of industry sectors.

The commercialisation of the ABD-850AM and ABD-900AM alloys, developed specifically for Additive Manufacturing, highlights the potential of the platform and its capabilities for developing custom materials that meet specific requirements from industry.

The Institute of Physics (IOP) is the professional body and learned society for physics in the UK and Ireland. It is committed to working with 'physics-based' businesses to support innovation and growth.

The IOP's Business Awards incorporate three categories – Business Innovation, Business Start-Up and the Lee Lucas Award (for early-stage companies in the medical and healthcare sector). The IOP Business Start-Up Award specifically recognises young companies with a business idea founded on a physics invention, with the potential for business growth and significant societal impact.

Michael Holmes, CEO of Alloyed, commented, "Everything we do in every bit of our business rests on the foundations provided by physics, and we're delighted that the judges believe we have made a contribution to the field."

Jonathan Flint, Institute of Physics president, stated "The IOP Business Awards recognise and reward the achievements of physics-based businesses of all sizes; innovative companies that have developed new technologies or repurposed existing ones, and that are at the cutting edge of the UK and Ireland's scientific research and development."

"These companies, old and new, large and small, have the power to drive the economy," he continued. "They use the applications of physics to create positive individual, social, industrial and economic change, both at home and overseas."

www.alloyed.com
www.iop.org

Alloyed has won the Institute of Physics' Business Start-up Award 2020 (Courtesy Alloyed)

Roboworker launches RPS Compact for precision part handling

Roboworker Automation GmbH, headquartered in Weingarten, Germany, a producer and supplier of automation and inspection systems, reports that it has launched the RPS Compact, a new machine for re-palletising a wide variety of precision parts from, and onto, all kinds of trays.

The RPS Compact can sustainably increase the productivity of all manufacturers of high-quality small parts (< 100 mm), states the company. The basic system consists of tried and tested modules for tray and parts handling, which can be flexibly combined with each other. It can be extended with various inspection functionalities or sample processing using the latest software technologies and image processing systems.

According to Roboworker, the almost teach-free system can be set up in a very short time and is then ready for operation and equipped for new products. Having an optimised footprint, the RPS Compact is available as a stand-alone version for manual loading as well as with a docking system for loading via AGV or for inline integration.

Key characteristics of the RPS Compact system include:

- Portal robot with combi grippers for flexible tray handling
- Precision robot with an integrated gripper exchange interface, as well as an interface for position detection
- Universal gripper set for all kinds of part and a gripper station for automatic gripper change
- Automatic change-over to the next order and part type
- Simple operation via a touch screen, with the latest HMI and Windows 10 based control technology
- Optional connection to ERP system

www.roboworker.com

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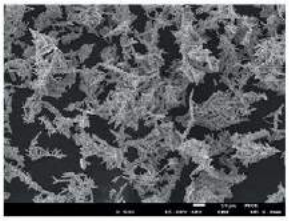
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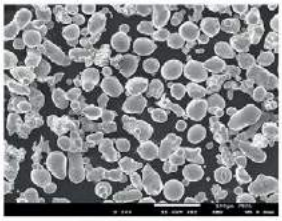
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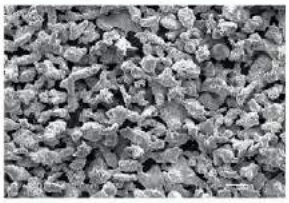
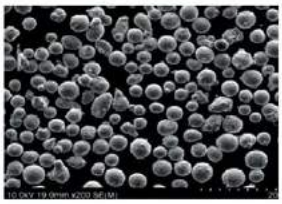

Copper Alloy Powder


Diffusion Powder


3D Printing Copper Alloy Powder

Products Include

- **Copper:**
  - –irregular
  - –spherical
  - –dendritic
- **Copper alloys**
- **Tin**
- **Press-ready premix bronzes**
- **Infiltrants**
- **Speciality powders**

GRIPM Advanced Materials Co., Ltd., in Beijing, China, since 2004 (former factory from 1997), held by GRINM Group Co., Ltd (a Chinese national corporation group since 1952)
Annual capacity: > **30000MT**
FIVE subsidiary companies, including **Makin Metal Powders (UK) Ltd.**

MAKIN METAL POWDERS
A Member of the GRINM Family of Companies

Makin Metal Powders (UK) Ltd has achieved its current position as one of the leading Copper and Copper Alloy powder producers in Europe by supplying the powders that match customer technical specifications in the most cost effective manner on a consistent basis.

GRIPM Advanced Materials Co., Ltd.
TEL: +86-10-61669867 Fax: +86-10-61667989 E-mail: info@gripm.com www.gripm.com

Makin Metal Powders (UK) Ltd.
TEL: +44(0)1706717317 Fax: +44(0)1706717310 E-mail: sales@makin-metals.com www.makin-metals.com

Verder Scientific acquires Porotec GmbH

Verder Scientific, a division of Verder Group headquartered in Haan, Germany, has acquired Porotec GmbH, located near Frankfurt am Main, Germany, in order to further expand its particle characterisation business.

Porotec develops and sells particle and porosity measurement instruments and operates as a dealer for Microtrac MRB, which Verder Scientific acquired in 2019, who also specialises in particle characterisation.

Verder Scientific explains that with the acquisition of Porotec, Microtrac MRB enhances its expertise and market position in gas adsorption, porosimetry and density measurement, while strengthening its German team in the areas of application, sales and service. Porotec contributes relevant technical experience and in-depth knowledge of the market.

Microtrac MRB was established in 2020 by uniting the companies Microtrac Inc., MicrotracBEL Corp. and Retsch Technology GmbH and is said to provide the world's widest product offering for particle characterisation.

www.verder-scientific.com | www.porotec.de

Left to right: Dr Jürgen Pankratz, CEO of Verder Scientific Division and Microtrac MRB, Carsten Minkley and Dr Jürgen Adolphs, managing directors of Porotec GmbH (Courtesy Verder Scientific)

Capstan Mexico upgrades facility with new furnace and nitrogen system

Capstan Inc., headquartered in California, USA, reports that its Capstan Mexico facility, located in Guadalajara, has installed new nitrogen tank gas systems to connect to its new Abbott Furnace, which is expected to be fully installed in Q4 2020.

Capstan specialises in producing structural Powder Metallurgy components and porous metal filters. The company explains that the Capstan Mexico upgrades will bring the facility in line with its other facility capabilities.

www.capstan.com

Novamet acquires Rhode Island metal powder atomisation facility

Ultra Fine Specialty Products, LLC, a division of Novamet Specialty Products Corporation, Inc, Lebanon, Tennessee, USA, has acquired a high-purity, fine metal powder atomising facility, located in Woonsocket, Rhode Island, USA. The facility was formerly owned by Carpenter Powder Products, Inc., a subsidiary of Carpenter Technology Corporation.

The company explains that Ultra Fine will now focus on refining and expanding the capabilities of the Ultra Fine atomising facility to produce high-quality metal powders in the finest range of sizes available through gas atomisation. The process used by Ultra Fine to produce powders is said to be unique, enabling the highest possible quality powders in the size range of under 30 µm.

Ultra Fine was recently formed by Jeffrey Peterson, Novamet CEO; John Torbic, Novamet president; and Novamet General Counsel Michael Hinchion, to locate and acquire technically-oriented production assets to support the advancement of metal powder technologies and their use in aerospace, electronics, batteries, industrial parts and other markets in the US and around the world.

Novamet was formed in 1976 to apply its technology for the development of nickel-based powders and technologies into different morphologies, shapes and sizes for various industrial uses, focusing on nickel powders produced by its then-parent company, Inco.

The company was acquired by investors in 2010 and after nearly forty years in Bergen County, New Jersey, USA, moved its headquarters and manufacturing facilities to Lebanon, Tennessee. Novamet currently processes and distributes various metal powders and coated products for the Metal Injection Moulding, aerospace, automotive, coatings and electronic materials markets.

"We are very excited about the beginning of Ultra Fine as a separate organisation, and its acquisition of this facility," stated Peterson. "Ultra Fine will not only supply its own customers high-quality products as it did before, but it will be a source for Novamet of a broader selection of competitively priced, high-quality feed materials from a US-based provider that is focused on supporting our markets."

Torbic commented, "Novamet has a strong record of working with the types of powders this facility can produce, and we see even more potential for growth as Novamet and Ultra Fine combine their technical strengths and manufacturing skill sets."

www.novametcorp.com

Kennametal introduces KCS10B for superalloy applications

Kennametal Inc., Pittsburgh, Pennsylvania, USA, has introduced a new turning grade for nickel, cobalt and iron-based superalloys used in aerospace and other high-temperature applications. The new grade, KCS10B, is said to feature a coating applied to an ultra-fine grain carbide substrate for superior layer adhesion.

According to the company, KCS10B delivers up to 50% greater tool life, more predictable processes and improved productivity when working with difficult-to-machine superalloys. It is capable of overcoming the most common challenges encountered in turning superalloys – cratering and depth-of-cut notching – which may lead to unexpected and even catastrophic tool failure.

KCS10B is available in the most popular turning insert shapes (Courtesy Kennametal)

KCS10B is available in the most popular turning insert shapes, sizes, and geometries. Robert Keilmann, Senior Global Product Manager for Turning, stated that KCS10B's development was achieved using Kennametal's proprietary High-Power Impulse Magnetron Sputtering (High-PIMS) technology.

Rather than the 'light rain' of droplets that falls on cutting tools during traditional PVD coating processes, High-PIMS generates a fine mist of AlTiN, building a series of "extremely thin, smooth, and wear-resistant layers," Keilmann explained.

In addition, metals such as Inconel 718 and Stellite 31 are notorious for causing rapid wear and unpredictable tool life, and KCS10B is reportedly proven to reduce DOC notching and extend tool life from three minutes to upwards of five minutes in roughing operations.

Tool life in finishing operations is said to fare even better, with visible cratering and subsequent tool failure often delayed by a factor of two or three compared to competitive brands. Positive and negative rake inserts are available, as well as various chip formers, edge preparations, and geometries, making KCS10B an effective solution for turning iron-based (S1), cobalt-based (S2), or nickel-based (S3) alloys.

"Aside from a smoother surface, the new coating process also allows us to create a much sharper edge," added Keilmann. "Our advanced honing and edge-preparation process reduces the friction that leads to heat, which further improves tool life."

"It also means less built-up edge, another common failure mode in superalloy materials. When coupled with the excellent dimensional accuracy that Kennametal turning inserts are known for, shops can now expect the increased performance, stability, and predictability needed to be successful with these challenging alloys."

www.kennametal.com

Fraunhofer IFAM launches new research area on soft magnetic materials

The Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM) in Dresden, Germany, has launched a new research area working group on soft magnetic materials. This research is particularly important for the highly topical areas of renewable energy and electromobility.

With energy demand increasing globally and the electrical market growing, the share of electrical energy converters is also increasing, explains the institute. On average, 9% of all energy generated is lost during transformation and transmission and the energy losses in electromagnetic components, i.e. magnetic cores, play a decisive role here.

By using improved soft magnetic materials, the institute says these energy losses can be significantly reduced and a decisive contribution made to the preservation of resources. Fraunhofer IFAM is pursuing the goals of the Climate Protection Plan 2050, of which increasing the efficiency of electrical machines and converters to reduce emissions is a key component.

The aim of the institute's research is to produce soft magnetic components with high performance and the lowest losses possible at comparatively low cost. Under the leadership of materials scientist Dr Inge Lindemann, the goal is to improve material properties in a targeted manner through the use of innovative Powder Metallurgy technologies.

The use of PM technologies will enable a wider variety of possible materials to be used, including material combinations, to lower material losses, since parts can be produced close to net shape. At the same time, more complex geometries will be made possible and additional integrated functions will be enabled.

The PM processing of soft magnetic materials is a new research topic, not only for Fraunhofer IFAM, but for the entire Fraunhofer-Gesellschaft. The fields of application for these materials range from electric motors for electromobility to inverters in solar power systems and magnetic shielding.

www.ifam.fraunhofer.de

ADDITIVE MANUFACTURING


Powder atomization plant


Vacuum induction melting furnace


Printed Inconel air knife

POWDER ATOMIZATION PLANT FOR ADDITIVE MANUFACTURING

With the launch of the Demo Center for additive manufacturing, SMS group is showcasing its know-how in powder metallurgy and additive manufacturing processes.
The newly developed type of metal powder atomization plant, which includes downstream process stages such as screening, classification and packing, as well as an SLM 3D printer, serves to guarantee the cost-effective production and application of high-purity metal powders made from a range of different metals and alloys.

Today we are already using additive manufacturing to improve and optimize plant components and spare parts.
So you as our customer reap the benefits of our expertise for your powder atomization plants.
Let's add value along the entire value chain, together.

Leading partner in the world of metals

SMS group GmbH
Ohlerkirchweg 66
41069 Mönchengladbach, Germany
Phone: +49 2161 350-1691
Additive.Manufacturing@sms-group.com
www.sms-group.com

SMS group
www.sms-group.com

Ceratizit adds Sacmi's first electric hardmetal press to its Reutte facility

The Sacmi Group, headquartered in Imola, Italy, has reported that its first electric press for hardmetal compaction has been successfully installed at Ceratizit Austria GmbH's manufacturing plant in Reutte, Austria.

The Sacmi e-MP20 supplied to Ceratizit is a 20-ton press for the production of carbide inserts. The press is said to offer high precision (+/- 0.001 mm) and high efficiency, due to the integration of the company's Assisted Programming Interface (API), said to drastically reduce the press programming and tuning times.

Ceratizit has installed the Sacmi e-MP20 electric press at its Reutte facility (Courtesy Sacmi Group)

Jointly developed with Laeis GmbH, part of the Sacmi Group, the new press is said to have been designed with generous structural frames to increase the machine rigidity and allow better internal accessibility, while keeping a small footprint for this class of press.

In addition, a fixed die concept allows for higher precision and better forming on the upper surface of the inserts, simplifying filling and removal. The design of the press allows for high versatility and future extensions, such as the integration of additional pressing axes or the use of cross-pressing systems.

Founded more than 100 years ago, the Sacmi Group accounts for over eighty production plants, distribution companies and service centres in thirty countries. It has over 4,650 employees worldwide and a turnover close to €1.25 billion. Laeis GmbH specialises in the design and manufacturing of highly sophisticated presses for refractories, technical ceramics and special applications.

www.sacmi.com | www.laeis.eu
www.ceratizit.com

India's ARCI reports novel metallurgical process for Fe-P-based soft magnetic alloys

Scientists at the International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI), India, have developed a novel metallurgical process schedule to realise Fe-P based soft magnetic alloys, according to a post by Venkatraman Venkitachalam, founder chairman, The EvXprts Foundation, on LinkedIn.

The wrought Fe-P alloys are said to have higher magnetisation and lower coercivity than the expensive non-oriented Si-steel available in the market. The process developed by ARCI involves controlled heat treatment through the phase-field, which reportedly results in the formation of nanoscale Fe3P precipitates of suitable size and distribution.

Prototypes are said to have been tested under laboratory conditions using the Fe-P alloy with promising results, and field trials are expected shortly. For the Indian automotive market, the availability of a domestically-developed and produced soft magnetic material could save on foreign exchange costs and strengthen the supply chain.

According to Venkitachalam, the newly-developed magnetic material could prove to be crucial for EV motors.

www.arci.res.in

New Powder Flow Testing for AM eBook

Freeman Technology, a Micromeritics company based in Tewkesbury, Gloucestershire, UK, has released a new eBook titled 'Powder Flow Testing for Additive Manufacturing.'

The publication focuses on the measurement of bulk powder properties, particularly flowability via dynamic testing, that is being used to enhance throughput and AM product quality, states the company. Including a range of case studies, the eBook provides valuable, expert guidance for materials scientists and engineers looking to optimise the application and performance of AM.

www.freemantech.co.uk

Sandvik announces restructure and new executive management

Sandvik AB, Stockholm, Sweden, has announced plans to restructure its Sandvik Machining Solutions business area, adding two business area segments from October 2020.

A new business area segment will consist of the current divisions of Sandvik Coromant, Seco Tools, Walter, Dormer Pramet and Wolfram. This segment will take the name Sandvik Machining Solutions, and is to be headed by Nadine Crauwels, current president of Sandvik Coromant.

Sandvik announced that Crauwels will be appointed as a new member of the Sandvik Group executive management effective October 1, 2020. Crauwels has been president of Sandvik Coromant since 2017, and since 2000 has had several management positions within Sandvik Coromant.

"I am happy and proud to take on the role as head of the newly formed business area segment and I look forward to further building on the unique strengths we have in our various divisions," stated Crauwels.

A second business area segment will be formed under the name of Sandvik Manufacturing Solutions, consisting of the divisions Applied Materials Technology and Additive Manufacturing. This segment will be led by Lars Bergström, current Sandvik Machining Solutions business area president, until his retirement at the end of 2020, after which Stefan Widing, Sandvik's president and CEO, will be responsible for the segment during a transition period. Bergström will remain a member of the Sandvik Group executive management until January 1, 2021.

As of October 1, 2020, Widing will take over responsibility as president for the business area, which will be known as Sandvik Manufacturing and Machining Solutions as of January 1, 2021. "The new organisation aims to further increase focus on the growth opportunities within both our core area of metal cutting and within adjacent areas such as software solutions and services for the wider component manufacturing industry," stated Widing.

"I see great potential in exploring new opportunities within a manufacturing industry that becomes more digital and connected, and our new structure will ensure that we capture the potential in a lean and swift way," he concluded.

According to the company, the organisational change does not affect Sandvik's other two business areas, nor does it affect reported figures for the business areas in the Sandvik Group.

www.home.sandvik

Formnext 2020 to be a virtual-only event amid ongoing COVID-19 crisis

Mesago Messe Frankfurt GmbH, the organiser of Formnext, the leading international event for Additive Manufacturing/3D printing, has confirmed that it will now be held solely as a virtual event. Named 'Formnext Connect', the dates of the event have been shortened to November 10–12, 2020.

In an official statement, the organiser explained, "Due to the recent rise of the coronavirus (COVID-19) infection figures worldwide, and the associated increase in travel restrictions, Mesago Messe Frankfurt GmbH has decided to hold Formnext 2020 purely virtually."

"The digital event will be named 'Formnext Connect'. Formnext 2020 was previously planned as a hybrid trade fair, that is, with the on-site event at the Frankfurt exhibition grounds plus a digital add-on component. This plan was based on the Corona Contact and Operating Restrictions Ordinance valid in the State of Hesse and a health and hygiene concept agreed upon with the City of Frankfurt am Main, the State of Hesse and Messe Frankfurt."

Formnext Connect will reportedly offer a wide range of digital services which will include exhibitor presentations in showrooms (products, information, videos, chat function, lead generation/lead tracking), intelligent matchmaking with all participants supported by AI, live streaming and on-demand content of the supporting programme and webinars as well as the scheduling/assignment of appointments for online meetings with exhibitors.

Petra Haarburger, president of Mesago Messe Frankfurt, stated, "The current rise of the COVID-19 infection figures in Germany, Europe and around the world have led to increasing uncertainty among exhibitors and visitors. Together with the renewed tightening of official and in-house travel restrictions, this will no longer allow the otherwise highly international Formnext to be carried out in the accustomed quality."

www.formnext.mesago.com

JPMA announces Nobuhiro Hashimoto as president, and welcomes new board members

The Japan Powder Metallurgy Association (JPMA), based in Tokyo, Japan, has announced the election of a new president and the appointment of a number of new board members at its General Assembly, May 18, 2020. Yoichi Inoue, Fine Sinter Co., Ltd., retired as president of the association and was succeeded by Nobuhiro Hashimoto, Sumitomo Electric Industries, Ltd.

Following his retirement from the presidency, Inoue remains a permanent member of the JPMA board.

www.jpma.gr.jp

Nobuhiro Hashimoto, Sumitomo Electric Industries, Ltd. has been announced as the new president of the Japan Powder Metallurgy Association (Courtesy JPMA)

Tekna celebrates its 30th anniversary

Tekna, a supplier of plasma induction systems and high-purity metal powders, headquartered in Sherbrooke, Quebec, Canada, is celebrating its 30th anniversary.

"Earning the trust of the customers every day of this journey has been the priority of devoted men and women working at Tekna. This 30th anniversary celebration is in recognition of their dedication to the success of our company and that of our customers," stated Luc Dionne, CEO at Tekna.

The company began with the development of its Inductive Coupled Plasma Torch back in the early 1990s, and has continued to build a portfolio of inventions and innovations.

Tekna's plasma torch spheroidisation technology allows the transformation of crushed, atomised and sponged powders into dense spherical powders. Powder densification and spheroidisation is one of the major applications of induction plasma technology; the technique basically consists of heating and melting of feed particles followed by cooling under controlled conditions.

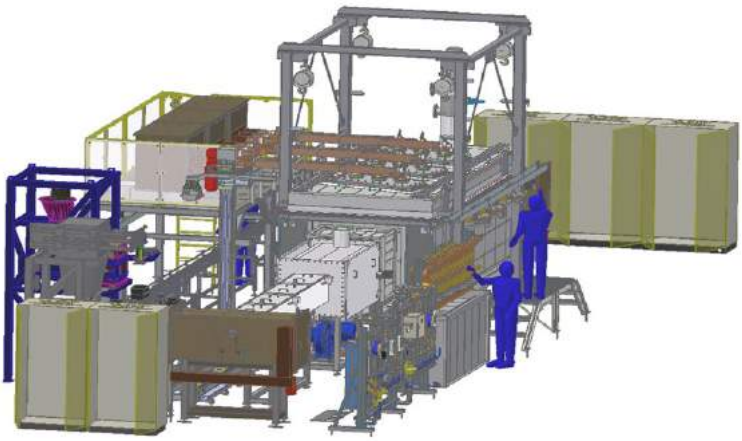
The company's nanopowder manufacturing technology also provides the means for the high volume production of a wide range of materials. Nanoparticle production is one of many induction plasma applications, due to its high-temperature processing capabilities and high gas quenching flow rates.

Tekna is a subsidiary of Arendals Fossekompani ASA and operates certified AS9100 manufacturing facilities in Canada and France, as well as sales and distribution offices in China, India and South Korea.

"Three decades of excellence are more than words to us," commented Rémy Pontone, VP of Sales & Marketing. "It is about taking special care of the customer needs and providing solutions that make them successful in their own markets."

www.tekna.com

CREMER completes project to develop industry-first 2500°C industrial furnace



The CARBIDE2500 industrial furnace could enable the production of tungsten carbide materials up to five times stronger than currently available (Courtesy CREMER Thermoprozessanlagen GmbH)

CREMER Thermoprozessanlagen GmbH, Düren, Germany, has completed its EU-funded CARBIDE2500 project. The project launched in May 2018 and is reported to have met its objectives, developing the first 2500°C industrial furnace, enabling higher efficiency and the production of tungsten carbide with up to five times higher material strength than otherwise possible.

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, at the time of the project's launch in 2018, the economic downturn and subsequent recovery in Europe had resulted in increasing demand for higher-strength materials.

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 company in 2018 expected the global tungsten carbide powder market 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, was also said to be increasing.

Over the course of the project, material tests were conducted by CREMER to compare the properties of tungsten carbide powder (WC) produced using the same input material at 1600°C, 2200°C and 2500°C in the CARBIDE2500 furnace. The analysis results clearly show the change in particle morphology obtained at 2500°C in comparison to the lower carburization temperatures. The company states that the results show the potential of the plant to produce WC powder with a whole range of characteristics, tuned by selecting the optimum input material and process parameters needed for a specific application. High-quality tungsten carbide powder is not only used to produce hardmetal tools, but is also relevant for AM products as well as coatings, cladding or hardfacing.

The total project cost was reported at €1,331,000, of which the EU contributed €931,700 through its Horizon 2020 research and innovation programme.

www.cremer-polyfour.de

MPIF releases Standard 35 – Materials Standards for PM Structural Parts

The Metal Powder Industries Federation (MPIF) has released the 2020 edition of its Standard 35 – Materials Standards for PM Structural Parts.

The document provides design and materials engineers with the latest engineering property data and information available to specify materials for structural parts made using Powder Metallurgy.

The MPIF explains that each user-friendly section of the standard is clearly distinguished by easy-to-read data tables (inch-pound and SI units) and provides explanatory information for each material listed.

Revised and expanded, this standard was developed by the Powder Metallurgy commercial parts manufacturing industry and includes new data on Sinter-Hardened Steel FLC2-4208 and Iron-Copper and Copper steel FC-0205-42 & FC-0208-53, as well as new Engineering Information for aluminium axial fatigue and thermal conductivity.

This standard does not apply to materials for PM self-lubricating bearings (SLB), powder forged (PF) or Metal Injection Moulded (MIM) products which are covered in separate editions of MPIF Standard 35.

The new MPIF Standard 35—Materials Standards for PM Structural Parts is available to purchase via the MPIF website.

www.mpif.org

Global Tungsten & Powders

Think Tungsten. Think GTP.

Global Tungsten & Powders focuses on the production of tungsten metal powders, tungsten carbide powders, and ready-to-press powders for the hard metal industry, oil & gas, thermal spray, additive manufacturing, and many more industries. Our laboratories are equipped with the latest testing technologies analyzing material down to the atomic level.

GTP will recycle any tungsten containing scrap you may have from your processes. Benefit from our long standing expertise especially in utilizing the zinc process for recycling of tungsten carbide in industrial scale. Let us discuss how we can help.

During the 2020 COVID-19 pandemic, GTP kept all production locations operative 24/7. Rely on our plants in the US, Finland, and in the Czech Republic, to provide you with an uninterrupted supply chain independent from China.

www.globaltungsten.com

6K Additive commissions first two UniMelt systems for its new facility

6K, a developer of microwave plasma technology for the production of advanced materials, headquartered in North Andover, Massachusetts, USA, reports that its 6K Additive division has commissioned the first two commercial UniMelt® systems for its new 3,700 m^2 (40,000 ft^2) manufacturing plant in Burgettstown, Pennsylvania, USA. The company was due to begin customer sampling in August for its Onyx In718 material followed by its Onyx Ti64, which it announced in 2019.

According to the company, its process has the ability to convert certified chemistry machined millings, turnings and other recycled feedstock sources into premium metal powders. 6K recently became a member of MESA's association for sustainable manufacturing and is going through the process of certification as a sustainable manufacturing factory for its new plant.

"The commissioning of the first commercial UniMelt systems is the culmination of terrific work by experts in manufacturing, process and materials at both 6K Additive and our parent company 6K," stated Frank Roberts, president of 6K Additive. "Customers and strategic partners have been eager to sample and use our Onyx powders and we're ready to deliver."

"Accompanying the new UniMelt systems, the new facility encompasses automated manufacturing equipment and industry-leading safety and health systems that confirm our organisation is hitting our production goals while ensuring the utmost in safety for our employees."

The UniMelt system is a microwave production-scale plasma, with a highly uniform and precise plasma zone with zero contamination, and capable of high-throughput production of advanced materials including Onyx In718 and Onyx Ti64 AM powders.

The company's UniMelt technology can also reportedly spheroidise ferrous alloys like SS17-4PH, SS316, other nickel superalloys including Inconel 625, HX, cobalt-base alloys like CoCr, refractory metals like Mo, W, Re, reactive alloys such as Ti-6-4, TiAl, Al alloys as well as high-temperature ceramics such as MY and YSZ.

The new facility is said to be near 100% completion and has significant expansion capabilities available to it on the company's 45-acre site. The company plans to commission further UniMelt systems throughout 2021 to meet the demand for its premium AM powders.

www.6Kinc.com

39th Hagen Symposium postponed until next year

The 39th Hagen Symposium on Powder Metallurgy, organised by the Fachverband Pulvermetallurgie (FPM) and originally scheduled to take place in Hagen, Germany, on November 26–27, 2020, has now been postponed until November 25–26, 2021.

The 39th symposium's theme and programme is expected to stay the same. With a focus on 'Powder Metallurgy – Sustainable Solutions and New Markets,' the symposium will look at the changes in transport technology and challenges of energy transition, where sustainability is becoming increasingly important. With PM facing major challenges, there are also numerous opportunities for new products and innovative and sustainable solutions for applications in existing and new markets.

www.pulvermetallurgie.com

Höganäs appoints Per-Olof Larsson as Product Manager of Iron and Special powders

Sweden's Höganäs AB has appointed Per-Olof Larsson as its new Product Manager of Iron and Special powders in the group's product area Electro-Magnetic Technologies. Larsson started at Höganäs in 2001 as a Development Engineer and currently heads the Future Technologies team in the company's R&D division.

In his new position, he will be responsible for driving the development of global product strategies and product portfolio management, among other duties. Höganäs stated, "With all his experience and expertise, Per-Olof will be a great asset in the new role."

www.hoganas.com

ALD Thermal receives sixth consecutive GM Award

ALD Thermal Treatment Inc., Port Huron, Michigan, USA, a subsidiary of Germany's ALD Vacuum Technologies, has received General Motors' Supplier Quality Excellence Award for the sixth consecutive time since 2014.

ALD provides case hardening as a toll processing service by vacuum heat treatment. The technology is widely applied to harden parts which require high quality and low distortion, such as gears, transmission shafts, bearing parts, dies, drills and many more in the automotive sector and in mechanical engineering.

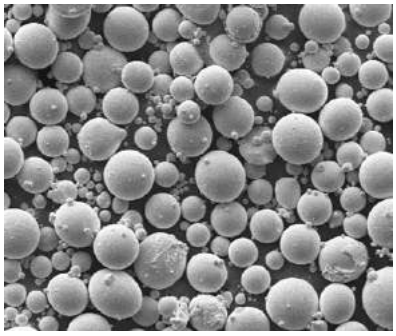
The ALD facility in Port Huron has processed well over 250 million parts on ALD ModulTherm furnaces for GM, with a defective rate of zero parts per million.

www.heat-treatment-services.com

CNPC introduces new aluminium alloy powder for Additive Manufacturing

CNPC Powder, headquartered in Vancouver, Canada, and with production facilities in China, reports that its recently established Automated Metal Production (AMP) line is producing a new range of aluminium powder explicitly designed for Powder Bed Fusion (PBF) metal Additive Manufacturing.

The aluminium alloy powders are said to exhibit good flowability and sphericity, with few satellites. CNPC states that the powders are positioned to provide value to large-volume AM applications in industries such as automotive and aerospace.



CNPC produces a range of metal powders including aluminium alloys (Courtesy CNPC)

The company's new AMP line is the latest development at its production facility. "We have achieved success with our AMP line and suite of Al alloys by redesigning atomisation beyond existing atomisation capabilities, such as VIGA, PREP and EIGA," the company states. "This bottom-up redesign has allowed for increased efficiency and lower production costs, all while improving flowability and sphericity, almost eliminating impurities, and increasing output."

In addition to the new aluminium alloy powder, CNPC manufactures a wide range of metal powders including iron and copper alloys, nickel, stainless steel and more.

www.cnpcpowder.com

Constellium launches Aheadd high-performance aluminium powders

Constellium, a global manufacturer of high value-added aluminium products, headquartered in Paris, France, has launched Aheadd®, its new aluminium powder aimed at the Additive Manufacturing sector.

The new powder is said to be tailored to customer needs for a wide range of applications including aerospace, motorsports and defence industries. The company stated that the Aheadd powder brings unmatched thermal stability, allowing replacement of titanium in selected applications to reduce weight and cost.

Constellium has signed a contract with Poly-Shape, an AddUp company, for the development and production of additively manufactured components based on the new Constellium powders.

"As a global leader in innovative aluminium products and solutions, we are at the forefront of the evolving and fast-changing Additive Manufacturing market, and we are proud to be expanding our portfolio to serve and meet the needs of our customers across all industries," stated Jean-Marc Germain, CEO of Constellium.

"The global Additive Manufacturing market has great potential with new design and production possibilities, and we look forward to further expanding its potential by providing unique and high-performance aluminium powders customised for our customers," added Germain.

www.constellium.com

Sino-Euro receives Chinese FDA clearance for Co-Cr alloy powder

Sino-Euro Materials Technologies of Xi'an Co., Ltd., Xi'an, China, a subsidiary company of the NIN Group, reports that its SS-PREP® SMT-Co25Cr5W5Mo spherical powder has been granted clearance by the Chinese Food and Drug Administration (CFDA), which will reportedly allow the powder to be commercialised for application in the dental industry.

Sino-Euro specialises in Powder Metallurgy, pre-alloy spherical SS-PREP powders, wire feedstock for Additive Manufacturing, bar and substrate, and HIP services and components. The company states that it is the first factory-based supplier with CFDA-III accreditation in Greater China.

According to Sino-Euro, Co-Cr alloy is considered one of the most advanced materials due to its good biocompatibility and mechanical properties, such as high strength and high corrosion resistance. It is gaining popularity in various engineering and medical applications such as dental implants, medical prosthetics, wind turbines, jet engine components and other mechanical parts.

The Co-Cr alloy SS-PREP SMT-Co25Cr5W5Mo is said to be suitable for dental restorations and appliances such as crown and fixed prostheses produced by Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing.

"We are thrilled to be officially releasing SS-PREP SMT-Co25Cr5W5Mo spherical powder this year to expand our business in the dental industry," commented Dr Liang, General Manager, Sino-Euro. "With the application for CFDA-III granted SS-PREP® Ti6Al4V ELI and the accreditation of ISO13485, Sino-Euro is ready to fully serve the medical industry."

www.c-semt.com

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JPMA report shows fall in demand for PM structural parts and bearings in 2019

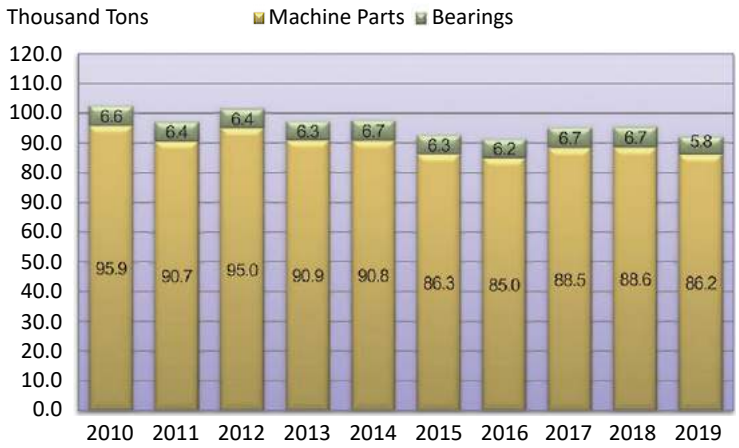
The Japan Powder Metallurgy Association (JPMA) has published statistics showing the change in production volumes of Powder Metallurgy structural parts and bearings in Japan in 2019. The trade association stated that in 2019, the volume of structural parts produced was 86,194 tons, a 2.7% decrease from the previous year. The volume of PM bearings produced was 5,822 tons, a 13.2% decrease from the previous year.

In 2019, the automotive industry remained the largest consumer of PM structural parts and bearings by volume. Structural parts production volume for vehicles was 81,463 tons, a 2.3% decrease from the previous year.

According to the JPMA, the market for PM structural parts for vehicles was affected by the trade conflict between the USA and other major vehicle producers such as China, and the resulting decrease in exports. Production volume was also negatively impacted by an increase in consumption tax in Japan, natural disasters and an increase in overseas production at foreign plants owned by Japanese companies.

The production volume of bearings specifically for vehicles was reported at 3,776 tons, a 13.3% decrease from the previous year. This was said to be due to the continuing reduction in vehicle engine sizes and the decrease in foreign demand. The trend of smaller capacity engines, and increases in overseas production, are expected to continue, stated the JPMA.

www.jpma.gr.jp



Production volume of PM structural parts and bearings in Japan from 2010–19 (Courtesy JPMA)

Höganäs looks to use residual products from metal powder production in artificial reef project

Sweden's Höganäs AB reports that its residual products from steelmaking are being investigated as a suitable material as part of the EU's LIFE Lophelia project which aims to deploy artificial reef structures in Kosterhavet, Sweden, to give coral a chance to recover.

Supported by the county administrative board for Västra Götaland and the University of Gothenburg, the project reportedly involves manufacturing and placing artificial reef structures in the sea. At the University of Gothenburg's marine laboratory in Tjärnö, work is said to be underway on designing the artificial structures, by breeding coral larvae to test what attracts them.

"The eye coral larvae are natural to our waters, but they need to attach to hard surfaces that protrude from the bottom in order to thrive and grow into coral reefs," stated Anita Tullrot, Project Manager for LIFE Lophelia on the county administrative board for Västra Götaland.

Ann Larsson, a researcher at Gothenburg University, noted, "We investigate different materials and surface structures to see what the larvae prefer to attach to. We also believe it is important how we design the artificial reefs so that favourable streams and swirls are formed that facilitate larvae to become attached."

According to Höganäs, its production of metal powder also produces residual by-products which have high surface complexity and contain lime. Part of the project will investigate whether these products may be suitable for use in the artificial reef structures. Currently, 80% of the company's residual products are said to be used as raw materials in new products such as soil improvers, asphalt raw materials and insulation.

Björn Haase, who is responsible for Höganäs' work with residual products commented, "I am constantly trying to find new uses for Höganäs' residual products as part of our efforts to contribute to a circular economy. Being able to participate in and contribute to a better environment through this project feels very important and good."

www.hoganas.com

MPIF's PM Sintering Seminar to run online

The Metal Powder Industries Federation (MPIF) reports that its popular Powder Metallurgy Sintering Seminar, which runs every two years, will take place as a virtual on-demand event from September 28–October 1, 2020.

The seminar contains nearly sixteen hours of technical content which can be watched at the attendee's own pace between the scheduled dates and will have the opportunity to learn about the following topics:

- Sintering parts at normal or elevated sintering temperatures
- Increased productivity by reducing rework and scrap
- Improving properties of PM parts with sintering
- The latest equipment capabilities
- Troubleshooting sintering problems
- Efficiency in daily sintering operations
- Debinding and sintering of MIM and metal AM components

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

www.mpif.org

Tekna's powder manufacturing operations achieve AS9100 and ISO 9001 compliance

Tekna, a subsidiary of Arendals Fossekompani ASA with its headquarters in Sherbrooke, Canada, has announced that all of its powder manufacturing facilities are now in compliance with AS9100 and ISO 9001 quality management system requirements.

The announcement includes the company's recently-certified plant in France, where its nickel-base superalloy powders are produced, as well as its Canadian plant, which produces titanium and aluminium powders and was certified in 2017.

"This certification reinforces our position as a major player offering personalised client approach in the market. We are delivering on our commitment: Powder on time, every time, everywhere," stated Rémy Pontone, VP Sales & Marketing at Tekna.

"This milestone is a major achievement for Tekna on its mission to consistently deliver high quality plasma powders among the most regulated business segments in the world: aviation, space and defence," added Luc Dionne, CEO at Tekna.

www.tekna.com

SKF reports strong operating result despite fall in demand for first half 2020

Sweden's SKF has released its report for the first half of 2020, in which it states that it has seen strong operating results, despite a sharp fall in demand. The company is the world's largest producer of ball bearings, and other products include Powder Metallurgy parts such as sintered bronze bushings.

SKF saw its net sales fall organically by 25% to SEK 16.6 billion in the first half of 2020. Sales in both Europe and North America were said to have decreased by about 30%, while sales in Asia were 10% lower compared to the previous year. Sales were said to have continued to be impacted by both government-imposed restrictions and lower underlying demand.

Despite this significant drop in demand, the company reported an adjusted operating margin for the second quarter 2020 of 9.4% (Q2 2019: 12.7%), with an adjusted operating profit of SEK 1.6 billion. Items affecting comparability, including restructuring costs and customer settlements, were reported at SEK 896 million.

SKF's Industrial business reportedly delivered an adjusted margin of 14% (Q2 2019: 15.7%), despite a 17% drop in organic sales. Its automotive business, which continued to be impacted by customer closures and lower underlying demand, delivered an adjusted margin of -8.4%, largely driven by a 45% drop in organic sales.

The company stated that it has continued plans to reduce costs and adjust the size of the business, with the ambition of being more flexible and better able to support its customers. Investments in modernisation and automation of its factories, as well as increasing its regional manufacturing capacity, continued, and during Q2 2020 SKF announced a further SEK 400 million investment in its Xinchang ball bearing factory in China.

During the first six months of the year, the company reduced its staff by letting go of 1,350 permanent employees and 750 temporary/agency employees. This contributed to its reported restructuring costs of SEK 657 million. As these efforts continue, the company expects to see a continued elevated level of restructuring costs during the second half of 2020.

Alrik Danielson, SKF's president and CEO, stated, "We have delivered another very strong operating result, despite sales falling by 25% during the second quarter. This performance allowed us to continue to build a stronger SKF, maintaining high levels of investments in our factories and new customer offerings whilst at the same time capitalising on new ways of working. In June, we also announced that our manufacturing operations will be carbon neutral by 2030."

www.skf.com

Fritsch launches new laser particle sizer ANALYSETTE 22 NeXT

Fritsch has launched the ANALYSETTE 22 NeXT, a new laser particle sizer (Courtesy Fritsch GmbH)

Fritsch GmbH's Milling and Sizing division, Idar-Oberstein, Germany, has released its new laser particle sizer, ANALYSETTE 22 NeXT which is said to be ideal for particle size analysis in production and quality control, research and development, or for controlling manufacturing processes.

The ANALYSETTE 22 NeXT Micro has a measuring range of 0.05–1500 µm for all typical measurement tasks and the high-end instrument ANALYSETTE 22 NeXT Nano has an extra-wide measuring range of 0.01–3800 µm for maximum precision and sensitivity for smallest particles with an additional detector system.

The company states that the new generation ANALYSETTE 22 NeXT operates like every Fritsch laser particle sizer with the patented reverse fourier design. The laser particle sizer operates with only one laser and is said to not need an additional light source even for backward scattering. It records the entire measuring range with only one scan, making work faster as more measurements can be conducted at the same time.

A powerful centrifugal pump, with individually adjustable speed, is said to ensure stable measuring in the dispersion unit. Fritsch added that with its new design and solid engineering, the dispersion unit of the ANALYSETTE 22 NeXT has an especially long service life and is practically maintenance-free.

www.fritsch.de

Yxlon launches new x-ray and CT system for non-destructive testing

Yxlon International, a company of the Swiss Comet Group and designer and producer of radioscopic and CT inspection systems for a variety of applications and fields, has released its new universal X-ray and CT system, the Yxlon UX20. According to Yxlon, the system's operation requires no specialised X-ray knowledge, enabling it to be used by even untrained personnel to achieve optimal inspection results.

Yxlon UX20 is a universal x-ray and CT system (Courtesy Yxlon International)

This is said to be made possible by the company's Yxlon Geminy software platform, which combines all the programmes involved in inspection. Offering intuitive menu navigation, numerous pre-settings and the ability to switch rapidly between radioscopy and computed tomography, non-destructive testing can be performed quickly and easily.

UX20 is suitable for the inspection of a range of components, using its advanced CT functions parts of sizes up to 800 mm in diameter and 1100 mm in height can be inspected reliably, with a height-adjustable operator work area directly attached to the system.

Having a compact footprint, the UX20 is said to be specially designed for use in harsh environments like foundries in the automotive and aviation industries. Components such as the generator, cooler and high-voltage cable are integrated into the cabin for protected and extended use, while remaining easily accessible for maintenance work.

www.yxlon.com

ASM International publishes new book on *Binder and Polymer Assisted Powder Processing*

ASM International has published a new book, *Binder and Polymer Assisted Powder Processing*, co-authored by Randall M German and Animesh Bose.

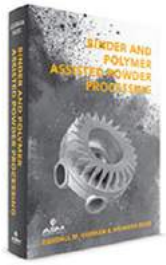
The 273-page book focuses on the basic principles and options available for the application of polymers and natural organics to powder processing. It links materials, powder characteristics, forming processes and product attributes together to give what the authors believe to be the first unified treatment on polymer-assisted powder processing.

The processes discussed include injection moulding, sinter-based Additive Manufacturing, uniaxial die compaction, tape casting, extrusion, slip casting and slurry casting. In each process, the technical requirements are outlined and polymer candidates are identified.

ASM International explains that the book bridges the practical aspects of cost, availability and safety with fundamental structure, properties, processing and tests. Each chapter concludes with a review of current industrial standards and examples of practices.

The book covers the following topics as dedicated chapters:

- Engineering powders
- Binder constituents



- Binder formulation
- Powder-binder feedstock mixing and testing
- Shaping processes
- Binder removal
- Sintering densification
- Component mechanical properties
- Case studies of powder-binding processing practices
- Opportunities for powder-binder forming technologies

www.asminternational.org

William Rowland atomises first 100% revert blend of metal powder for Additive Manufacturing

William Rowland has been supplying metal powder for over forty years (Courtesy William Rowland)

William Rowland, Barnsley, South Yorkshire, UK, reports the successful atomisation of its first batch of metal powder from a specially selected 100% revert blend, for use in both laser and electron beam Additive Manufacturing.

Thanks to its access to a vast range of high-purity metals and alloys, it was able to select a feedstock with the right chemistry and compact density to trial the melt using a toll atomising partner. The material (F75), a cobalt-chrome alloy typically used in the medical industry, was successfully atomised to 15–53 µm and 53–106 µm, suitable for Electron Beam Powder Bed Fusion (PBF-EB) and Laser Beam Powder Bed Fusion (PBF-LB).

The company has been supplying metal powder for over forty years, and whilst much of its offering has been elemental powders, it has recently begun to address the challenges facing the metal Additive Manufacturing industry.

The company stated that it accepted the challenge to atomise this first 100% revert powder blend because it was of the view that the AM industry will face the same structural input cost challenges as more established wrought methods did in order to become commercially viable and upscale. This will, it reports, involve to some degree a move away from virgin materials and pre-alloyed bar stock, which have typically been the raw materials of choice in the developmental phases of AM.

The material from atomised batch was supplied to the customer, but a small batch of samples was retained by William Rowland for interested parties including current and prospective customers.

www.william-rowland.com

Ipsen to establish global Technology Excellence Centres

Ipsen USA, Cherry Valley, Illinois, USA, reports that it is establishing Technology Excellence Centres, while further strengthening the company's offerings, in order to ensure it is addressing market needs of its current and future customers.

Ipsen states that an important outcome will be faster response times, supported by advanced new service products, in all the regions that Ipsen serves.

The company's equipment manufacturing business will be driven by an Atmosphere Technology Excellence Center in Kleve, Germany, and a Vacuum Technology Excellence Center near Rockford, Illinois, USA. Ipsen explains that this focus on one field of technology will enable faster-paced innovation and a laser-focus on performance and quality.

As a result of this change, new furnace equipment will reportedly be manufactured at fewer locations globally with a focus on specialisation. The Ipsen Germany location will exclusively build Atmosphere Batch and Continuous Systems while the US location will exclusively build all types of Vacuum Furnaces.

In addition, Ipsen India will continue to build Atmosphere furnaces for the India and Southeast Asia markets, noted the company. Its China and Japan locations will no longer manufacture new furnaces and will focus on customer service and the sale of new equipment from the Excellence Centres.

The company states that the customer relationship with Ipsen will remain unchanged and will continue to support its customers from all of our global locations. All Ipsen plants remain open in all regions as the aftermarket support of its customers is said to be more than half of Ipsen's annual business. Activities such as upgrades, local inventory of parts and service are expected to continue to be fully supported on a local basis.

According to Ipsen, this consolidation of equipment manufacturing sites together with the uncertainty of the coronavirus (COVID-19) pandemic does result in a reduction of staff, which the company reports is a regrettable but necessary outcome from its carefully planned strategic step.

www.ipsenusa.com

Toyota and Mazda invest a further $830 million at USA automotive facility

Toyota Motor Corporation and Mazda Motor Corporation plan to invest an additional $830 million into an automotive assembly plant which is currently under construction in Alabama, USA, reports Nikkei Asian Review.

The Mazda Toyota Manufacturing site is a joint venture that was announced by the company in 2018 to produce SUVs. The initial investment was said to be $1.6 billion, but this was reduced by approximately $200 million at the start of construction.

As part of the funding, the plant is expected to be equipped with state-of-the-art production equipment and employee-training facilities to increase productivity. Production staff will be recruited later this year, with a total of up to 4,000 expected to be working at the facility by 2022.

The total investment is reported to be approximately $2.31 billion. Annual production capacity is expected to remain unchanged at 300,000 units.

Toyota has confirmed that it will manufacture a new SUV at the plant instead of originally planned Corolla subcompact. Production is expected to be evenly divided with Mazda SUVs.

www.global.toyota
www.mazda.com

Dr Gopal Shankar Upadhyaya, distinguished Powder Metallurgy expert, has died

Dr Gopal Shankar Upadhyaya, a well-known and highly respected expert in Powder Metallurgy, passed away on July 19, 2020, in Varanasi, India, aged eighty-two. Born in Varanasi, his metallurgical education began at Banaras Hindu University, from where he graduated with his first degree in 1960.

He received his MSc degree from the department of Physical Metallurgy at the University of Birmingham, UK, in 1962 and later a PhD from the Kiev Institute of Technology, Kiev, Ukraine in 1969 under the guidance of Professor GV Samsonov.

His academic career began at the University of Roorkee from 1964–1975, and continued at the Indian Institute of Technology, Kanpur (1976–2001), as a Professor in the Department of Materials and Metallurgical Engineering.

Dr Upadhyaya published over 300 original papers and authored/edited a number of books on a wide range of metallurgical topics.

He also won many prestigious awards, including the Niobium Medal of the Max Planck Institute for Metals Research, Germany, in 1989; the Samsonov Prize of the International Institute for the Science of Sintering in 1993; Medal of the Materials Research Society of India, also in 1993; GD Birla Gold Medal of the Indian Institute of Metals in 1994; Distinguished Alumnus of Banaras Hindu University in 1998; Dr Daya Swarup Memorial Lecturer of the Indian Institute of Metals in 2008; and the DN Agrawal Memorial Lifetime Achievement award of the Indian Ceramic Society in 2009.

Pfeiffer Vacuum celebrates 130-year anniversary

Pfeiffer Vacuum GmbH, Asslar, Germany, is celebrating its 130th anniversary as a provider of vacuum technology.

Founded in 1890 by Arthur Pfeiffer in Wetzlar, Germany, the company was initially devoted to the production of remote ignition systems for gas lamps. Once electric light bulbs had established themselves on the market, the company's founder turned his attention to the new lighting technology, investigating the vacuum technology used in its production.

According to the company, Pfeiffer quickly realised the significant impact that vacuum technology could have in practically all areas of industry and research, and subsequently concentrated his efforts entirely on this field. Since then, Pfeiffer Vacuum reports that it has played a pivotal role in shaping vacuum technology.

Now, Pfeiffer Vacuum's products are still used widely in industry by customers such as the Max Planck Institute, CERN, XFEL and EADS. Vacuum pumps produced by Pfeiffer are also in use in the International Space Station.

Dr Eric Taberlet, Chief Executive Officer of Pfeiffer Vacuum Technology AG, commented, "With our durable products and customised vacuum solutions, we are able to satisfy practically every customer requirement and to establish relationships that will endure for years to come."

"At Pfeiffer Vacuum, 'sustainability' is not just an empty word," he continued. "We are aware of our responsibility.

Pfeiffer Vacuum was founded 130 years ago in 1890 (Courtesy Pfeiffer Vacuum GmbH)

And this is why, at all our locations around the world, we establish the necessary conditions to make sure that our staff enjoy working for Pfeiffer Vacuum."

"We are socially committed because we want to give something back, and we produce our products in the most energy-efficient and environmentally-compatible manner possible. We have been living and breathing sustainability – by tradition – for 130 years."

www.pfeiffer-vacuum.com

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HyProMag leads project to recycle rare earths for electric vehicles

A new project led by HyProMag, Birmingham, UK, which has licensed a patented process for extracting neodymium-iron-boron (NdFeB) rare earth alloy powders from magnets embedded in scrap and redundant equipment, will develop technologies for recovering rare earth materials from old equipment and recycling them for use in new electric motors.

According to *Drives & Controls*, the £2.6 million project, RaRE (Rare-earth Recycling for E-machines), has secured £1.9 million funding from the UK's government-backed Innovate UK. The remaining £700,000 balance of the project costs is being split between the project partners. Participating companies include electric motor developer Advanced Electric Machines Research, Bentley Motors, Unipart Powertrain Applications and Intelligent Lifecycle Solutions.

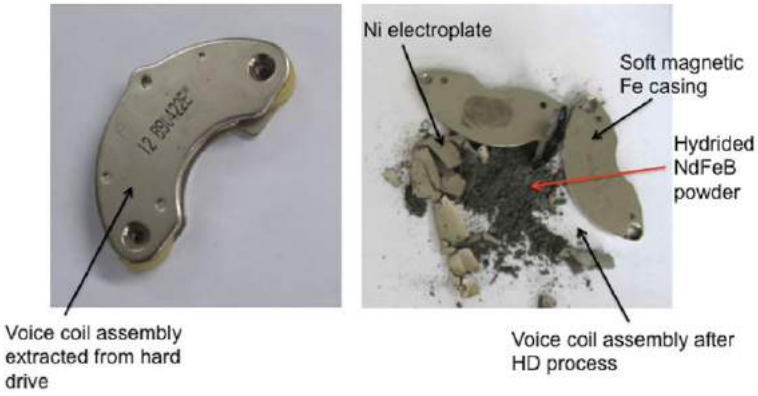
Rare earth materials are used to create permanent magnets used in electric motors and other applications. Electric and hybrid vehicles may contain large quantities of these magnets in applications such as drive motors, fans, generators, power steering, pumps, seat motors and loudspeakers.

China currently dominates the global supply of rare-earth materials, due to being home to the majority of the natural rare earth deposits in the world, and may raise their prices dramatically during periods of tension, meaning that the global supply of rare earths is unstable. Few companies currently recycle rare earths because of technical difficulties in separating magnets from waste.

HyProMag's process for extracting NdFeB rare earth alloy powders from scrap and redundant equipment is called Hydrogen Processing of Magnet Scrap (HPMS), and was originally developed by the University of Birmingham's Magnetic Materials Group. The RaRE project aims to establish an end-to-end supply chain to incorporate recycled rare earth magnets into ancillary motors, primarily for electric vehicles.

HyProMag reportedly plans to scale up the HPMS process and convert rare earth materials into new magnetic materials at pilot scale to demonstrate the quality of the materials, in terms of their magnetic behaviour, mechanical performance and corrosion resistance. Intelligent Lifecycle Solutions will establish the scrap-sorting process to maximise its efficiency and the volumes of the rare earth materials produced.

www.hypromag.com



The HPMS process when applied to a voice coil assembly of a hard disk drive (Courtesy HyProMag)

Call for papers issued for MPIF's PowderMet2021 conference

The programme committee for the International Conference on Powder Metallurgy & Particulate Materials (PowderMet2021), scheduled to take place at the Walt Disney World Swan and Dolphin, in Orlando, Florida, USA, from June 20–23, 2021, has issued a call for papers and posters.

The four-day event is co-located with Additive Manufacturing with Powder Metallurgy (AMPM2021) and the 10th International Conference on Tungsten, Refractory & Hardmaterials (Tungsten2021)

The technical programme co-chairmen for 2021 are Gregory (Jerry) Falleur, AAM—Metal Forming, and Roland T Warzel, III, North American Höganas Co. Abstracts are invited covering PM and particulate materials technology. All topics related to metal Additive Manufacturing should be submitted to AMPM2021, for which a call for papers has also been issued.

"The annual PowderMet conference reunites the robust Powder Metallurgy industry," stated James P Adams, Executive Director & CEO, Metal Powder Industries Federation. "It includes the largest North American exhibit to showcase leading suppliers of PM, particulate materials, and metal Additive Manufacturing. Additionally, strategic networking opportunities bring delegates face-to-face, to finally catch up on the latest research and development, celebrate industry achievements, and more."

The abstract submissions deadline is November 13, 2020. Further information and registration details are available via the event website.

www.powdermet2021.org

MTC Powder Solutions highlights use of HIP in subsea manifold systems

MTC Powder Solutions, Surahammar, Sweden, a leading producer of near-net shape products produced by Hot Isostatic Pressing (HIP), has highlighted the use of its technology in the manufacture of subsea manifolds.

Manifold systems are key components utilised to collect oil/gas from several wells in an oil and gas field, the company explains. The manifold is a critical part, and failure must be avoided at all costs as this would lead to a well shutdown, which can then result in millions of dollars lost.

Traditionally, manifold systems consist of a variety of standardised shaped piping components used to create various flow paths and interfaces. The piping components are joined together with a large number of welds, which is a time-consuming process, requiring various pre-weld qualification programmes and high-integrity inspections after completion (Fig. 1).

According to MTC Powder Solutions, today's challenging market conditions have increased the focus on reducing the total project cost, together with a focus on reducing the time from investment decision up to production launch.

By using HIP for manifold systems, the company explains that the number of components and welds can be drastically reduced thanks to the freedom in design the technology offers. Manifold sections can be produced with integrated flanges, tees, bends and pig bars, without a single weld being undertaken.

Using a HIP designed manifold, where the overall length of the piping is reduced, can also result in a smaller and lighter subsea template which would also reduce the footprint on the ocean floor (Fig. 2). This, the company suggests, could also reduce installation costs, potentially allowing more templates to be fitted via the same installation vessel, reducing the amount of mobilisation required and ultimately reducing total project costs even further.

www.mtcpowdersolutions.com

Fig. 1 Conventionally manufactured manifolds (top) would normally be produced from a minimum of four forged components welded together (middle). All components are integrated into one piece (bottom), eliminating the need for welds to produce the manifold section (Courtesy MTC)

Fig. 2 Using a HIP designed manifold, where the overall length of the piping is reduced, can result in a smaller and lighter subsea template (Courtesy MTC)

Plansee receives three supplier awards from key customers

Plansee Group, headquartered in Reutte, Austria, reports that Plansee China Ltd, has received three awards from key customers, including AMEC, Texas Instruments and Sony. The Supplier Awards were presented to Plansee for their service and support during 2019.

AMEC is a global micro-fabrication equipment company based in China, serving customers in the semiconductor industry and related high-tech sectors. Plansee has supplied the company with various products for metalorganic chemical vapour deposition (MOCVD) since 2017, including rare earth outer heaters, molybdenum liners, spindles and filaments. The excellent properties of the products and their consistently high quality are said to have made Plansee the preferred supplier for AMEC.

Texas Instruments (TI) designs and manufactures semiconductors and various integrated circuits, which it sells globally. Plansee has been a longstanding supplier of the company, and was presented with the "Regional Supplier Recognition Award" due to its performance in: environmental and social responsibility, technology, responsiveness, delivery reliability, quality and costs.

Sony is another longstanding customer of Plansee, purchasing semiconductor and MOCVD products. Plansee and its sales partner TCS were awarded by Sony the breakthrough prize for the development of a tungsten-liner source, extending the life and reducing the costs for their CIS process.

www.plansee.com

Conference on Advanced Manufacturing Technologies for Novel Microstructures, Components Shapes and PM set for 2022

The 16th International Conference on Advanced Manufacturing Technologies for Novel Microstructures, Components Shapes and Powder Metallurgy (ICAMTNMCSPM) is set to take place from March 29–30, 2022, in Paris, France.

The conference is organised by the International Research Conference, a federated organisation dedicated to bringing together a significant number of diverse scholarly events.

ICAMTNMCSPM 2022 will invite leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of advanced manufacturing technologies for novel microstructures, components shapes and Powder Metallurgy. It will also provide a platform for practitioners and educators to present and discuss the most recent innovations, trends and concerns in the field, as well as practical challenges encountered and the solutions adopted to overcome them.

A call for research abstracts, papers and e-posters has been issued for ICAMTNMCSPM 2022. High-quality research contributions describing original and unpublished works of conceptual, constructive, empirical, experimental or theoretical work are invited in all areas of advanced manufacturing technologies for novel microstructures, components shapes and PM.

https://waset.org/

Ulf Engström retires after forty-three years with Höganäs

Sweden's Höganäs AB has announced that Ulf Engström has retired from his role as Interim Manager PM Business Development, after working with the company for forty-three years.

Having joined Höganäs in 1977 Engström has been involved in the development of some of the company's most successful products. During his career he has trained thousands of customers and colleagues, and been awarded the prestigious Kami Prize, amongst other industry recognitions.

Ulf Engström has retired from Höganäs after forty-three years (Courtesy Höganäs AB)

Explaining that Engström has been indispensable for the development and success of metal powders, Hans Söderhjelm, Senior Vice President of Research & Development, stated, "Ulf was the one who drove the metal powder market forward by dramatically improving the powder's performance and quality. When he started at Höganäs, around 50,000 tonnes of powder were sold for PM and a total of 100,000 tonnes of iron powder. In recent years, sales have reached almost 400,000 tonnes for PM and around 100,000 tonnes for other powders."

In the early 2000s, Engström was responsible for the company's technology centre in Stony Creek, USA, and in the 2010s he had a similar role in Shanghai, China.

"I was asked if I could go to the US in early 2001, to take care of technical support. It was a challenge. But I wanted to work more closely with customers and help them find solutions, while at the same time train employees," added Ulf Engström.

In recognition of his influence and work in Powder Metallurgy, Höganäs established the Ulf Engström Award in 2016 to encourage and recognise employee contributions to technical advancements and expanded commercial use of PM technology.

Caroline Larsson, who heads the Materials & Products team within Electro & Mechanical Technologies and who was awarded the Ulf Engström Award in 2018, commented, "Ulf is very knowledgeable and generous and is happy to share his ideas. He is a fantastic mentor."

According to Höganäs, after forty-three years of faithful service to metal powder, a welcome retirement awaits. There is no doubt that Engström will miss Höganäs and the metal powder industry, but the question is whether they will miss him more. "In short, Ulf is Höganäs' Mr PM. In fact, you could probably say that he is the world's Mr PM," concluded Söderhjelm.

www.hoganas.com

Wall Colmonoy expands powder analytical capabilities

Wall Colmonoy Limited has recently invested £500,000 in the research & development laboratory at its European Headquarters, in Pontardawe, UK, as part of its plans to improve product development, technical support and advancement.

The company explains that it has developed its R&D lab into a fully comprehensive suite of analytical equipment for characterising powders; including laser diffraction, chemical analysis, dry powder and fluid rheometry, and optical and electron microscopy. With a recent move into materials for Additive Manufacturing, where powder properties such as particle shape and size are often more critical, there was a need to expand its analytical capabilities.

"We have manual microscopy and electron microscopy, which allow us to qualitatively check the products we manufacture, but we also needed a technique that could provide quantitative data on a statistically representative sample," stated Tom Roblin, Process Engineering Manager, Wall Colmonoy Limited.

The company has added a Malvern Panalytical Morphologi 4 to measure particle shape and size. The Morphologi 4 is said to provide an automated optical imaging platform capable of analysing a large number of particles and image analysis capabilities that automatically quantify the shape and size distribution of those particles. The R&D laboratory is home to further metal powder analytical equipment including a full SEM / EDS suite and ICP Spectrometer.

"Morphologi 4 is used to quantitatively measure the particle shape of our atomised alloy powders," Roblin added. "By investing in this measurement equipment, we can benchmark and improve our current processes and products."

The Morphologi 4 reports shape information using parameters such as elongation, circularity, convexity to quantify particle irregularity, and surface roughness. Said to be more efficient than manual microscopy and electron microscopy, automated imaging provides statistics on tens of thousands of particles. It has reportedly aided in the development of a new range of Colmonoy (nickel-base) and Wallex (cobalt-base) powders.

www.wallcolmonoy.com

VBN Components receives award for its cemented carbide Vibenite alloy

VBN Components, Uppsala, Sweden, has received a "Best of Industry Award" in the category of Additive Manufacturing from Germany's MM Maschinenmarkt, for its cemented carbide Vibenite® 480 alloy. The company received the award on June 25, during an online ceremony broadcast from Würzburg, Germany.

The company states that the patented Vibenite 480 alloy is extremely heat-resistant (up to at least 750°C) and wear-resistant and corrosion-resistant. Processing via Additive Manufacturing is enabling the production of complex shapes for industrial tools and components, and reducing environmental impact.

According to VBN Components, the Vibenite 480 is based on metal powder produced through large scale industrial gas atomisation, said to minimise both cost and environmental impact. The new material combines the toughness of Powder Metallurgy High-Speed steels (PM-HSS) with the heat resistance of cemented carbides, which is why this new group of materials is named as hybrid carbides.

Vibenite 480 has a carbide content of ~65% but is said to be tougher than regular cemented carbides and therefore suitable for more complex details. Typical applications for this material are cutting tools for milling, drilling and gear cutting, which require good wear resistance at high temperatures, combined with good toughness. The AM process opens up completely new possibilities in the design of the tools, states the company.

In addition, Vibenite 480 is also reportedly suitable for all components that are subject to high wear, such as pump components, nozzles, and baffle plates – said to be an ideal alternative to hardmetals or wear-resistant alloys. With Additive Manufacturing, the components can rapidly be produced in near-net-shape, with design options offering new approaches to make components more wear-resistant. Additively manufactured cutting tools or wear components can be manufactured with very short lead times, which opens up many new approaches to build, test and improve prototypes and finally take the optimised component or cutting tool to serial production.

"The company vision is to renew the materials industry in the world by developing materials that offer uniqueness and improved industrial performance, and the Best of Industry Award is a great recognition to our achievement," stated Ulrik Beste, CTO of VBN Components.

www.vbncomponents.se

A Vibenite 480 compressor screw (Courtesy VBN Components)

Pfeiffer Vacuum introduces OmniStar and ThermoStar gas analysers

Pfeiffer Vacuum GmbH, Asslar, Germany, has introduced two new benchtop gas analysers, the OmniStar and ThermoStar GSD 350. The compact and portable analysers, for analysing gases at atmospheric pressure, are particularly suitable for applications in metallurgy amongst others.

The gas inlet is fitted with a heated capillary for use at up to 350°C, preventing vapours from condensing during process gas analysis. Thanks to the two-stage inlet system, almost segregation-free gas supply is possible. The ThermoStar solution was specially developed for coupling with thermo balances. The inlet system with a quartz capillary and a platinum orifice ensures that even the smallest concentrations can be analysed, explains the company.

The OmniStar was developed for a wide range of applications and uses a stainless steel capillary as well as a valve which can interrupt the sample gas stream. Unlike other analytical methods such as FTIR or GC-FID, the two new devices allow simultaneous detection of all gases within the mass range.

With the new PV MassSpec software, it is said to be possible to perform qualitative and quantitative analyses. This software offers a clear and user-friendly platform for recording and displaying measurement data and parameter settings. Even complete measuring procedures can be programmed and automated. With a variety of equipment variants available, the mass ranges of 1 to 100 u, 1 to 200 u and 1 to 300 u are covered.

www.pfeiffer-vacuum.com

Call for Papers & Posters

Abstract Submission Deadline: November 13, 2020

TECHNICAL PROGRAM:
Co-located conferences PowderMet2021, International Conference on Powder Metallurgy & Particulate Materials, and AMPM2021, Additive Manufacturing with Powder Metallurgy, provide attendees with access to over 200 technical presentations from worldwide experts on the latest research and development.

TRADE EXHIBIT
The largest annual North American exhibit to showcase leading suppliers of powder metallurgy, particulate materials, and additive manufacturing processing equipment, powders, and products.

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Including special guest speakers, awards luncheons, and evening networking events.

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The MPIF reflects on the state of the North American Powder Metallurgy industry

The coronavirus (COVID-19) pandemic has meant that the majority of this year's Powder Metallurgy industry events were cancelled, among them the highlight of the year, the World Congress on Powder Metallurgy & Particulate Materials (WorldPM2020). This year, it was the turn of the Metal Powder Industries Federation (MPIF) to organise the biennial event, which had been set to take place in Canada in June. Without this gathering of the global PM industry, the MPIF chose to release its yearly presentation on 'The State of the PM Industry in North America' via its website. Here we present MPIF President Dean Howard's overview.

The annual 'State of the PM Industry in North America' report is a chance for the MPIF to reflect on the activity of its members, the state of the market and the outlook for the coming year. At the start of the year, prior to the coronavirus (COVID-19) outbreak, MPIF President Dean Howard reported that the business outlook was tempered by cautious optimism; based on the MPIF's annual PM Industry Pulse Survey from September 2019, the majority of responding companies expected sales to increase in 2020 compared to 2019, but showed concern that the economy may be due 'correction'.

"Of course, at the time, the shocking COVID-19 pandemic damage on manufacturing and the global economy was unthinkable," Howard noted. "But, could this global disruption be a wake-up call and trigger a robust movement to reshore manufacturing? Time will tell."

Business and technology trends in 2019

When the final numbers were tallied for 2019, metal powder shipments, a 'bellwether indicator', signalled a continuing negative trend in traditional PM sectors. Total North American metal powder shipments declined by an estimated 11% to 412,973 mt (455,317 st). Iron powder shipments decreased by 10.4% to 352,234 mt (388,351 st). PM and friction-grade powder shipments

Fig. 1 MPIF President Dean Howard reflects on the state of the North American PM industry (Courtesy MPIF)

	2018		2019	
	Short Tons	Metric Tons	Short Tons	Metric Tons
Iron & Steel	433,203	392,915	388,351	352,234
Stainless Steel	8,750*	7,936*	7,960*	7,220*
Copper & Copper Base/Tin[1]	18,500*	16,780[a]	16,900*	15,328*
Aluminium	33,660*	30,530*	26,448*	23,988*
Molybdenum	820[r]	744[r]	550*	499*
Tungsten	1,750*	1,587*	1,689*	1,532*
Tungsten Carbide	8,590*	7,791*	7,919*	7,183*
Nickel	6,100*	5,533*	5,500*	4,989*
	511,373	463,815	455,317	412,973

*estimate [r]revised | [1]PM parts only | 1 st = 0.907 mt

Table 1 North American powder shipments 2018/2019

were also down by 10.4% to 320,257 mt (353,095 st). Welding applications dropped by 13.3% to 13,735 mt (15,143 st). Cutting, scarfing and lancing applications declined by 14% to 871 mt (960 st). Miscellaneous uses declined 6.4% to 17,372 mt (19,153 st).

In 2019, stainless steel, copper and nickel powder shipments all declined by an estimated 9–10%. Stainless steel powder shipments decreased to 7,220 mt (7,960 st); copper and copper-base powder shipments to 15,328 mt (16,900 st), and nickel powder shipments to 4,989 mt (5,500 st).

Aluminium powder shipments declined by more than 21% to an estimated 23,988 mt (26,448 st). Molybdenum shipments declined by an estimated 32.9% to 499 mt (550 st). Tungsten powder shipments decreased by an estimated 3.5% to 1,532 mt (1,689 st), and tungsten carbide powder shipments decreased an estimated 7.8% to 7,183 mt (7,919 st).

On the automotive segment, Howard reflected that, "Vehicle production is a crucial element of the North American economy. Like many other manufacturing segments, vehicle production has slumped in the past three years due to increased production costs, changes in supply chains, and – primarily – consumer needs." In 2016, manufacturers in North America produced a record 18 million passenger vehicles. In 2019, around 16.8 million vehicles were produced in the region. Of those vehicles, roughly 10.9 million were assembled in the United States, with Mexico and Canada assembling around six million between them.

"Vehicle production is a crucial element of the North American economy. Like many other manufacturing segments, vehicle production has slumped in the past three years..."

Vehicle sales declined by 1.3% to 17,047,725 vehicles in 2019. While automotive applications account for about 75% of traditional PM part production, there seems to be a disconnect between the sharp drop in iron powder shipments for parts vs vehicle production and sales figures which remain robust.

Regarding this apparent disconnect, Howard commented, "Several thoughts come to mind, including the growth of hybrids and electric vehicles, but the downsizing of engines and transmissions and a fading market for traditional sedans are the obvious culprits." Sedans, which make up about 28% of the North American sales, are predominantly available only from transplanted Asian and European manufacturers. "Designers in these regions have been less 'PM friendly' and hesitant to adopt and utilise PM in their designs," he explained. In fact, it has been estimated that less than 30% of the global passenger vehicles' connecting rods are powder forged. Powder Forged connecting rods have been proven to outperform connecting rods produced by other technologies, and the Powder Forged connecting rod continues to be an opportunity for the PM industry which, according to the MPIF, should be considered for hybrid passenger vehicles.

The greater acceptance of turbochargers to increase engine efficiency, including fuel economy, torque, and horsepower, was said to have assisted in reducing engine sizes from 8 to 6 to 4-cylinders, resulting in fewer connecting rods and main bearing caps per vehicle along with smaller transmission carriers. For example, 5 and 6-speed transmissions are being replaced by 8 and 9-speed designs that use smaller parts, which are more open to less costly castings and stampings. Many turbocharged 4-cylinder engines, and 3 and 4-cylinder hybrid engines, are designed in Asia and Europe without Powder Forged connecting rods and PM main

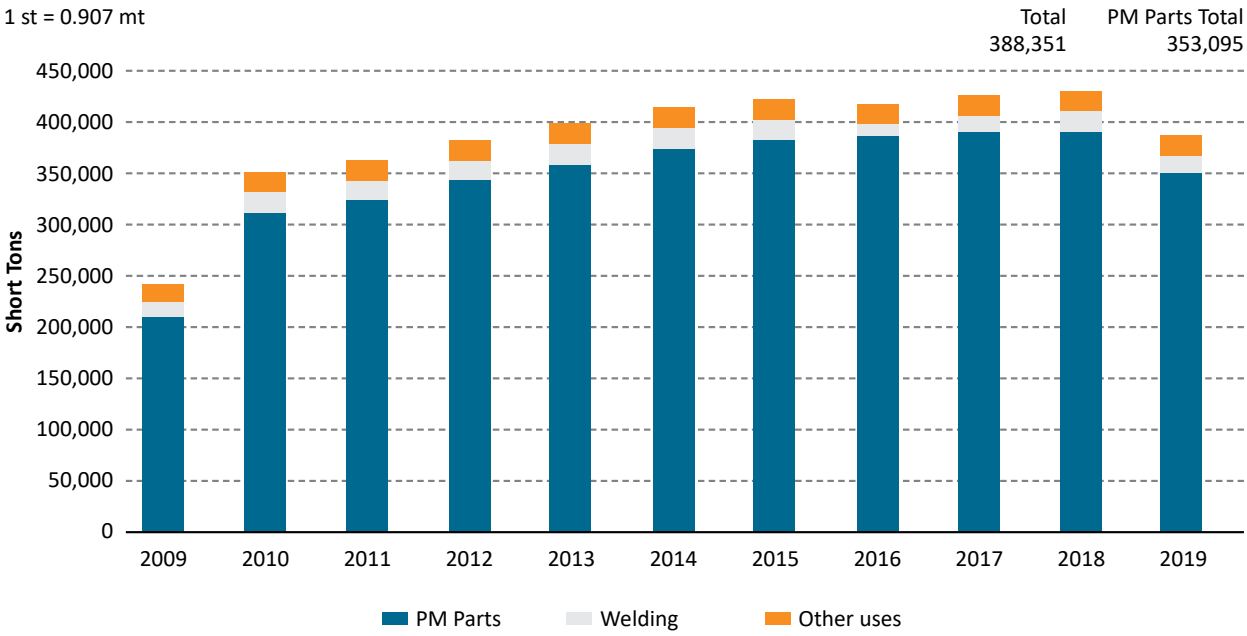

Fig. 2 North American iron powder shipments 2009 - 2019

bearing caps. "As you can imagine, this has caused great concern for the North American PM industry," Howard noted. "The MPIF has initiated what I believe to be the deepest dive to date to estimate the total PM in a North American passenger vehicle. It is a difficult task to provide one, all-inclusive weight as there are numerous variables such as the platform: pickup, large SUV, crossover, sedan; the make and design: North American, Asian, or European; the engine type: internal combustion, hybrid electric, electric; or the drivetrain: all-wheel, front-wheel, rear-wheel, and 4-wheel drive."

In 2019, it was reported that the estimated average PM weight in a 2018 North American passenger vehicle was 19.5 kg (43 lb). This was based on robust pickup truck and large SUV sales with 8-cylinder engines and 4-wheel drive that likely skewed the estimated average as calculated. As a result, the estimate for 2018 was slightly overstated. After thorough review, the estimated average weight in a 2019 North American passenger vehicle was reported at 17.7 kg (39 lb), a decline of 9.3%. "Many industry experts project the PM weight in passenger vehicles will decrease 1–2% annually without new applications or a greater acceptance of Powder Forged connecting rods and PM main bearing caps in hybrid engines," Howard stated.

Metal Injection Moulding and Additive Manufacturing

In contrast to the press & sinter community, Metal Injection Moulding (MIM) and metal Additive Manufacturing (AM) gained in 2019. Sales of MIM parts in the US increased by an estimated 5% to a range of $460–480 million in 2019. It is estimated that MIM-grade powders, aka powders of less than 20 µm, consumed in the US, domestically produced and imported, increased by 5% in 2019 to 3,637,627 kg (8,020,968 lb). This amount includes MIM-grade fine powders for metal AM applications.

"Interest in metal AM as a complement to MIM parts manufacturing is growing," Howard observed. "More than ten Metal Injection Molding Association (MIMA) member companies reported that they anticipate purchasing metal AM production machines within the next two years, with the Binder Jet process leading the way. Initially, MIM parts makers expect to use metal AM to print prototype designs to avoid the need for costly tooling. Additionally, others will use metal AM to build tooling to reduce the time from part design to part production."

MIM end-markets remained stable in 2019, dominated by firearms and medical applications.

Refractory metals

The refractory metals market in 2019 was mostly flat to down. Imports of lower-cost tungsten carbide powders were up significantly, which negatively impacted North American powder shipments. In addition to lower-cost imports, the tungsten and tungsten carbide markets were reported as being down in 2019 due to: a devastated oil and gas market, decreased global mining, and a decrease in demand for tungsten carbide cutting tools due to a reduction in manufacturing during the second half of the year.

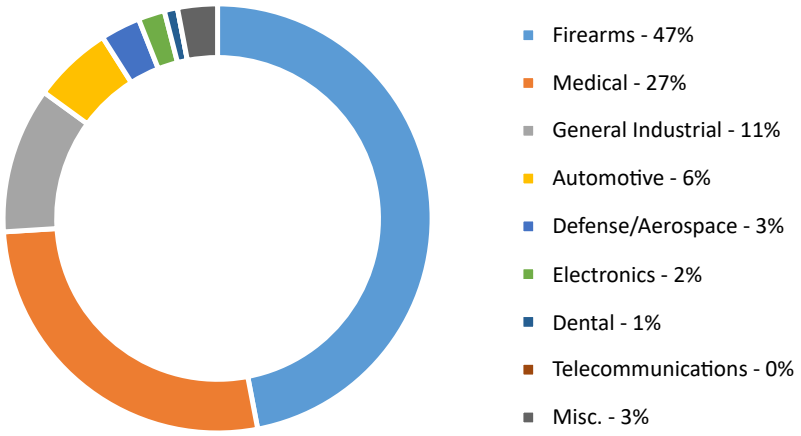

Fig. 3 MIM market mix according to weight of parts shipped

North American oil and gas rig counts were near the lowest levels since record keeping started in 1949. Global mining activity, which drives demand for tungsten and tungsten carbide, also remained at less than normal levels. Mining is highly dependent on global economies in North America, Asia, and Europe, with those economies performing from expanding to flat to negative, respectively. One positive highlight was observed as US defence demands remained strong throughout 2019.

"It should be noted that in 2018, considerable molybdenum powder production moved offshore, negatively affecting shipments of powder produced in North America," Howard noted. "After further analysis, a restatement of the 2018 molybdenum shipments is required." New estimates for 2018 reflect a reduction from 856 mt (944 st) to 744 mt (820 st), a decrease of 34% in shipments compared with 2017, which had 1,125 mt (1,240 st). In 2019, North American molybdenum powder demand was estimated to be down by 50–55%.

Trends for 2020

"20/20 is considered to be perfect vision, but the year 2020 outlook is quite obscure," Howard commented. "We can view the current state of the PM industry through short-term, fear-tinted glasses or gain a clearer picture of long-range opportunities. Just like US manufacturing in general, the PM industry has been impacted negatively by the pandemic."

"We can view the current state of the PM industry through short-term, fear-tinted glasses or gain a clearer picture of long-range opportunities..."

"Many economists forecast a gradual 'U' or 'W' recovery, resulting in a North American recession that will limit new housing builds and automotive production. The US has witnessed high unemployment rates nearing the level of the Great Depression. Elk County, Pennsylvania, for example, where the PM industry hub of St. Marys is located, approached 26% unemployment earlier this year, the highest unemployment rate per capita in Pennsylvania. These economic events, unprecedented in modern times, are testing the public consumer and corporations alike."

"Cautionary signs seeded the new year, with companies forecasting a range of options: low single-digit gains, flat sales, or modest declines in the first quarter," Howard continued. "January and February iron powder shipments for PM applications decreased by 5%, before a 19.2% year-over-year plunge in March, a foreshadow of the COVID-19 pandemic. Copper powder and stainless steel forecasts remained flat just before the pandemic storm mutated into a deadly hurricane in April, devastating the entire domestic and global economies."

In many areas across the US throughout the pandemic, manufacturing companies were deemed non-essential businesses and forced to close their operations to adhere to local government regulations. Companies that had less than 500 employees were eligible for government programmes such as the Payment Protection Program, but many were forced to furlough or lay off employees.

Industry begins to resume following pandemic

As signs of the pandemic subsided, the North American automotive industry – which had been shut down since March – resumed production in mid-May. "New safety policies, self-distancing protocol, and a disrupted supply chain posed more challenges than expected resulting in the month ending in serious negative territory," Howard commented. "Some US factories explored alternative suppliers to compensate for plants that remained closed or were overwhelmed by orders for parts in high demand. General Motors, for example, reportedly delayed plans to increase production of pickup trucks in May because of a

Fig. 4 MPIF Industry Award winning parts continue to showcase the many and varied applications for Powder Metallurgy

shortage of parts from Mexico. Many manufacturing plants in Mexico, which surpassed China as the top trading partner to the US last year, were ordered closed early during the pandemic."

Howard stated that, "Overall, the second quarter appears to be a lost cause for most of manufacturing, including PM companies."

On a positive note, he added that US jobs had increased by 2.5 million in May, by far the biggest one-month jobs gain since at least the Great Depression. This gain decreased unemployment to 13.3%, far better than the 19.5% economists had projected.

"PM equipment suppliers hunkered down as well," according to Howard. "A veteran toolmaker reports PM tooling builds are down as much as 75%. Some press and furnace suppliers reported providing start-up services to their customers as most equipment had not been in operation for nearly two months. Traditional PM parts makers are hanging on in a survival mode, especially those connected to automotive OEMs. However, the smaller family-owned shops that are more diversified seem to be doing better."

"HVAC manufacturers are still ordering furnaces and air conditioners, along with agricultural, lawn & garden, and medical equipment customers, for parts going into hospital beds and wheelchairs. Gym equipment for home use continues to expand and could be an interesting new market for conventional PM due to shelter-in-place orders."

"One family-owned company executive reports some customers have moved up ordering to build up inventories for the future," he noted. "As a result, he sees June orders rebounding somewhat. He is also making lemonade from the lemons he is dealing with by investigating process improvements, such as reducing scrap. In another facility, company engineers are devoting time to installing and qualifying new robots connected to compacting presses, furnaces, and machining centers. Automation will continue to be utilised industry wide."

Another family-owned facility was said to have experienced a recent surge in new, mostly non-automotive parts. They also reported an increase in former customers investigating the option of reshoring parts that were lost to low-cost suppliers over the past decade.

Metal AM and MIM more positive outlook

MIM and metal AM markets have a brighter outlook for 2020. "The firearms and medical markets will dominate MIM production again," Howard explained. "Firearms sales, for both handguns and long guns, are expected to be robust in response to recent social injustices and this Fall's presidential election.

Medical and dental shipments could suffer a slight downturn as elective medical/dental procedures were prohibited due to state lockdowns. At best, MIM parts sales may increase by single digits or stay even with last year."

"Metal AM continues to be on a roll, especially for aerospace and medical applications such as custom implants that replace forgings," he added. Some common metal AM materials include nickel-cobalt alloys, aluminum-silicon-magnesium alloys, low-alloy steel, stainless steel and Inconel.

It was noted that there continues to be tremendous activity in the metal AM sector. From one manufacturer reportedly concentrating on making large parts, up to 450 kg (992 lb), for the aerospace and

Fig. 5 The MPIF will continue to provide education and training to support the metal powder industry

defence industries, to another developing binder jet AM of tungsten heavy alloys and the Directed Energy Deposition (DED) of molybdenum, there are many opportunities for this sector. In addition, advances continue for metal AM processes such as Binder Jetting and Material Extrusion (MEX), all of which are debound and sintered, leveraging the existing successes of MIM technology.

The MPIF believes metal Additive Manufacturing could become a significant growth market for aluminium powders as customers explore the light metal's environmental and lightweight benefits. "Metal AM trends in the next decade will focus on enhancing throughput, printing larger parts, multi-material printing, and repairing and refurbishing expensive parts and tooling," Howard predicted.

Changing automotive sector

Returning to the fate of PM in the automotive industry, Howard stated, "Without a doubt, the global automotive market is changing. Long-standing PM champions face a shrinking universe of opportunities. While the Detroit three – General Motors Corporation, Ford Motor Company, and Fiat Chrysler Automobiles – restarted production in mid-May, forecasts for light vehicle sales and production still look gloomy. Who would have thought that we would be offered incentives to purchase vehicles that included no interest for 84 months, no down payment, and 120 days before the first payment? During the midst of the shutdown, IHS Markit forecasted a 26.7% sales collapse in North America directly related to the pandemic. The result is the US auto market sales dropping to 12.5 million units and production declining to 12.2 million units."

"Without a doubt, the global automotive market is changing. Long-standing PM champions face a shrinking universe of opportunities."

"We need to keep an eye on this as we are nearing record levels of unemployment that will also negatively affect automotive sales," he urged.

Changes to trade agreements

Commencing on July 1, 2020, new rules will govern how vehicles are produced as a result of the United States–Mexico–Canada Agreement, or USMCA, that will include that rules of origin are to be met on automobiles, specifically that 75% of the finished vehicles' value is to come from within the USMCA governed region: an increase of 12.5% from the previous North American Free Trade Agreement, or NAFTA.

"This could be a great opportunity for re-shoring parts and assemblies," Howard observed. "Positive results will be obtained from more value-added parts assemblies and providing more families of parts. Opportunities still exist for new PM designs outside of engines and transmissions. There could be a new metric rising besides focusing on pounds per vehicles based on large parts. Are there opportunities in smaller, more highly engineered PM parts in non-drivetrain systems? Have we begun to tap the hybrid vehicle and electric vehicle markets? Low gasoline prices will delay the move from larger to smaller engines, but gaining acceptance of PM in 3- and 4-cylinder hybrid vehicles should be a primary focus."

"And what about the millennials?" he asked. "Will they continue to choose ride-share services, rental cars, bicycles and electric scooters over car ownership? Many news reports suggest that the COVID-19 pandemic has changed the minds of many millennials who will prefer their own automobile and house over the risk of cross-contamination and recirculating air in apartments and condominiums."

Technological advancements

Looking ahead at how the PM industry can tackle the challenges it is presented with, Howard stated, "The PM industry has a strong

technology base, built on the interaction of manufacturers, academia, and research organisations. As a maturing industry, we must not let this diminish as every industry needs to continue to evolve or it will simply die. Investments in R&D for new materials, equipment advancements, and process refinement will need to remain strong."

"Metal powder producers are actively working on high-performance materials," he continued. "For example, one powder producer is focusing on a specialised material with high-apparent density to improve die-filling for thin-walled parts and faster production rates. Another powder producer is launching stearate-free lubricants for medium to high-density compaction. A third powder producer is focusing on advanced machinability additives to improve tool life and productivity by reducing machining cycle-time."

"Compacting press and sintering furnace suppliers are also dedicated to improvements. Some advancements include faster tool exchange systems, electric presses for high-production manufacturing of smaller PM parts, and implementation of robots. Sintering improvements include a new approach to remove lubricants from green compacts thoroughly prior to sintering and reducing energy expenses by up to 80%."

New applications

"We continue to see new applications for metal powders. Universities from Canada to the Netherlands are researching metal powders as a sustainable energy source. It is easy to transport and recycle," Howard commented. For example, if iron powder is combusted with hot gases to drive an engine, the result is rust. Extracting the oxygen from the rust particles using hydrogen produced from electricity surpluses from sustainable sources can turn it into iron powder again. Other applications include water purification. "Not only is this of great benefit to community water sources, but it is also a humanitarian effort for developing countries that need to remove multiple contaminants from groundwater and drinking water in a single step. These are just a couple of examples of how metal powders and Powder Metallurgy will continue to evolve."

Education and training

The MPIF, the Center for Powder Metallurgy Technology (CPMT), and the National Science Foundation (NSF) have long been champions of advancing the PM technology through educational outreach. Over the past three years, over 150 engineering students have been awarded full conference grants, including lodging, through the efforts of these organisations. These grants provide the opportunity for the PM industry to showcase the technology to some of the brightest young minds, who will someday hopefully select PM as their metal-working solution. The NSF has already extended the 2020 conference grants to be awarded in 2021, used due to the cancellation of WorldPM2020.

"There will always be a need to advance the technology through education," Howard stated. "Earlier this Spring, after cancelling the Montreal conferences, we launched the complimentary MPIF Webinar Series as a member benefit for our MPIF and APMI members. This has been extremely well received by the members and has also reinforced why membership is important. If you are not an MPIF or APMI member, you should consider joining so that you have access to these important educational offerings."

Reinforcing its focus on education, the MPIF recently announced plans to hold its annual Basic Powder Metallurgy Short Course virtually as a result of COVID-19, instead of postponing the event until 2021. The Basic PM Short Course brings over a dozen industry experts together for a thorough review of numerous PM processes, including conventional press & sinter, MIM, AM, and refractory metals. Later this year, the MPIF will also offer its PM Sintering Seminar virtually. "These are great opportunities for individuals to take advantage of attending the Basic PM Short Course and Sintering Seminar, while saving travel & lodging expenses, enjoying reduced registration fees, and no time away from their facilities," Howard commented.

Conclusion

"The one certainty for 2020 is uncertainty," Howard stated. "The future is bright for manufacturing adaptation and the PM industry. Despite armies of naysayers from every political persuasion, positive signs are flashing on the horizon for US manufacturing. Ugly short-term tremors cannot define us. Fortunately, throughout its history, the PM industry has survived the ups and downs of the macro economy. The industry is well-prepared for whatever comes our way and well-equipped to shape the future. We will improve the technology through R&D, education, and cooperative efforts, while adapting our resources to ensure we can respond in an agile manner to forces beyond our control, such as the COVID-19 pandemic."

"The entrepreneurial spirit embedded in PM's DNA is still alive," he continued. "Opportunities are waiting to demonstrate PM's problem-solving advantages for now and the future. It is unfortunate that we were unable to gather in Montreal this year, but MPIF looks forward to hosting you at PowderMet2021 and AMPM2021, June 20–23, 2021, in Orlando. We anticipate an exceptional event and look forward to you spending time with us."

Contact

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Next-level defect detection with advanced Acoustic Resonance Inspection

Many in the Powder Metallurgy industry have long been familiar with acoustic resonance inspection (ARI), also called resonant frequency (RF) inspection, as a method of non-destructive inspection. In one form or another, ARI has been in use for more than twenty-five years. Although the technology has evolved over time, the last meaningful development was introduced almost twenty years ago. Now, a significant advancement in ARI technology is reported following the release of SmartTest™ from Advanced Material Solutions. In this article, Peter Miller, the company's president, provides an overview of the basic principles of ARI, and introduces the benefits of using the SmartTest system for the non-destructive testing of components.

In acoustic resonance inspection, the resonances of a part are measured to determine the structural characteristics of that part in a single test. The entire part is examined for both external and internal structural flaws (Fig. 1).

The resonances of a part are determined by its mass, its structural stiffness and the structural damping of the part. Flaws that are structurally significant, whether arising from material issues (hardness, grain structure, inclusions, residual stress) or from process-related issues (cracks, voids, missing material, dimensional issues), will affect one or more of the mass, the stiffness or the damping of the structure, causing detectable shifts in the resonances of the part.

Once measured, the resonances of the subject part are compared to those from a control set of normal parts, and the subject part is determined to be normal (OK) or not normal (NOK).

A four-step process

In a mass-production inspection context, ARI comprises a simple four-step process:

1. Excite the part structure – a mechanical impact is used to induce vibration throughout the entire part structure
2. Measure the response – a specialised microphone measures the 'ringing' of the part structure in response to the vibration
3. Process the data – a signal analyser is used to transform the microphone signal into the full

Fig. 1 A typical ARI system configured for inline or offline use

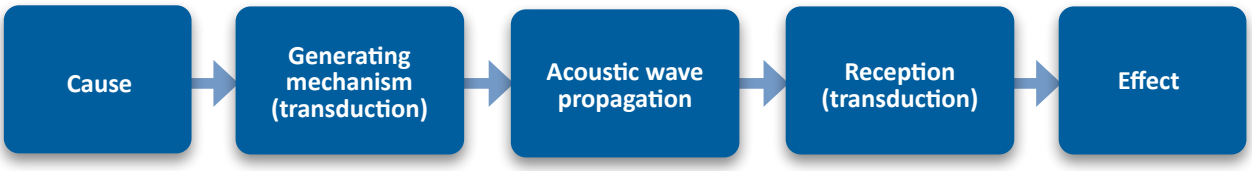

Fig. 2 These steps occur in any acoustical event or process

frequency waveform, or spectrum, for the tested part

4. Assess – the acoustic resonance software application compares the waveform to agreed acceptance limits to determine if the tested part is normal (OK) or not normal (NOK)

Why ARI works

For centuries, objects were tested by hitting them with a mallet and listening for a tonal quality difference. The natural resonance of an object gave evidence that the struck object was free from imperfections. Striking a rail car wheel with a hammer, and listening for the response, has been used for over 100 years to detect large cracks.

Acoustic Resonance Inspection systems work on the same principle, but use a much more sophisticated instrument resulting in a completely controlled and reproducible test process.

In a single measurement, ARI-based techniques can test for numerous defect types including cracks, chips, cold shuts, inclusions, voids, oxides, material contaminants, missed processes or operations, and variations in dimension, hardness, porosity, nodularity, density and heat treatment.

Acoustics

Acoustics is the branch of physics that deals with the study of all mechanical waves in gases, liquids and solids, including topics such as vibration, sound, ultrasound and infrasound. The study of acoustics revolves around the generation, propagation and reception of mechanical waves and vibrations.

The steps shown in Fig. 2 can be found in any acoustical event or process. There are many types of causes, both natural and artificially induced. There are many kinds of transduction processes that convert energy from some other form into sonic energy, producing a sound wave. The five basic steps are found equally well whether we are talking about an earthquake, a submarine using sonar to locate its foe, or a band playing in a rock concert.

Wave propagation

The central stage in the acoustical process is wave propagation. This falls within the domain of physical acoustics. In fluids, sound propagates primarily as a pressure wave. In solids, mechanical waves can take many forms, including longitudinal waves, transverse waves and surface waves.

All material media undergo a deformation when they are stressed by an external action. This deformation is caused by a certain number of particles within the medium being displaced from their position of equilibrium.

In elastic media, the first particles to be disturbed start to vibrate around their position of equilibrium. The vibrations are then transmitted to the particles in the adjacent layers, which also start to oscillate. In this way the initial stress, which involves only a portion of the medium, propagates throughout the entire medium (Fig. 3).

This atomic movement is constrained by the elastic properties of the carrier, but even the slightest movement of the atoms is passed along through the densely packed molecular structure in the form of mechanical energy (Fig. 4).

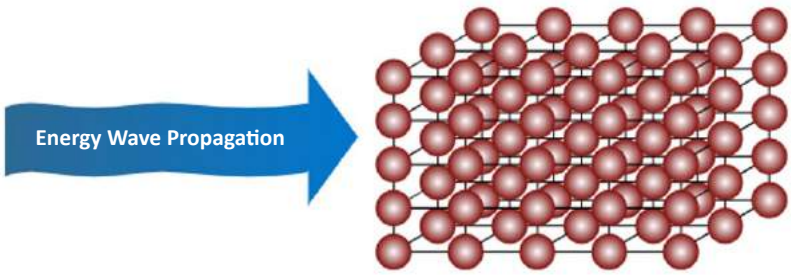

Fig. 3 Wave propagation

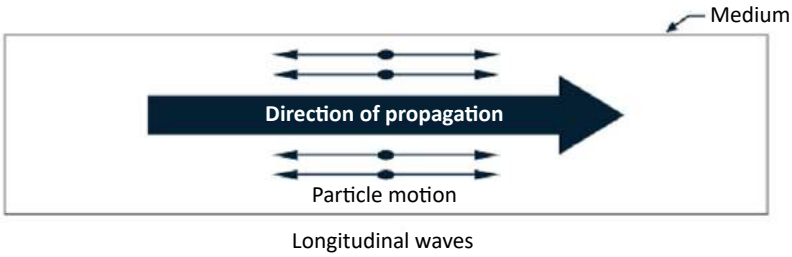

Fig. 4 Longitudinal wave propagation

Modal analysis

All structures, even structures such as sintered metal components, forgings, castings, or similar parts that are apparently rigid to the human eye, undergo deformation. They vibrate in special shapes called mode shapes when excited at their resonant frequencies. By understanding the mode shapes, all the possible types of vibration can be predicted.

Modal analysis is defined as the study of the dynamic characteristics of a mechanical structure or system by measuring and predicting the mode shapes and frequencies of a structure. Under normal operating conditions, the structure will vibrate in a complex combination of all the mode shapes.

The tuning fork shown in Fig. 5 is a simple structure that could be represented by very few points. An impact hammer is used to excite the structure and the resonant frequency responses are recorded at positions along the legs using a signal analyser (Fig. 6). The resonant frequencies are the peaks that appear at every point at the same frequency. The amplitude of the peak at each location describes the mode shape for the associated resonant frequency.

Time and frequency analysis

Structural vibration can be converted into electrical signals. By analysing the electrical signals, the nature of the vibration can be understood. Signal

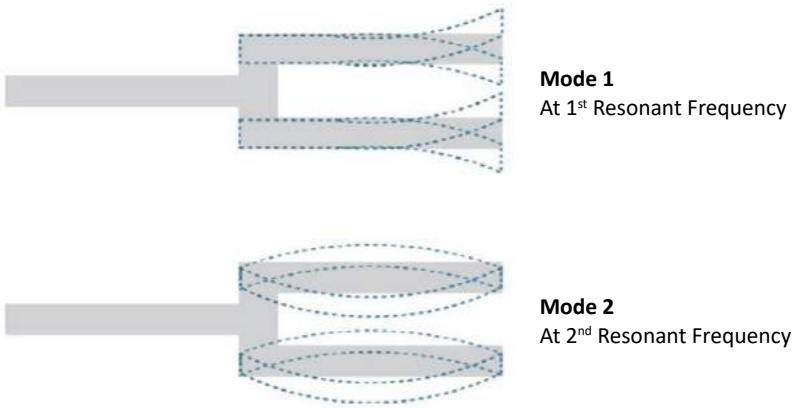

Fig. 5 The first mode shape of the tuning fork has the base fixed and the maximum deflection at the end. The second mode shape has the ends fixed and the maximum deflection at the middle

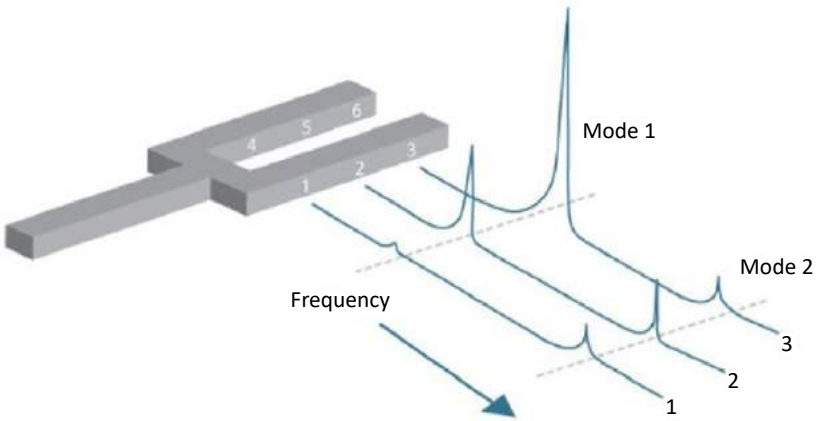

Fig 6 Modal analysis of a tuning fork results in RFs for each point on the structure with the amplitudes at each resonant frequency describing the mode shape

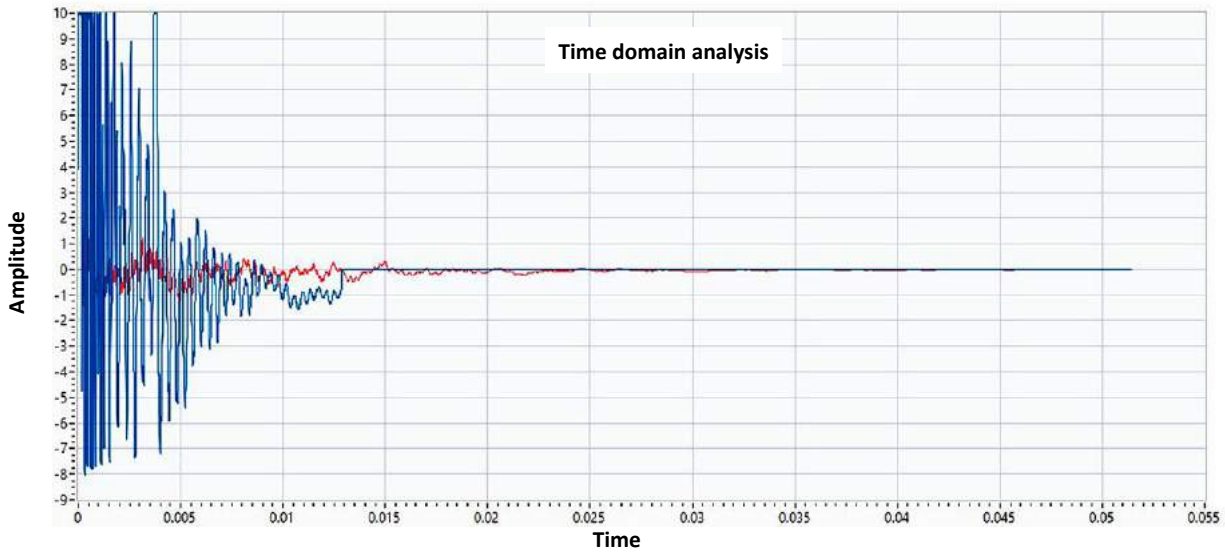

Fig. 7 Time domain analysis

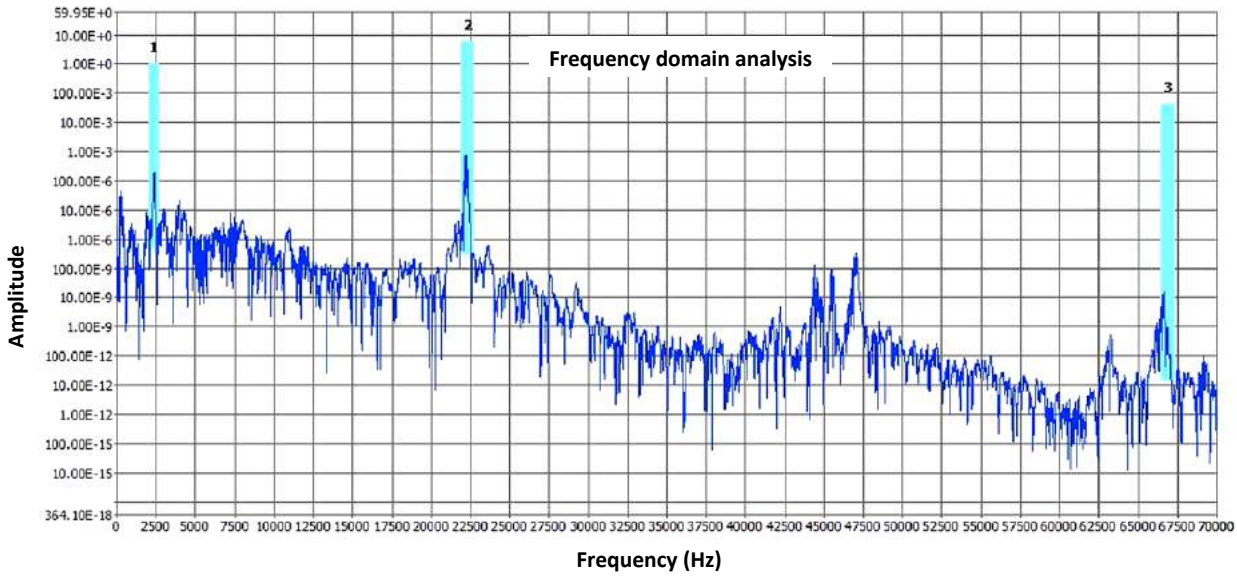

Fig. 8 Frequency analysis provides information about structural vibration

analysis is generally divided into time and frequency domains; each domain provides a different view and insight into the nature of the vibration.

Time domain analysis starts by analysing the signal as a function of time. The plot of vibration versus time (Fig. 7) provides information that helps characterise the behaviour of the structure. Its behaviour can be characterised by measuring:

- The maximum vibration (or peak) level, or
- Finding the period (time between zero crossings), or
- Estimating the decay rate (the amount of time for the envelope to decay to near zero)

Frequency analysis also provides valuable information about structural vibration (Fig. 8). Any 'time history' signal, for example the microphone signal in an AR inspection system, can be transformed into the frequency domain, giving us the full structural response of the subject part in the frequency domain.

Fundamentals: In summary

- All structures undergo a deformation when they are stressed by an external action, for example the impact used to excite the part in an AR inspection system
- The initial stress from the impact, which directly involves only a portion of the structure (the part), propagates throughout the entire structure according to the very predictable laws of wave propagation
- Modal analysis is used to determine the resonant frequencies of the structure, i.e. the structural response
- The structural response of a given part to a given excitation is both unique to that part and very repeatable. The same part, struck in the same way, will yield the same structural response
- Flaws that are structurally significant, whether arising from material issues (hardness, grain structure, inclusions, residual stress) or from process related issues (cracks, voids, improper sintering, missing material, dimensional issues), will affect sound wave propagation through the part structure
- The altered wave propagation in the flawed part will lead to shifts in one or more of the resonant frequencies, making it possible to detect the presence of any flaw.

Material Related Concerns	Process Related Concerns
• Composition • Microstructure • Hardness • Density • Inclusions	• Cracks, chips • Missing material • Dimensional issues • Missing features • Malformed features • Mixed parts

Table 1 ARI has the unique ability to detect both material and process related structural defects, whether internal or external

The types of detectable flaws

Wave propagation, modal analysis, resonant frequency evaluation and, therefore, acoustic resonance inspection are repeatable and reliable. This leads to ARI having a unique ability to detect both material- and process-related structural defects, whether internal or external (Table 1).

Advantages and limitations of ARI and other common NDT methods

There are many NDT methods and several are commonly used in our industry. Among them, ARI is perhaps the most versatile and effective. As mentioned above, ARI can detect both internal and external defects and can identify concerns related to both material- and process-related characteristics. Another key attribute of ARI systems is that the pass / fail judgement is made by the inspection system. Containment of rejected parts is typically automated. ARI systems are not application specific. Virtually any part shape can be run on a single system with minimal effort needed to change over from one part shape to another. AR inspection is very fast, at two to three seconds per part, with no need for any part preparation beforehand nor clean-up after.

All these considerations are important factors when deciding which NDT methods to implement in a high volume production environment. Table 2 provides a summary comparison of ARI with the other commonly used methods.

	Visual	Eddy Current	Mag Particle Penetrant	Ultrasonic	X-Ray	ARI
Flaw Type						
Crack, chip, missing material	✓	✓	✓	✓	✓ ✗	✓
Porosity, void	✗	✗	✗	✓	✓	✓
Material property	✗	✓ ✗	✗	✗	✗	✓
Missed process, feature	✓ ✗	✓ ✗	✗	✓ ✗	✓ ✗	✓
Mixed parts	✓ ✗	✓ ✗	✗	✗	✓ ✗	✓
Variation among lots	✗	✓ ✗	✓	✓	✓	✓
Flaw Location						
External (surface)	✓ ✗	✓	✓	✓ ✗	✓ ✗	✓
Internal	✗	✗	✗	✓	✓	✓
Braze, bond, weld	✗	✗	✗	✓ ✗	✓ ✗	✓
Other Considerations						
P/F Judgement	**Machine/Man**	**Machine**	**Man**	**Machine**	**Man**	**Machine**
Technician training required	**Low**	**High**	**High**	**Medium**	**High**	**Low**
Application agnostic	✓	✗	✓	✗	✓	✓
Automation	✓ ✗	✓	✗	✓	✗	✓
Process speed	**Fast**	**Fast**	**Slow**	**Fast**	**Slow**	**Fast**
Auto reject containment	✓ ✗	✓	✗	✓	✗	✓

Table 2 Comparison of ARI with the other commonly used NDT methods

Next-level defect detection

As mentioned in the opening, the last meaningful changes to ARI technology were introduced nearly twenty years ago. Today, though, a significant advancement in ARI technology is available. This advancement will enable those using or looking to implement or improve their ARI to overcome nagging limitations of the earlier technology, such as:

- Inability to detect all flaws of interest
- Being limited to only detection of gross flaws
- Being forced to accept high false reject rates, yet still not getting complete flaw detection
- Having to re-run rejected parts to recover false rejects
- The need to add secondary inspections like visual, magnetic particle or others, following AR inspection
- Facing poor productivity due to system downtime or human error
- Or, simply, the desire to have higher daily throughput to meet demand.

So, what is next-level defect detection?

Arizona-based company Advanced Material Solutions (AMS) has introduced the SmartTest™ family of acoustic resonance inspection systems, featuring SmartTest Advanced Resonance Software. SmartTest takes defect detection to the next level with major advances in several areas:

Extended bandwidth enables identification of more failure modes

Extending the inspection bandwidth to 95 kHz enhances defect detection by revealing many more resonant peaks, which in turn may reveal failure modes not detectable with lesser bandwidth. This is particularly important where the parts to be inspected have small, precise or intricate features, which tend to resonate at higher frequencies; for example gear teeth or parts with appendages where the risk of green state defects such as chips or missing material are high. Legacy systems with bandwidth limited to only 25 or 50 kHz cannot evaluate these additional resonant peaks, which potentially means defective parts go undetected (Fig. 9).

Ultra-high resolution enables the detection of smaller flaws

Increasing inspection resolution to as high as 89k spectral lines provides the most accurate waveform available. Greater spectral line density, i.e. 89 k wide vs 32 k wide for example, is an indication of how many 'points' are plotted on the waveform over the bandwidth to be evaluated. The higher the density, the more accurate the resulting waveform. As seen in Fig. 10, the waveform shown in white has 89 k spectral lines. The waveform in gray is that of the same impact plotted at 32 k spectral lines. One can see that both waveforms have a similar overall shape, but the 89 k waveform shows both more definition and significantly higher amplitude. This more accurate waveform reveals ever smaller flaws, eliminates false peaks and reduces false rejects.

Modern, reliable hardware offers more power, less downtime

The entire SmartTest system architecture has been optimised for data processing power and speed – including the analyser, software program, and how PC resources are utilised. This means SmartTest gains full benefit of the enormous

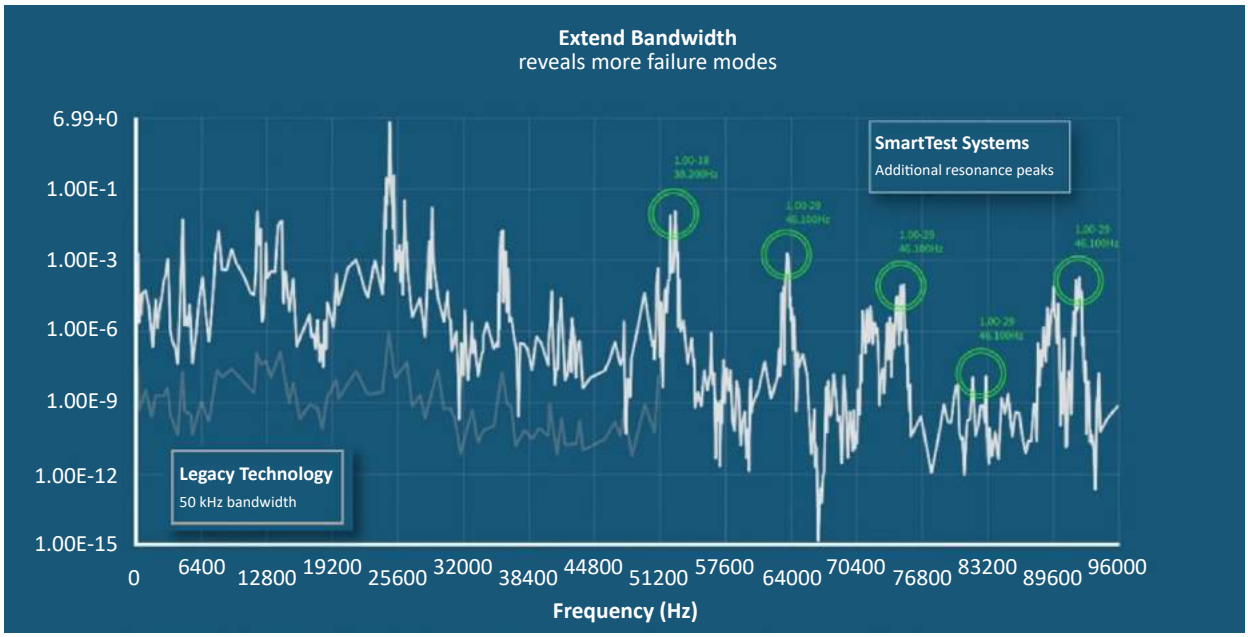

Fig. 9 Resonant peaks at frequencies above 50 kHz (circled in green) simply are not available in earlier ARI technologies, limiting the scope of potential defect detection

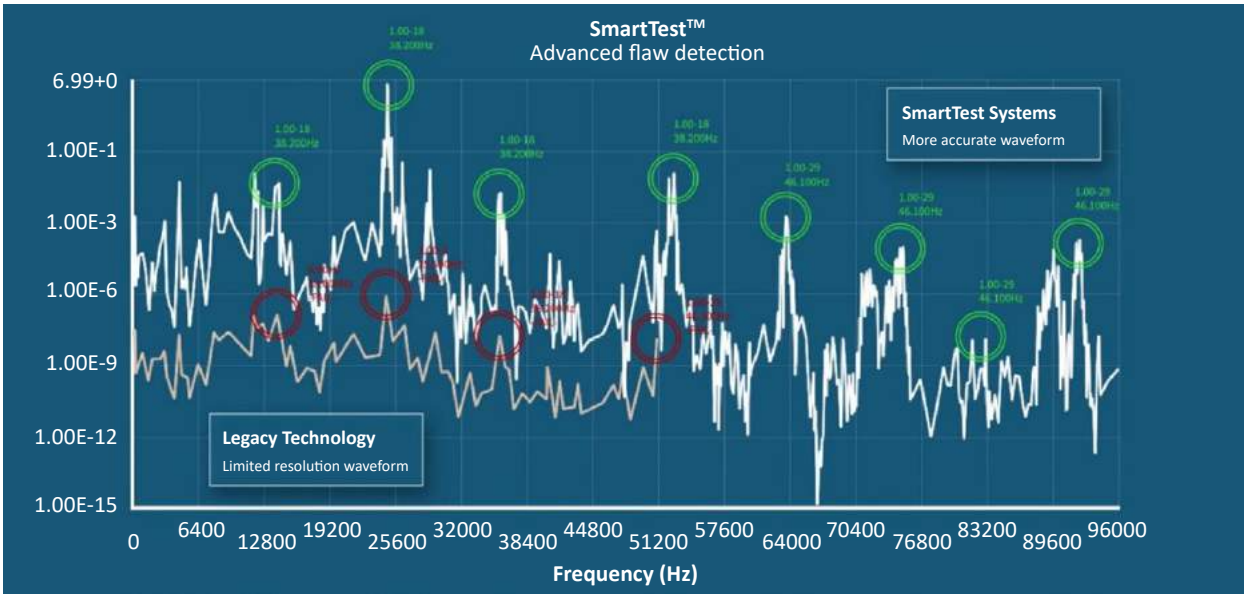

Fig. 10 Increasing inspection resolution to as high as 89 k spectral lines provides the most accurate waveform available

advances in computational and signal processing technology enacted over the past twenty or so years. SmartTest has the capacity to deliver ultra-fast cycle times, while running at twice the bandwidth and up to four times the resolution of legacy systems. Additional updates to technologies used throughout the SmartTest hardware and sensor platforms mitigates common causes of downtime and human error.

Integral process compensation – Fast, reliable, and effective enhancement to defect detection

In cases where process compensation is needed to accommodate everyday variation in manufacturing processes, for example with PM, cast or sheet metal components, SmartTest's integrated solution avoids the need for an external interface and complicated data communication between multiple programs. Each part is weighed on a high resolution check weigher, while in motion, and the inspection process runs at normal cycle times of 2-3 seconds per part with zero risk of downtime and zero compromise to throughput. Defect detection is enhanced, downtime is eliminated; cycle time, productivity, reliability and quality are improved.

In the two scatter plots seen in Fig. 11 and 12, blue data points

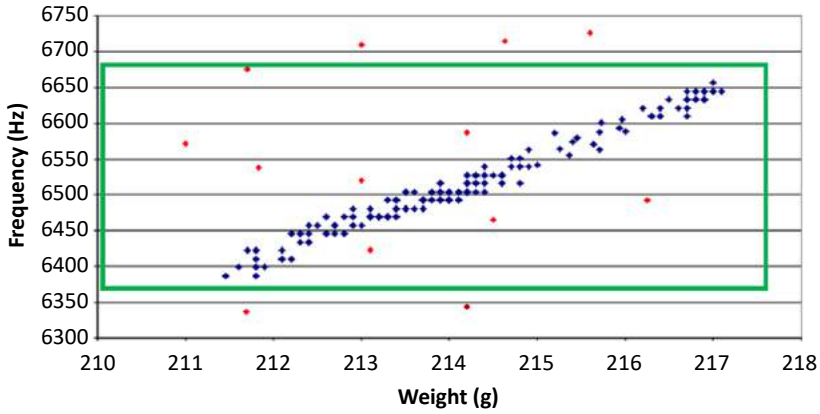

Fig 11 The data from a legacy ARI test. Blue data points represent parts that are acceptable (OK). Red data points represent parts that have minor defects (NOK). The green rectangle in the first scatter plot represents the acceptance window

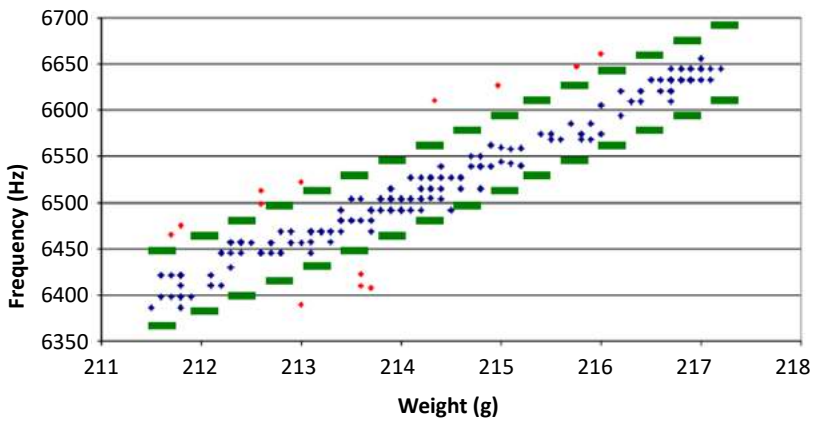

Fig. 12 Defect detection is significantly enhanced using SmartTest. Using process compensation acceptance limits are set at every 0.1 g increment of weight, meaning the acceptance 'window' now takes the stair stepped form

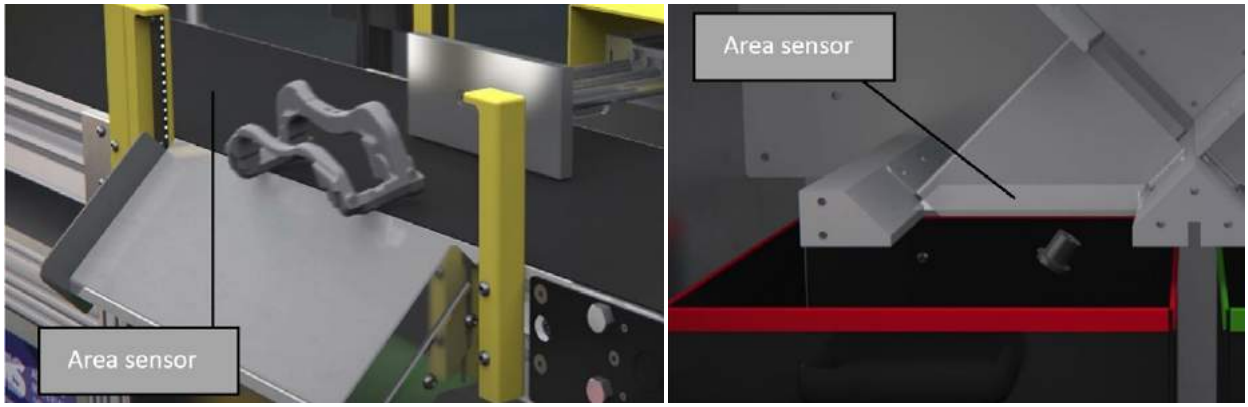

Fig. 13 Rejected parts are contained and cannot escape

represent parts that are acceptable (OK). Red data points represent parts that have minor defects (NOK). The green rectangle in the first scatter plot represents the acceptance window. Data points, or parts, that lie inside the green rectangle are accepted, those outside are rejected. In the first plot, notice that the blue data points range from around 6400 Hz to around 6600 Hz (Y axis) and from 211.5 to 217 grams (X axis). If we run without process compensation due to concerns about throughput or system reliability, as is often the case with legacy ARI systems, and we are to accept all OK parts, the acceptance window has to be set as shown in the first plot. One can see that the blue data points are all accepted, but so are several of the red data points. Defect detection is compromised in the interest of preventing downtime or safeguarding throughput.

However, with SmartTest, there are no compromises required when implementing process compensation. Inspection speed and reliability are completely unaffected, meaning process compensation can be used without negative consequences. When we use process compensation, acceptance limits are set at every one tenth gram increment of weight, meaning the acceptance 'window' now takes the stair stepped form seen in the second scatter plot (Fig. 12). Defect detection is now significantly enhanced because the red data points, i.e. the NOK parts with minor defects, are all reliably rejected, with no compromise to throughput, yield (blue data points (OK parts) are all accepted) or system uptime.

Contrast this with legacy technologies; both technical integration issues and forced reduction in throughput, due to the need to slow the process down to avoid data communication problems, lead to very infrequent adoption of process compensation. As a direct result, defect detection has been compromised for companies exposed to this need.

Confirmed reject capture means that rejected parts cannot escape

All SmartTest turnkey inspection systems feature 'positive capture sensing' of rejected parts, providing a confirmation that rejected parts have not merely been rejected, but have been rejected and contained and therefore cannot escape (Fig. 13).

Productivity suite offers maximum throughput and profit

All SmartTest products provide a host of features intended to reduce or eliminate lost production time in a mass-production environment - maximising throughput and profitability. New part setup, changeovers and daily criteria adjustments are sped up; human error is prevented; troubleshooting is simple and fast.

The most advanced ARI

ARI has always held the potential to help PM and MIM manufacturers attain zero defects in production, but limitations forced by ageing technology, have led to many manufacturers deciding against implementing it, while, for others, it has been implemented but is used only for gross flaw detection. Today, there is an alternative. SmartTest brings the underlying technology up to modern standards and with it, the potential to confidently rely on acoustic resonance inspection to prove next level benefits, enabling users to:

- Reliably detect all flaws of interest, without added false rejects
- When needed, utilise process compensation free of any compromises
- Eliminate the need to re-run rejects
- Eliminate secondary inspections
- Reduce scrap costs
- Maximise throughput and plant productivity.

Better flaw detection, reduced inspection costs, higher throughput; given the challenges faced by industry today, this could not be more relevant.

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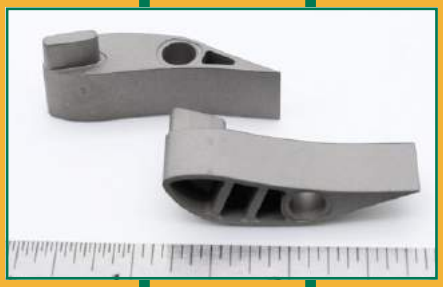

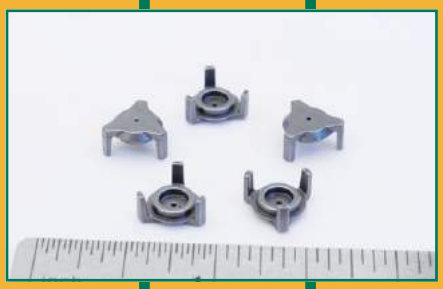

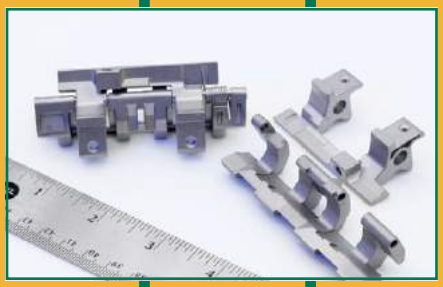

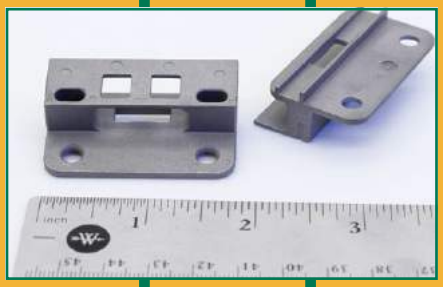

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A fully-integrated automated production cell for increased PM productivity

The automated handling systems available to the Powder Metallurgy parts maker can often result in reducing the output of a press, due to multiple control systems from different equipment manufacturers and a lack of full system integration. To address these issues, Osterwalder AG studied the cost structure and infrastructure of its customers. Based on the findings of this study, the company developed the Smart Press Cell, an integrated approach to part handling in the production of PM parts. Here, Jens Moecke, Osterwalder's Marketing Manager, explains how the system can improve productivity in a PM facility.

In a typical Powder Metallurgy production line, the powder press and handling systems are generally sourced from independent suppliers with individual user and data interfaces. The set-up for these can often be complicated and time-consuming, where each system must be programmed separately. The motion profiles of the axes involved are autonomous, time-optimised polynomial movements and must be set through 'on-the-fly' waypoints. With each new production run, many new waypoints must be added, which is slow when manually inputted. This drawback is even more evident when production batches are small, which is typical in the case of many just-in-time orders.

Current solutions are not designed for efficient production, having weaknesses in integration, interface, parameter exchange and control, with no optimal safety integration. Based on feedback and the requirements of PM part makers, Osterwalder developed the Smart Press Cell to address these issues (Fig. 1).

Understanding the PM production workflow

An investigation was launched by Osterwalder to identify the various equipment configurations found in the facilities of Powder Metallurgy part producers worldwide. Having delivered and set up over 850 Osterwalder presses, in numerous global facilities, Osterwalder's customers were considered an ideal source to provide a realistic perspective on the current situation. Based on the product portfolio, the assessment was divided into two major segments:

- Tungsten carbide
- Metal powder & others

From the collected data, Osterwalder established that in the tungsten carbide segment more than 90% of production lines used

Fig. 1 Osterwalder developed the Smart Press Cell following feedback from PM part makers

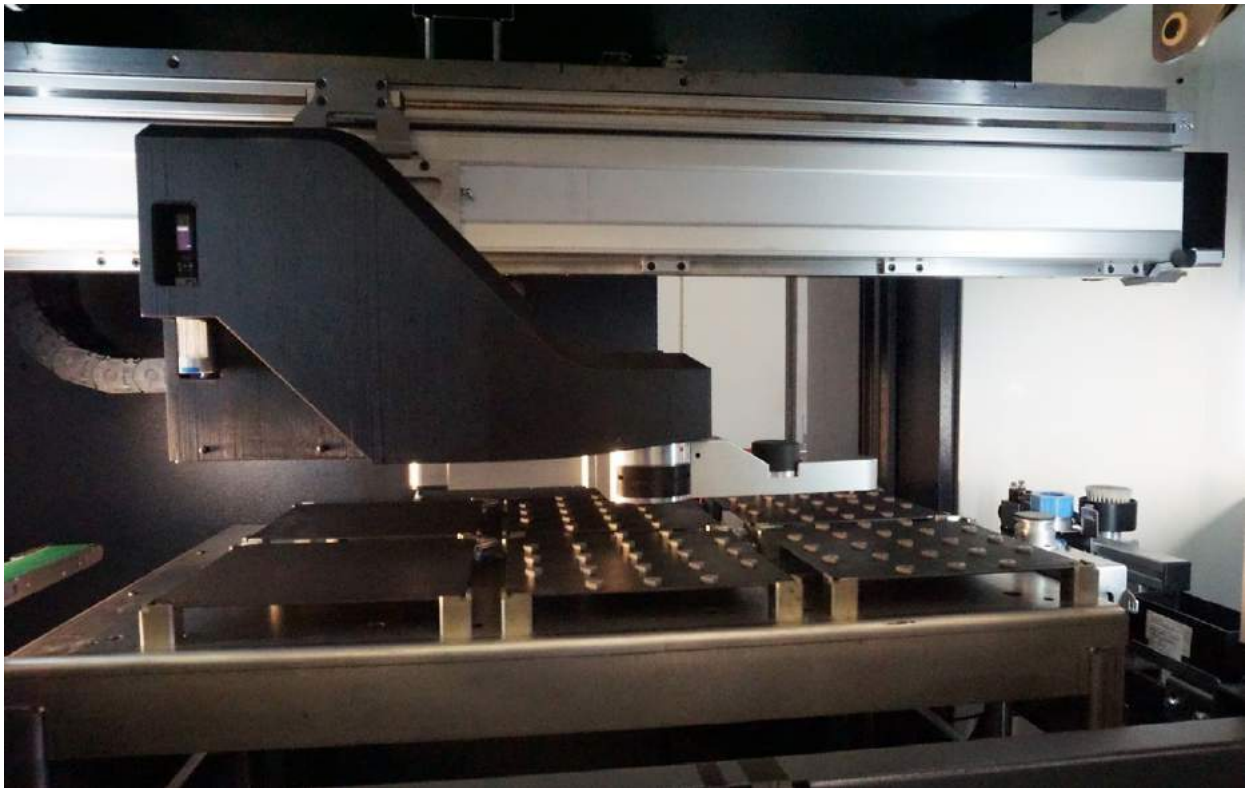

Fig. 2 New linear axis development with twin-arm gripper and integrated punch cleaner

standardised part-handling systems. In the metal powder production lines the results were quite different, a mix of methods was seen, with mostly customer-made non-standard part-handling, with a predominance of semi-automatic or automatic systems.

Concentrating on the available standard systems in tungsten carbide production, it is interesting to understand how part-handling equipment is selected. Three key main factors were identified:

- Time – Decisions have been made on how fast the part-handling can be executed, as well as the speed of additional processes, such as punch cleaning, tray measuring, etc. It was important to see how this influenced the machine availability and OEE.
- Investment – Cost of initial purchase and running costs
- Supply chain – The available suppliers for automated part-handling systems.

Time

To better understand the first of these factors, a study was established to fully examine the throughput rate for the production of pressed parts. The process time not only includes the part pick-up from the press, weighing and part-placing on tray, but also includes the typical time to periodically clean the punch as required.

We can assume that both the manufacturers of powder compacting presses, as well as those of part-handling systems, do their best to supply high-output equipment for best output ratio. Nevertheless, existing solutions are based on two different controls and separate HMI for programming and operation. Additionally, the interfaces between separate systems are certainly not optimised and are limited in aspects of open communication and data exchange. This makes existing solutions more cumbersome and results in higher downtime from the start of programming until first part out.

In most high-speed production cases, Osterwalder observed that the press is waiting for the automation, and this is not only during punch-cleaning operations, but also in stable production. This causes inefficient downtime. When it comes to required periodical punch-cleaning – in most cases – existing part-handling systems have to change their gripper from part pick-up to punch-cleaning device and back, losing additional productivity.

To document this, and establish a fundamental throughput calculation, Osterwalder set up a typical tungsten carbide press cycle. A representative sample part was pressed on a SP160 press using a first supplier part-handling system for pick-up and placing on flat tray. A stroke rate of 46 parts/min, without using automation, is the maximum output possible with well-designed parts. When running this with automation, where just the pick-up from the press followed by part placing on the tray is automated, it was noted that the stroke rate had to be reduced by 25%.

However, with the necessary periodical operations such as punch-cleaning and weighing included, as is established in real-world operation, the stroke rate lowers further to only 15-17 parts/min. Sub-processes on existing part-handling systems cause high levels of downtime, mainly because these concepts require a gripper exchange from part handling to punch cleaning and backwards again. The resulting downtime is significant and too long.

Investment
The main disadvantage of the described set-up is that it requires hardware and software for two separate systems. The additional controls, HMI, PC infrastructure, etc., add to the total investment, and when calculating manufacturing costs this can be a significant addition. Although some manufacturers are able to offer the hardware at lower prices, especially those based in Asia, additional transport costs, lack of CE declarations of conformity, etc, have to be considered.

Supply chain
Particularly in the last fifteen years or so, the choice of part-handling systems has been limited, seemingly dominated by one European and one Asian provider. We have seen growth in suppliers in Asia, but mainly for the local market. With such limited choice, it is Osterwalder's belief that the market cannot act as freely as it could if there were more suppliers, and this can also hinder technological developments.

To summarise:

- Investment costs could be reduced through the elimination of equipment
- Programming of the two systems is inconvenient and causes downtime
- Compacting press stroke rate is limited by part-handling automations
- Suboptimal data communication continuously slows down the press stroke rate
- Subprocesses, such as punch cleaning, are additional limiting factors
- Full tracing of pressed parts is not optimal due to non-integrated data communication.

The solution: Smart Press Cell

Fully-integrated production unit
The Smart Press Cell (SC) developed by Osterwalder consists of a number of revolutionary innovations, of which some are under patent application. These include:

- A new-developed linear axis system for extremely accurate and fast movements
- A revolutionary gripper invention with integrated punch cleaning
- A flexible set-up for various tray arrangements and formats – with optional stacker for high-end automation

The automation is encapsulated and has programmable internal suction and an exhaust interface for central facility-wide suction systems. The recurring question of pickup heights has been answered, as the Smart Press Cell set-up allows easy adaption to various pick-up heights, due to the adjustability of the main axes and sinter plate holders. Good visibility for the operator onto the scale, cleaning and deburring stations, has also been ensured.

One-point control and HMI
Press programming has been simplified through the use of a set-up wizard. The centralised data management stores all programs in one single file for press and part-handling, containing all relevant performance and tracking data.

The time-consuming reference runs required after an emergency stop, where the measuring systems of separate machines do not communicate the precise location of the parts, have been overcome through improved controls, resulting in no loss of handling position data.

With the SC, the user has consistent tracking, with data from the press linked to the specific position of the green part on the sinter tray. Full traceability is possible for quality and ISO certification purposes.

Axis development
The SC design can achieve over forty strokes per minute, with high positioning repeatability. The concept optimises the mechanics, resulting in the lowest possible moving masses. The rigid frame structure and revolutionary new axis system, minimise the travel from pick-up of the press die to tray lay-up. The double X main beam for the pick-up compensates the typical imprecision and mass movements of the Z and Y axes. This increases the overall rigidity and accuracy and all movements are executed quickly and smoothly with high precision.

" The user has consistent tracking, with data from the press linked to the specific position of the green part on the sinter tray. Full traceability is possible for quality and ISO certification purposes..."

Gripper technology
The double-acting twin-arm set-up eliminates the need for gripper exchanges. Downtime for traditional gripper exchanges is no longer required, since this function is already included in the twin-arm device, guaranteeing the highest uptime and productivity. Punch

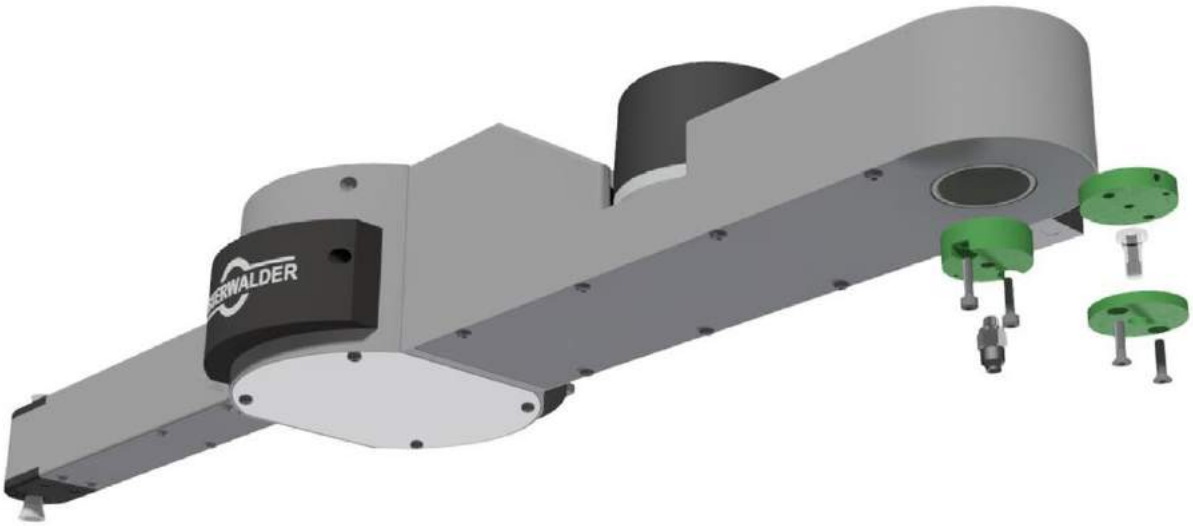

Fig. 3 Twin-arm gripper with integrated punch cleaning and insertions/adaptor for variety of part grippers

cleaning programming is simple and fully flexible, removing the need for additional, often expensive, software for contour cleaning of the upper punch.

A further advantage, in comparison to existing swivel-in systems, is offered by the non-interfering contours during gripping and elimination of malfunction caused by gripper exchanges. Accuracy and repeatability is enhanced due to the balanced equipment.

The twin-arm includes a basic gripper with pneumatic and electrical interface for holding inserts for vacuum, balloon and spreading grippers (an alternative to balloon). It includes a freely programmable rotation function between 0 - 360°, and has standard coupling for easy connection of alternative grippers, such as the Schunk CWS-50 and others, involving just a simple release and clamping by the operator.

In contrast to existing solutions, no expensive and large variations of grippers are required, as the twin arm offers flexible pick-up functions. This allows the part manufacturer to use smart insertions, which fit in the central twin arm and allow fast and very inexpensive adaptations for picking up a wide variety of parts. Furthermore, insertions and adaptations can be made by the user, resulting in significant cost savings. The gripper is prepared for 2 x pressure and 1 x vacuum media connections.

In addition to the basic gripper set-up, there are additional options such as a centric two-finger gripper with turning function, a gripper with tilt function (and pneumatic outside gripper), and a gripper with turning function which also has a pneumatic outside gripper.

The integrated identification of the gripper, through RFID, also avoids mistakes due to false installations. Gripper functions and dimensions are stored and checked when installed.

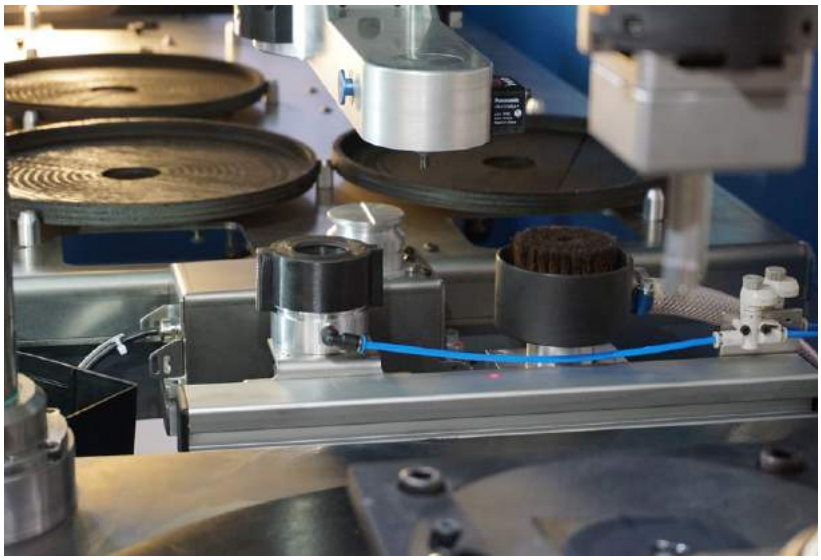

Fig. 4 Deburring stations brush and air cyclone and scale

Scale

The basic set-up is prepared for single or double-scale application and is also suitable for multicavity pressing of parts. An optional scale cleaning device is available as well.

Brush deburring station

In most production cases, deburring is required immediately after pressing of the green part. For deburring, the electric brush drive

comes with programmable speed, connection for brushes with 60 mm outer diameter and height adjustment. The SC offers a flexible positioning for up to four brushes and has an integrated programmable suction for cleaning operations to avoid powder dust contamination. Additional brushes are also available.

Air cyclone deburring station
The SC incorporates a blow-off station for cleaning and deburring by air, with exchangeable cyclone attachments and large central interface. The cleaning and deburring cyclone comes with optional programmable electrical pressure settings and flexible positioning. Various top adaptors are available for the cyclone according to the specific part form, offering round, inclined, straight, flat jet nozzles, or even customised versions. Changing those top part attachments is tool-free and quick.

Part inspection station
Pressed parts are checked during operation as required, and the timing is depending on customer's definition and requirements. The SC comes with a basic inspection which is already included in the standard configuration. From this manual removal for inspection, parts will be placed in drawers automatically according to the operator's programming.

A further option is the inspection with conveyor belt and step operation for programmable or spontaneous removal of the inspection parts. The programmable cadence for test part inspection (inspect 'X' number of parts of each 'Y' number of production amount) gives the operator full flexibility in an automatic mode.

Tray handling technology

Flexible plug and play tray set-up configurations and layouts are possible (rectangular, round, etc.) combined with the possibility for automatic tray fixation and alignment. The total available storage space is 500 x 1000 mm, which allows the flexibility for set-up of up to twelve trays. A support plate for using various sinter plate formats and shapes is also available. The tray sizes may vary from 100 x 200 mm up to 500 x 450 mm, and can be rectangular, round or even a mixture of both.

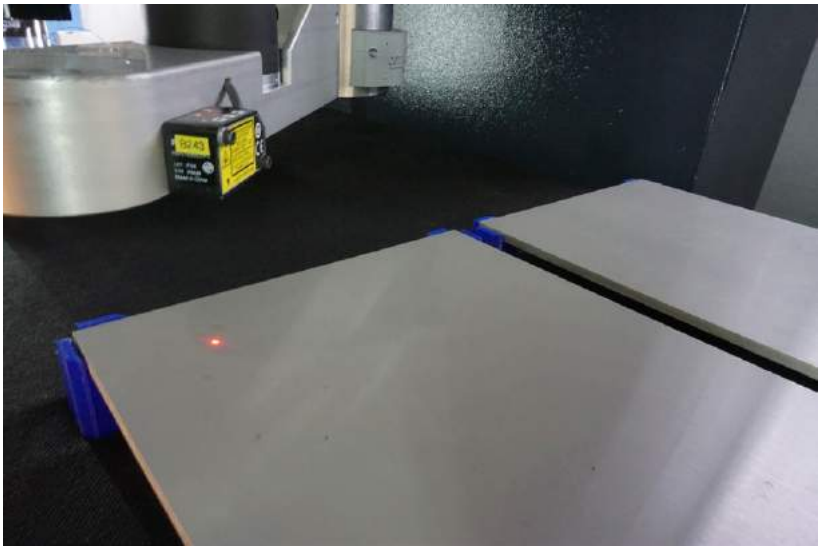

Fig. 5 Laser measuring of heights and tray flatness

An option is the sinter plate carrier with base centring for sinter plates with initiators, which monitors the presence of a sinter tray per each deposition port. Furthermore, the Smart Press Cell can be equipped with an optional tray self-alignment. A defined fixation of the sintered plate by clamping and surveillance automatically holds the sinter plate in perfect alignment.

An integrated distance laser for the detection of uneven trays measures height variations, tray flatness and corrects the positioning height for the gripper part lay-up. The height detection for various areas per tray is programmable.

The simple programming of tray patterns
A guidance wizard is utilised for creating the tray part lay-out pattern. Adaptations are possible by choosing from the available master patterns. The maximum amount of parts per tray is displayed for the operator when in the parameter setting.

The operator chooses the pattern layout eligibility from tray centre or tray border, tray shape (round/rectangular) followed by the part placing pattern for the tray (in rows, offset, compacted and turned, etc.)

> *" The total available storage space is 500 x 1000 mm, which allows the flexibility for set-up of up to twelve trays..."*

Modular tray handling automation
The system is available in several expansion stages, starting with manual sinter tray loading up to the automated version with stackers, automatic tray exchanges and trolleys and an AGV interface. A modular concept, which is very cost-effective and highly flexible

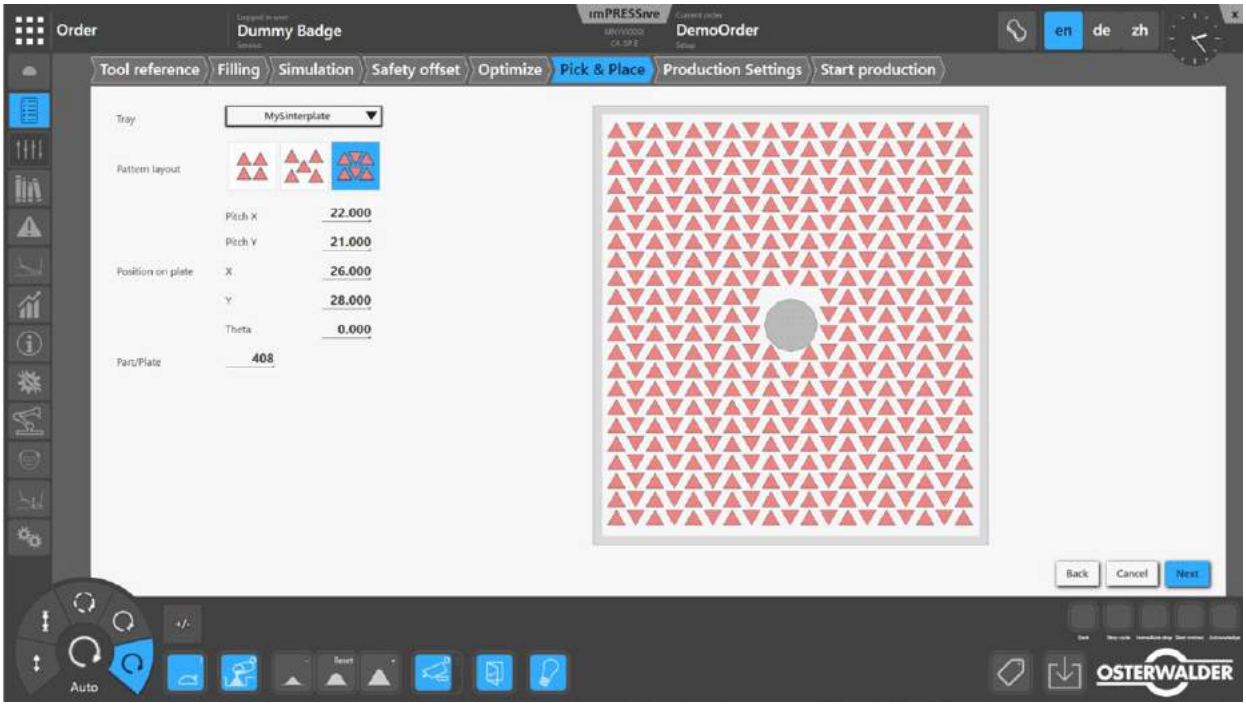

Fig. 6 Smart programming of sinter tray patterns for part layout

for later extensions. The customer is not limited to an initial decision but can scale-up and expand the basic configuration later.

Even the basic configuration, with manual sinter tray changes, can run for up to three hours without operator intervention. A conservative example of production cycle without tray change:

- Part dimension: 15 mm (18 mm with spacing)
- Tray size: 220 x 300 mm with six trays approximately 1100 parts
- Stroke rate: twelve strokes per minute (including punch cleaning)
- Time without operator intervention: 1 hr & 45 mins.

Stacker system

The Smart Press Cell is also available with automatic sinter tray handling from stacker to stacker, inclusive feeding, and removal of stacks by trolleys. Fully automatic tray handling, with two vertical and one horizontal axis, and a trolley interface to the automation from the front.

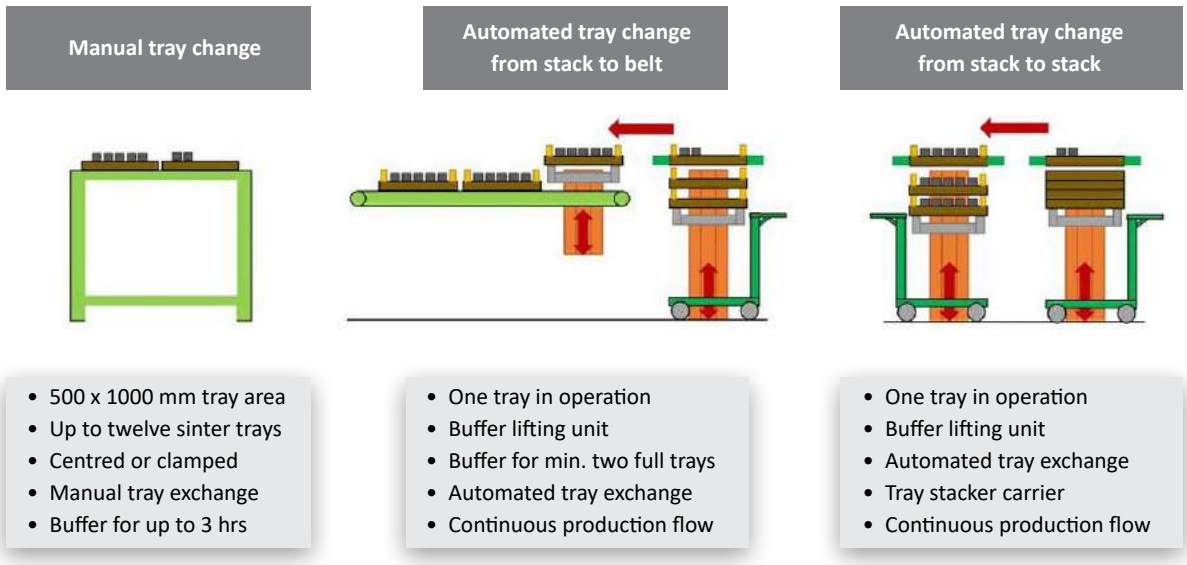

Fig. 7 Modular set-ups variations for sinter tray handling

Another option is an automatic sinter tray handling from stacker to conveyor belt, including trolley, which means feeding of empty stacks by trolleys and removal of full sinter trays individually with a conveyor belt.

In summary

The Osterwalder Smart Press Cell is a fully integrated production cell, offering improved productivity for Powder Metallurgy parts makers. The new system fully links the press and handling units, with control from one central Human Machine Interface (HMI) and is available for all Osterwalder electric powder compacting presses, from 80 to 2000 kN press force.

Osterwalder believes the Smart Press Cell offers huge benefits to the PM part producer, resulting in just one supplier for installation, training, service and support. Data acquisition is faster and open to enable efficient data communication, smart programming and higher productivity. Full traceability of the produced parts is also possible and seen as a key element for industrial process digitalisation.

Key features of the Smart Press Cell include:

- HMI and control operate from a central point
- Flexible tray arrangements and formats
- A revolutionary linear axis (patent application)
- Revolutionary handling arm with integrated punch-cleaning
- Gripper with smart adaptors for all standard part pick-ups
- Forty strokes per minute with 'SpeedMaster' option on SP presses
- Smart part cleaning with cyclone technology
- Programmable, central exhaust against powder spill out contamination
- Modular set-up for future extensions with tray stackers, AGV etc.
- Optimal floor space dimensions.

The shared user interface serves as a central point to control all machine operations, which significantly reduces system set-up times. The centralised system architecture enables efficient data communication between subprocesses, simplifies data acquisition and features full traceability of the produced parts, which is a key element for future innovations in the context of industrial process digitalisation.

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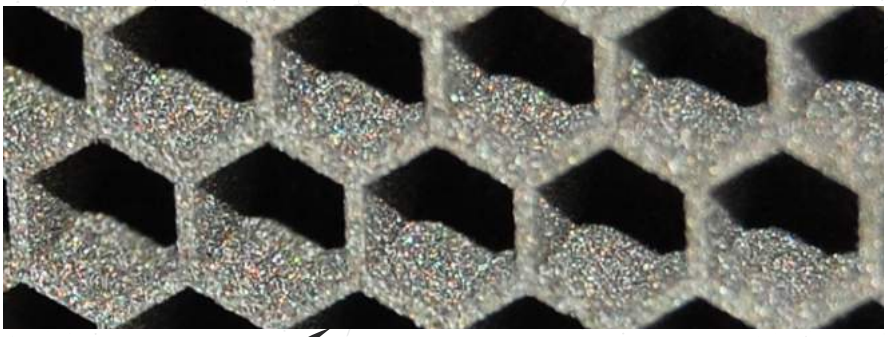

TECHNICAL PROGRAM:
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MPIF Powder Metallurgy Design Excellence Awards showcase range of demanding applications

The winners of this year's Powder Metallurgy Design Excellence Awards competition, sponsored by the Metal Powder Industries Federation (MPIF), were announced through a series of press releases due to the cancellation of the World PM2020 Congress. The awards included components made by conventional press & sinter Powder Metallurgy, Metal Injection Moulding and metal Additive Manufacturing. Here, we present the conventional 'press and sinter' PM components that received either Grand Prizes or Awards of Distinction.

The Metal Powder Industries Federation (MPIF)'s annual Powder Metallurgy Design Excellence Awards, open to all MPIF member companies, showcase the many possibilities of PM manufacturing. From the wide range of submissions, an expert panel evaluates the entries and awards Grand Prizes and Awards of Distinction to a number of components in various categories.

The winning components selected in 2020 demonstrate the capabilities offered by PM in a range of applications, including auto engines and transmissions, medical devices, consumer products, hardware and more.

A total of eleven Grand Prizes and fifteen Awards of Distinction were presented. Among those, ten awards were given to companies in the press and sinter PM category. Full details of the award-winning components in the MIM category will be published in *PIM International*, with winners in the metal AM category included in *Metal AM* magazine.

Automotive Category winners

The MPIF stated that innovation is at the hub of Powder Metallurgy manufacturing advancements in the automotive market. PM materials and consolidation processes are being utilised to support the most demanding applications, where transmissions, engines and chassis rely on performance components to provide durability and consistency.

Fig. 1 A Grand Prize has been awarded to Porite Taiwan Co. Ltd. for a VVT sprocket (Courtesy MPIF)

Fig. 2 PMG Indiana Corporation received a Grand Prize for this torque converter one-way clutch stator assembly used in an eight-speed transmission (Courtesy MPIF)

Grand Prizes

Automotive—Engine Category

The Grand Prize in this category was awarded to Porite Taiwan Co. Ltd., and its customer Schaeffler Technologies AG & Co. KG, for a VVT sprocket used in a new-generation E-VVT design that integrates a sprocket with the stator (Fig. 1). The function of the internal rotor is provided by the gearbox.

The unique design of this component was formed using two upper punches, four lower punches and two stepped core rods. Tooth groove cutting and deburring were carried out prior to induction hardening, while the inner diameter was machined after induction hardening.

Automotive—Transmission Category

The Grand Prize in this category was awarded to PMG Indiana Corporation for a torque converter one-way clutch stator assembly used in an eight-speed transmission made for FCA US LLC (Fig. 2). In the locked position, the part is subjected to a 350 Nm torque and traditionally the races are manufactured from wrought steel, or powder forged and case hardened to handle the high stress.

In the PM solution, the internal active form of the race was surface densified to a minimum density level of 7.8 g/cm^3, from an overall part density of 7.35 g/cm^3. The part was finally carburised, quenched and tempered to give a surface apparent hardness of 58-62 HRC. The core apparent hardness was 20 HRC. The final operation applied was double disc grinding.

The complex internal geometry of the outer race comprised nine pockets, each pocket being defined by a spring support surface transitioning along a hook area to an active load-bearing cam surface. In this part, surface roughness better than 0.8 µm was achieved.

Awards of Distinction

Automotive—Engine Category

Nichols Portland LLC received an Award of Distinction in this category for a variable displacement vane-pump rotor used in an automotive engine lubrication system (Fig. 3). The three-level part is said to possess numerous critical tolerance features achieved with minimal secondary operations (grinding and deburring).

The PM route created a high-bearing ratio surface finish, which ensured good performance in sliding wear.

A second Award of Distinction was given in this category to MPP for a high-strength camshaft-bearing cap

(Fig. 4). The part is made using a PM aluminium-copper-magnesium alloy. The machinability of the PM aluminium alloy closely matches that of the cast aluminium heads, permitting consistent line boring prior to installation of the camshaft.

Sizing of the PM part was able to match the required tolerance levels without the need for any machining and the sintered and sized material offered a UTS of 320 MPa, a yield strength of 300 MPa and a fatigue strength of 90 MPa.

The cap matched the coefficient of thermal expansion of the cast aluminium head and the porosity of the PM part was effective in providing lubrication to the camshaft.

The aluminium powder used contained a high level of recycled material.

Automotive—Transmission Category

An Award of Distinction was made to Allied Sinterings Inc. in this category for a sear pin assembly (Fig. 5). The part is used in a shift-by-wire automotive transmission actuator that causes an output shaft to rotate the sear pin, allowing a pawl to engage a default-to-park during a catastrophic transmission failure.

The component was an assembly of two parts, the pin and the flag. The pin was formed from the iron-copper elemental mix, FC-0208, at 6.8 g/cm^3 density and the flag from the iron-nickel elemental mix, FN-0208, at 6.9 g/cm^3 density. After assembly, the iron-copper material swelled during sintering, while the iron-nickel material shrank, thus creating a joint based on the generated mechanical interference and consequent diffusion bonding.

The key challenge in forming the pin was the requirement for a long powder fill in a thin section.

Sintering was carried out at 1150°C. After heat treatment by oil quenching and tempering and subsequent oil impregnation, both pin and flag showed a micro-indentation hardness equivalent to 60 HRC.

Fig. 3 Nichols Portland LLC received an Award of Distinction for a variable displacement vane-pump rotor (Courtesy MPIF)

Fig. 4 An Award of Distinction was given to MPP for a high-strength camshaft-bearing cap made using aluminium-copper-magnesium alloy (Courtesy MPIF)

Fig. 5 An Award of Distinction was made to Allied Sinterings Inc. for a sear pin assembly (Courtesy MPIF)

Fig. 6 Alpha Precision Group was awarded a Grand Prize for this diesel exhaust flange component used for sensor placement in regulating exhaust emissions (Courtesy MPIF)

Consumer Goods Category winners

The Consumer Goods Category awards prizes for parts produced by Powder Metallurgy, Metal Injection Moulding and metal Additive Manufacturing for consumer categories across a range of market segments, such as lawn and garden; off-highway; hand tools and recreation; industrial motors, controls and hydraulics; hardware and appliances.

Grand Prizes

Consumer Goods–Lawn & Garden/ Off-Highway Category

Alpha Precision Group was awarded a Grand Prize in the Consumer Goods category for a commercial diesel exhaust flange component used for sensor placement in regulating exhaust emissions (Fig. 6). The part combined what previously were three standalone components incorporating a flange and two bosses.

This 3.5 kg part was produced from SS-409LNi stainless steel. A specifically designed compaction press provided deep fill capability, the part requiring around 165 mm fill. Tooling with tapered flanges was

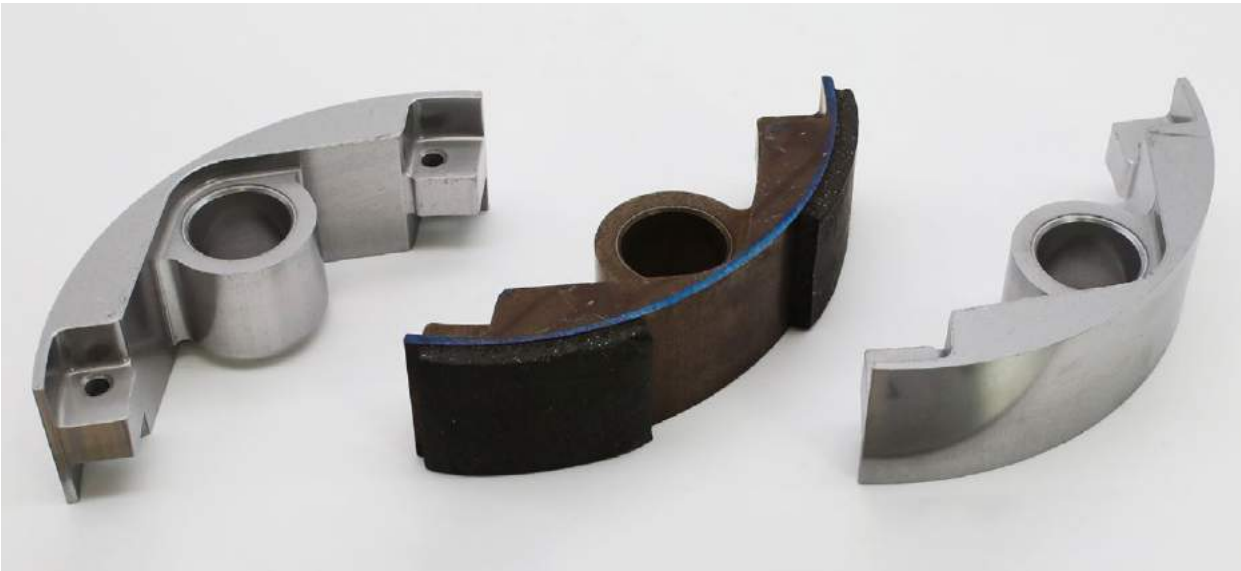

Fig. 7 A Grand Prize was awarded to Catalus Corporation for a shoe used in a clutch for a refrigeration compressor (Courtesy MPIF)

Fig. 8 FMS Corporation received a Grand Prize for a click-plate assembly used in an agricultural livestock feeder (Courtesy MPIF)

used to aid part release in ejection. Because of initial galling problems, die wall lubrication was used in combination with an admixed lubricant.

The part's green density was around 6.5 g/cm^3 and, after high-temperature sintering, a sintered density of 7.1 g/cm^3 was achieved.

The PM part was designed to allow two different final part geometries to be machined in-house from the same sintered component.

Consumer Goods–Industrial Motors/Controls & Hydraulics Category

A Grand Prize was awarded to Catalus Corporation in this category for a shoe used in a clutch for a refrigeration compressor (Fig. 7). The part has been in production since 1984 and has undergone numerous iterations over the years, and can now be made net shape at an increased compaction rate.

The most recent iteration, in 2017, involved forming on a hydraulic compaction press, with three upper punches, two lower punches and four core rods, using the FC-0208 material at a density level of 6.4 to 6.8 g/cm^3. The only post-sinter operation is tumbling.

Consumer Goods–Hardware/ Appliances Category

The Grand Prize in this category was awarded to FMS Corporation and its customer Hansen Ag Solutions for a click-plate assembly used in an agricultural livestock feeder. The assembly consists of an inner and outer click plate.

The plates were made from SS-410-90HT on a multi-action press with three lower punches and a stepped die. Mirror finishes were needed on the punch faces forming the customer logo and the interlocking teeth. Accurate tapers were needed on the core rods for the inner plate, due to the low compressibility and abrasiveness of the powder used.

Both parts were challenging due to their multi-level requirements, detailed lettering inscriptions, premium density/wearability in the teeth and a relatively complex core

Fig. 9 An Award of Distinction was given to Catalus Corporation for this spacer for a seatbelt assembly (Courtesy MPIF)

Fig. 10 An Award of Distinction was given to Metalpo Ind. E Com. Ltda for an upper stator used in a ceiling fan (Courtesy MPIF)

rod configuration for compacting the inner plate. The parts were sinter-hardened to provide a micro-indentation hardness equivalent to 55 HRC.

The PM parts have been successfully tested beyond one million clicking cycles, equivalent to around fifteen years of service.

Awards of Distinction

Consumer Goods–Lawn & Garden/ Off-Highway Category

An Award of Distinction was given to Catalus Corporation in this category for a spacer that serves as a poke-yoke locator and compression limiter where a seatbelt assembly is attached to the frame in a side-by-side vehicle (Fig. 9).

The part was compacted on a CNC hydraulic press using two upper punches, three lower punches and three core rods. The top inner punch formed the 8 mm long tab, the bottom outer punches formed the counter-bores and a punch provided powder transfer to the tab.

The material used was FN-0208-130HT. After sintering and heat treatment, the part was resin impregnated and zinc plated.

Consumer Goods–Hardware/ Appliances Category

An Award of Distinction was given to Metalpo Ind. E Com. Ltda in this Category for an upper stator used in a ceiling fan by its customer Philips do Brasil Ltda (Walita Division) (Fig. 10).

The part is of cylindrical form, with a nine-tooth, 20° helix angle helical gear form at one end. The material used was the diffusion-alloyed steel FD-0200 at a density of 6.4 to 6.8 g/cm^3.

Contact

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Metal Powder Industries Federation

The Metal Powder Industries Federation is the North American trade association formed by the Powder Metallurgy industry to advance the interests of the metal powder producing and consuming industries and provides a single point of reference for all MPIF member companies.

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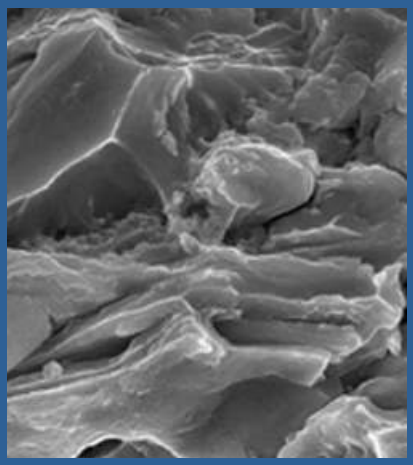

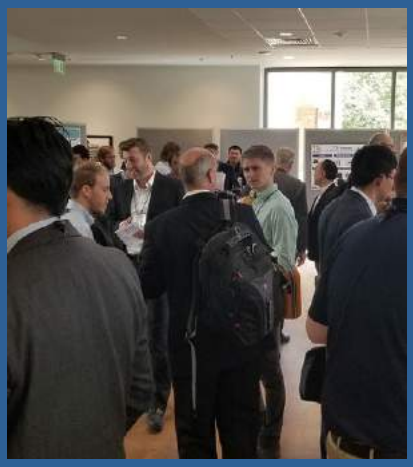

Global experts on powder metallurgy and additive manufacturing processing of titanium and titanium alloys will gather for academic exchange and technology transfer in Montréal, Canada.

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The micro-ingot route: A variant of the PM process that could offer new opportunities for the PM industry

A recently published patent, outlining a proposed method to produce alloyed metallic parts, could result in numerous opportunities for the Powder Metallurgy industry as it competes for new applications in a changing marketplace. By hot densifying metal powder comprised of atomised particles (micro-ingots), with each particle having a predetermined alloy content, the aim is to form a finished or near net shape highly homogeneous alloyed product, with minimum possible impurities and enhanced dynamic mechanical properties. The method is said to be applicable to a broad range of alloys and applications. In this article, Harb Nayar, president of TAT Technologies LLC, outlines the thought process behind the patent, as he looks to work with selected partners to further the technology.

In the field of engineering there are a number of factors for the popularity of steel. It costs relatively little to make, form and process steel parts; an abundance of raw materials are available, such as iron ore and scrap; and it offers an unparalleled range of mechanical properties.

The world's raw steel production was reported at just under 1.9 billion tons in 2019, with the next most-used engineering metal being aluminium at around 64 million tons [1, 2]. Each year, approximately 55% of the world's liquid steel is solidified in a continuous casting method as shown in Fig. 1, forming steel billets (90-160 mm square), steel slabs (1.3 m wide and 0.23 m thick) and blooms [3]. These are further processed through various metal working processes into semi-finished long products of various thicknesses, widths and diameters.

The semi-finished long steel products are cut into smaller pieces (below about 50 kg) to make final finished end-products by using either machining or various metal forming technologies such as forging, extrusion, ring rolling, rotary swaging, rolling etc., weighing from a fraction of a kilo to 20 kg or even heavier. Some of these are heat-treated to further enhance mechanical strength and other properties. These products are used primarily as structural products, covering a broad range of static and dynamic mechanical properties. Their compositions are broken down into three categories: carbon steels, low-alloy steels and medium-high alloy steels. This article will primarily address low-alloy steel products.

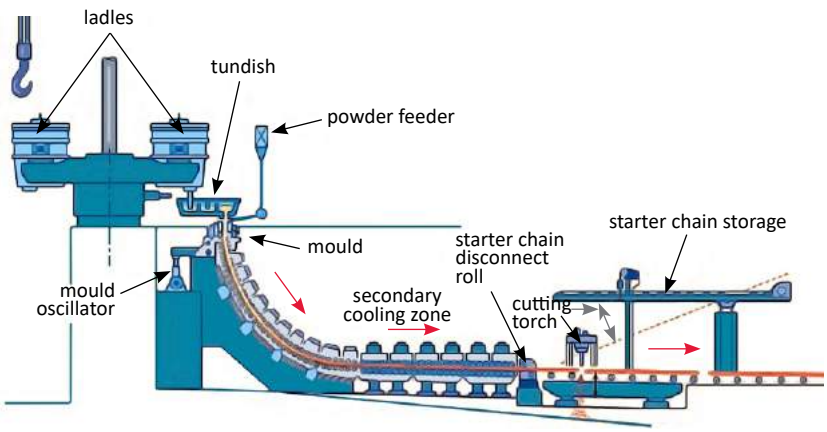

Fig. 1 A curved-mould continuous slab (Courtesy Encyclopedia Britannica Inc)

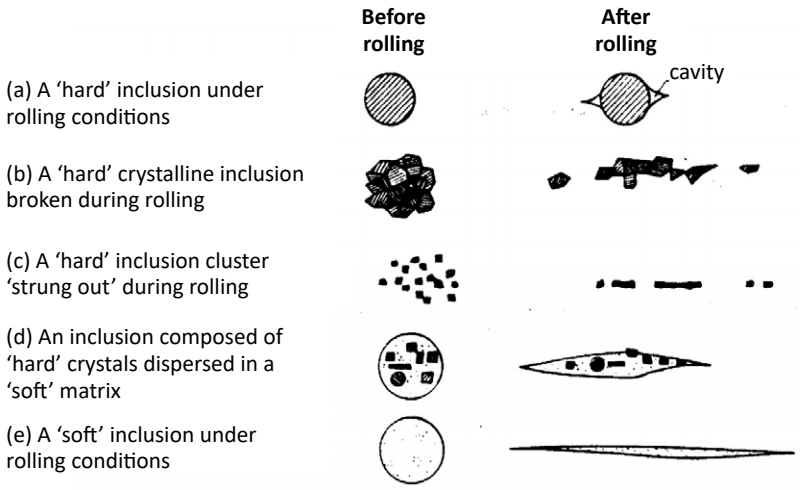

Fig. 2 Schematic representation of inclusions morphologies before and after deformation

Macro-ingots (wrought steel)

Literature defines the above described products as wrought steel products. However, for this paper, these will be described as 'macro-ingot' products. Their starting point, as with wrought steel, is a large ingot, billet or slab which is cast from a pool of liquid steel and solidified over many minutes.

An important characteristic of solidification processes, especially of alloyed steels, is segregation. This takes place because of a metallurgical process called liquation. The portion of the melt that solidifies first is purer than the remaining liquid melt from which it solidifies. Therefore, as steel solidifies, the alloying elements and solid inclusions grow in concentration in the remaining liquid, resulting in the enrichment of these elements and inclusions in the centre of the ingot that solidified last.

Segregation can be minimised by solidifying at a faster rate. As the solidified ingots are rolled down to smaller dimensions, the concentrated alloying elements and solid impurities of different types get changed and elongated in the central portions of the rolled semi-finished lengths. Different types of inclusions are shown in Fig. 2 [4]. With a significant amount of rolling, some impurities spread out lengthwise and are referred to as 'stringers'. The segregation of alloying elements and impurities leads to different properties along the length as compared with in other directions, higher variation in static mechanical properties and decreased dynamic properties like fatigue strength in the finished products. In short, all finished steel products made from macro-ingots (wrought steel) are inherently heterogeneous in their structure and the resulting properties.

Qualitative comparison between macro and micro products		
	Macro-ingot	Micro-ingot
Alloy homogeneity	OK	High
Oxide inclusions	Some	little
Stringers	Yes	No
Grain size	Variable	Uniform
Mechanical properties	Anisotropic	Isotropic
Fatigue strength	OK	Higher
Heat treat enhancement	Good	Better

Table 1 Qualitative comparison between macro and micro products

Micro-ingots (atomised prealloyed steel particles)

A different process for producing alloy steel products traditionally produced by the macro-ingot route

Water atomised low-alloy steel powder is solidified from an exceedingly small liquid steel droplet. The solidification rate is thousands of times faster than that seen in making continuously cast macro-ingots. Each water atomised steel powder particle can be appropriately called a 'micro-ingot'. The alloying elements and any other impurity are equally and uniformly distributed in each and every powder particle. All particles are equally homogeneous, and display none of the segregation seen in macro-ingots.

If the prealloyed micro-ingots are to be consolidated to a finished product by known and future technologies, the finished product will have less variation in static mechanical properties and higher dynamic mechanical properties like fatigue strength. This micro-ingot approach, when combined with newer heat treatment technologies, can lead to a redesign of the current macro-ingot products that can potentially help to reduce the weight of the finished product resulting in a longer product life span. Table 1 qualitatively compares the key characteristics of finished products starting with macro-ingot and micro-ingot.

One specific new technology for the consolidation of micro-ingots is covered in a patent issued on March

10, 2020, "Method of Producing Alloyed Metallic Products" [9]. It outlines both claims and teachings for producing both high-density (7.2-7.5 g/cm^3) and full-density homogeneous alloyed PM products, starting with un-annealed metal powder comprised of particles with a predetermined alloy content. The thought process presented in this article offers both challenges and many opportunities to convert parts currently made from macro-ingots (wrought steel) to the micro-ingot (prealloyed powder) route.

This patent is more specifically applicable to low-alloy steel products of relatively complex shapes, with total alloying content from about 1% to about 5%. Typical alloying elements are: Mo, Ni, Cr, Mn, Si, Cu, W, V, Co, and Ti. They can be divided into two categories: elements such as Cr, Mn, Si, V and Ti are easily oxidisable and elements like Mo, Ni, Cu, and Co are less oxidisable. Each alloying element provides specific enhancement to a given property, above and beyond conventional carbon steels. There are literally hundreds of different compositions in the overall category of low-alloy steels.

Commonly, the finished products are heat treated by heating and quenching, followed by tempering, to further improve mechanical properties. The finished products consist of many different shapes, sizes and weights and are used in a broad range of industries.

Fig. 3 Railroad wheel bearing from AISI 8620 steel

Currently, the three most common methods to manufacture these high mechanical property low alloy steel products are:

(A) Machining: The starting material is fully dense, low-alloy macro-ingot square or round bar. The example shown in Fig. 3 [5] is a railroad wheel bearing made from AISI 8620 macro-ingot pipe. It is 25 cm (10") in diameter and 20 cm (8") in height and is heat treated.

(B) Hot Forging: Closed or open die. The starting materials, as with (A) above, are fully dense, low-alloy macro-ingot. Examples shown in Fig. 4 [6] are all hot forged from different low-alloy steels.

Keys forged in 1045, 4140, 4340 and 8640

Lugs forged in 8637

Pintle adapters forged in 4340 and 4140

Fig. 4 Example of hot forged parts from macro ingots (wrought steel)

Fig. 5 Hot forged connecting rod

(C) Powder Metallurgy hot forging in a closed die: The starting material is generally pre-mixed powders of four to five different elements to give the pre-determined overall low alloy composition in the finished product. The largest single application of this method is connecting rods in the automotive industry (Fig. 5) [7]. There are a few other good examples, including a couple starting with micro-ingots, and the many powder-forging applications given in [8], a good read for those new to powder forging. Another example is the making of a large, 91 cm (3 ft) diameter aluminium alloy ring (Fig. 6) made via the hot particle ring-rolling process [10].

Overall the market share of method (C) is very much smaller than either method (A) or (B), in spite of the fact that significant R&D efforts have been applied during the past few decades using pre-mixed elemental powders, pre-mixed elemental-master alloy powders and some pre-alloyed powders to increase its market share. Market penetration in full density products has been limited.

Significant progress has been made in high-density range (7.2-7.4 g/cm^3) low alloy products using atomised pre-alloyed powders using the double press-double sinter method. Pre-alloyed powders are commonly used in MIM, AM and HIP methods. However, there is still a need to reduce cost and energy further to attract new applications in both high density and full density parts using pre-alloyed powders.

" At high sintering temperatures the porosity is more rounded, and the diffusion of alloying elements is improved..."

Theoretically, following the process described in the patent, one can expect a better combination of the following list of benefits for the low alloy steel finished products, both in the 7.3-7.5 g/cm^3 density range and full density:

1. Lower overall total cost per kg
2. Lower overall total energy per kg
3. Equal or higher tensile and yield strength for a given alloy and density before and after heat treatment
4. Higher toughness and fatigue strength for a given alloy and density before and after heat treatment
5. Less variation in all mechanical properties
6. Less variation in dimensional changes during heat treat
7. Inline continuous and connected process flow from start to finished heat treated part
8. Environmentally cleaner, friendly and well controlled overall manufacturing process
9. Higher material utilisation from start material to finished product

A walk through the thought process

The method outlined in the patent can perhaps be better described as a journey — starting with production of powder, passing through critical and inter-related complementary milestones along the way and ending with a finished heat treated, highly homogeneous alloyed product with minimum possible impurities such as oxides uniformly distributed throughout the product leading to static and enhanced dynamic mechanical properties with the least possible variations. This journey is applicable to a very broad range of alloys and applications.

The powder

A 100% pre-alloyed, un-annealed, relatively coarse, non-critical size distribution and non-spherical. It can be water atomised or crushed from already pre-alloyed machine chips. There are only two absolute requirements: alloy content control and clean powder with minimum amounts of impurities and internal/external oxides.

Advantages:

- Lowest possible starting material cost

- Alloying accomplished at the start
- All particles have the same alloy composition
- Lower risk of agglomeration, because of the coarser size
- Easier to mix and/or coat with lubricant and/or binder material
- High powder flow to fill the compacting die faster and uniformly, because of the coarser size
- Lower blending/mixing errors; more reliability in composition
- No need to worry about diffusion-based alloying down the road during sintering
- Lowest possible specific surface area, leading to easier reduction of powder surface oxides

Disadvantages:

- Low compressibility and green strength
- Thicker surface oxide layer
- Harder on the compacting die walls

Solutions to overcome the disadvantages:

- Use binder + lubricant to increase green strength
- Use irregular shaped powder for some interlocking to increase green strength
- Avoid the need for high compressibility by compacting to lower green density
- Use more wear-resistant die materials
- Oxide content will be substantially reduced during pre-sintering

Compaction stage

The goal at the compaction stage is to achieve less than 85% metallic density with plenty of interconnected porosity, relatively large pore size and sufficient green strength to transfer green parts to next step.

Fig. 6 This aluminium ring was produced using a hot particle ring rolling process

Advantages:

- Lower level of required compaction tonnage with lesser die wear, as compared with going to higher density using pre-alloyed un-annealed powders
- Much faster debinding/delubing with high interconnected coarse porosity (next step)
- Much faster and higher level of reduction of surface oxides on the interconnected large pores in the interior of the green parts with low density (important for the next step)
- Easier for the reducing gas like H_2 to move through the interconnected coarse porosity toward the centre of the part and, at the same time, easier for H_2O vapour, as the reaction byproduct, to move out of the interior (next step).

Pre-sintering/sintering options

The low-density green part is thermally treated under a controlled and super-zoned atmosphere system. In one continuous operation, using a single conveyor furnace with a relatively high belt speed, the following is accomplished:

a) Delubing/debinding in under 15 minutes using an oxidising, highly convective atmosphere

b) Reduction of surface oxides on every particle, using a highly reducing atmosphere through the high interconnected coarse porosity to bring the surface oxide content to a very low level

c) Heating to a pre-determined temperature and time, depending upon which of the following two options of sintering is to be carried out:

Option I, 7.3 to 7.5 g/cm^3:
If the goal is to achieve high density, the pre-determined

Fig. 7 Iron pillar of Delhi, India

Early example of Powder Forging: The Iron Pillar of Delhi

An incredibly old example of Powder Forging can be seen with the Iron Pillar of Delhi in India, shown in Fig. 7 [11]. Believed to be over 1600 years old, the 7.2 m high iron structure is understood to have been fabricated using a Powder Forging process.

The raw material used is naturally occurring magnetite (Fe_3O_4) 'blue dust powder', found in abundance in one part of India. The iron oxide powder was reduced to sponge iron by oxide reducing gases by burning charcoal under the pile of iron oxide powder. The sponge iron, while still hot, was forged successively into the huge iron piece shown in the figure.

The 3,000 kg pillar has not rusted in more than 1600 years, and powerfully demonstrates what can be done with the micro-ingot or powder route.

temperature and time for c) must be sufficient to anneal the sintered part for subsequent cold or warm compaction, to achieve density above 7.2-7.3 g/cm^3. This is followed by a final sintering at about 1150°C (2100°F) on a belt furnace, or above 1230°C (2250°F) using a high temp furnace for additional density increase and higher mechanical properties

Option II - full density:

To achieve full density, the pre-determined temperature and time for c) are those that are suitable for hot forging immediately after the pre-sintered part comes out of the furnace. Of course, the pre-sintered part is coated/sprayed with graphite before forging.

A final heat treatment

Any conventional heat treatment practice can be used. Which heat treatment would be the best option will depend on the alloy, final properties and the desire to have a truly continuous operation or not.

The option to heat treat immediately after hot forging is worth consideration, not just for saving energy and cost, but also for developing a better-quality, crack-free surface layer and possibly avoiding the need for any tempering treatment (unique feature of the technology) at the end. For this study, TAT collaborated with Akron Steel Treating Company in Akron, Ohio, USA, who specialise in much faster quench rates undertaken immediately after the part is hot forged. When using a somewhat lower-level pre alloy composition, this high quench rate technology could help obtain properties equivalent to those from a higher-level pre alloy material. There is no oil involved in this technology.

There are some other subtle teachings in the patent, but they can be addressed for each specific alloy, application and processing path chosen. It can also be expanded into medium-alloy powders, all the way up to stainless steel, composite alloys with complex microstructures.

Achieving the potential outlined in the patent

So far, no mechanical property data have been developed to demonstrate the degree of the nine benefits listed earlier in this article. However, depending on the alloy, desired properties and specific application, TAT feels strongly that the expressed thought process of the patent, with minor variations, will result in a highly beneficial combination of these factors. This needs to be demonstrated, and TAT is keen to undertake further collaboration with industry for any specific alloy, application, and desired properties.

The following three steps will form the next stage in that development:

Step 1:

The first goal is to obtain starting point mechanical property data on just one alloy. Using un-annealed, relatively coarse water atomised pre-alloyed 4600V powder, prepared by Hoeganaes Corporation, pre-sintered bars (4" x 0.75" x 1") with lowest possible oxide content and fully annealed state, will be prepared following the principles outlined in the patent.

The material's composition is: Mo: 0.56, Ni: 1.83, Mn: 0.13, C: 0.4%. Pre-sintered density will be below 85% of theoretical. Using pre-sintered clean and annealed samples, it is proposed to produce 7.3 g/cm^3, 7.5 g/cm^3 and full density bars based on the following:

- Cold press to 7.3 g/cm^3 and sinter at 1121°C (2050°F) - 30 minutes in N_2-H_2 atmosphere.

- Warm press to 7.5 g/cm^3 and sinter at 1121°C (2050°F) -30 minutes in N_2-H_2 atmosphere.
- Warm press to 7.5 g/cm^3 and sinter at 1232°C (2250°F) -30 minutes in N_2-H_2 atmosphere.
- Hot Forge to full density, followed by two different heat treatments: Conventional oil quench and high-speed quench.
- Determine dimensional and density changes, hardness, tensile strengths and elongation of parts from a) to d) above.
- Compare the properties with published data in the literature for a similar alloy composition at a density of 7.3 to 7.5 g/cm^3 and fully dense conditions.

Step 2:
Prepare a further White Paper detailing the process used in Step 1 above, along with the resulting properties.

Step 3:
Continue to work with companies interested in exploring and developing the potential benefits outlined in the patent, to produce either 7.3-7.5g/cm^3 or full density parts. Collaboration on company specific alloys, application and targeted mechanical properties.

To benefit and grow the PM industry

Moving forward, TAT has only one intention: To make the patent-based thought process reach its own high potential for the benefit and growth of the whole PM industry. It is our belief that by working with other suppliers, such as a powder producer and heat treat expert, we can assist the PM Industry convert current low alloy wrought (macro-ingot) steel products made via machining, forging or other metal working processes, to micro-ingot based products at a faster and higher level.

TAT intends to work with a powder supplier for its powder needs. For heat treatment, the plan is to work with a company that TAT believes is highly qualified in the fast quench rate arena. TAT, on its own, has no intention to become involved in any high-density PM parts manufacturing, powder production or heat treatment business.

Jointly, working with suppliers, universities and manufacturers of high and full density parts, TAT's ultimate goal is to cover a variety of steels that contain some amount of easily oxidisable elements, such as Mn, Cr, Mn, Si and Ti, with and without relatively expensive alloying elements like Cu, Ni, Mo, V, W, Co etc. For example, Series 41xx, 43xx, 61xx, 86xx, 92xx, 93xx, 94xx, 97xx, 98xx steels, most used in making wrought hot forged and machined low alloy products.

Ultimately, the aim is to expand into medium and high alloy for very high-performance properties made by various metal forming technologies, using the single most unique feature of PM - each powder particle is already a uniformly alloyed micro-ingot.

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