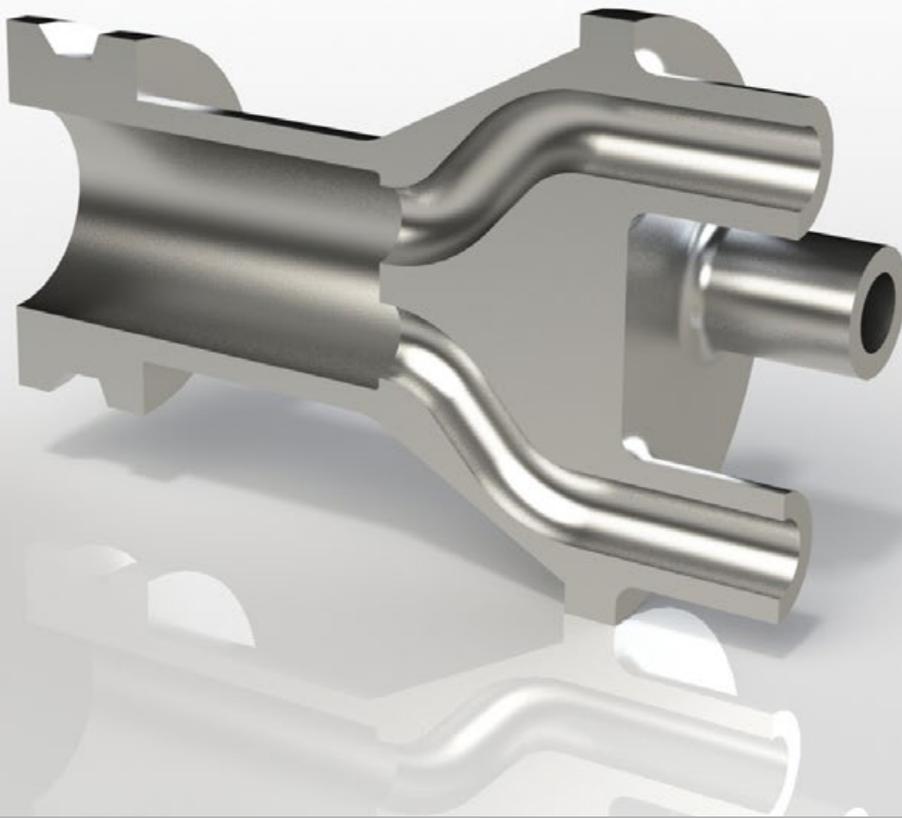


VOL. 11 NO. 2  
SUMMER 2022

# POWDER METALLURGY REVIEW



**NEAR-NET SHAPE PARTS BY HIP**  
**SAFEGUARDING PM'S PLACE IN AUTOMOTIVE**  
**UNDERSTANDING GAS ATOMISATION**



# Improved sustainability enhanced performance

---

**In the world of metal powders, Höganäs is always at the forefront of innovation.**

From more sustainable production processes to new and patented powder compositions, we are dedicated to offering you the optimal solutions while reducing environmental impact. With our range of metal powders designed for efficient press and sinter processes, we can offer powders designed for any application.

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

## Publisher & Editorial Offices

Inovar Communications Ltd  
11 Park Plaza  
Battlefield Enterprise Park  
Shrewsbury SY1 3AF  
United Kingdom  
Tel: +44 1743 469909  
www.pm-review.com

## Managing Director

Nick Williams  
nick@inovar-communications.com

## Group News Editor

Paul Whittaker  
paul@inovar-communications.com

## Features Editor

Emily-Jo Hopson-VandenBos  
emily-jo@inovar-communications.com

## Deputy News Editor

Kim Hayes  
kim@inovar-communications.com

## Assistant Editor

Charlie Hopson-VandenBos  
charlie@inovar-communications.com

## Consulting Editor

Dr David Whittaker  
Consultant, Wolverhampton, UK

## Advertising Sales Director

Jon Craxford  
Tel: +44 (0) 207 1939 749  
jon@inovar-communications.com

## Digital Marketer

Swetha Akshita  
swetha@inovar-communications.com

## Production Manager

Hugo Ribeiro  
hugo@inovar-communications.com

## Subscriptions

Jo Sheffield  
jo@inovar-communications.com

## Accuracy of contents

Whilst every effort has been made to ensure the accuracy of the information in this publication, the publisher accepts no responsibility for errors or omissions or for any consequences arising there from. Inovar Communications Ltd cannot be held responsible for views or claims expressed by contributors or advertisers, which are not necessarily those of the publisher.

## Reproduction, storage and usage

Single photocopies of articles may be made for personal use in accordance with national copyright laws. Permission of the publisher and payment of fees may be required for all other photocopying.

All rights reserved. Except as outlined above, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, photocopying or otherwise, without prior permission of the publisher and copyright owner.

## 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.

## Subscriptions

*Powder Metallurgy Review* is published on a quarterly basis. It is available as a free electronic publication or as a paid print subscription. The annual subscription charge is £150.00 including shipping.

## Design and production

Inovar Communications Ltd.  
ISSN 2050-9693 (Print edition)  
ISSN 2050-9707 (Online edition)  
© 2022 Inovar Communications Ltd.

This magazine is also available for free download from [www.pm-review.com](http://www.pm-review.com)

## A return to global networking for the PM industry

This issue goes to print shortly before we embark on our first PM-focused conference of 2022: PowderMet. Taking place this year in Portland, Oregon, the US event marks a welcome return for the Inovar team, after COVID-19 concerns forced us to forego attendance in 2021.

This year is shaping up to be a busy one for those in the PM world, as a number of key industry events are resuming in-person gatherings, and global travel restrictions seem stable, allowing the intercontinental gatherings of colleagues we have all missed. Making its return after four years is the much-anticipated WorldPM 2022, which will take place in Lyon, France, this October.

While we have all remained connected by technology and virtual events since the pandemic began, there is simply nothing quite like a real-life conversation over drinks or a meal to spark new ideas and challenge old ones. We look forward to being part of yours this year, and thank all the organisers who are putting their hard work into ensuring we can do so safely in 2022.

See you soon!

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



### Cover image

*Rendering of integrated S-shaped flow channels in a HIPed blank of a special fitting designed to direct one flow into four different flow loops (Courtesy MTC)*

RioTinto

# Imagine a Greener Future Together



## Rio Tinto Metal Powders' Commitment to Sustainable Development

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

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

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

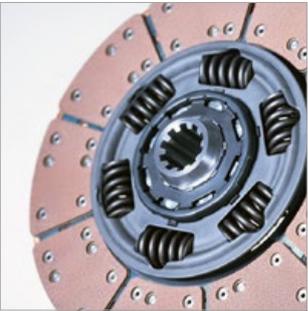
At Rio Tinto, we produce materials essential to human progress. For more information about Rio Tinto's policies, programs, and commitment to sustainable development please visit the Rio Tinto home page at [www.riotinto.com](http://www.riotinto.com)



Metal Powders  
[www.qmp-powders.com](http://www.qmp-powders.com)



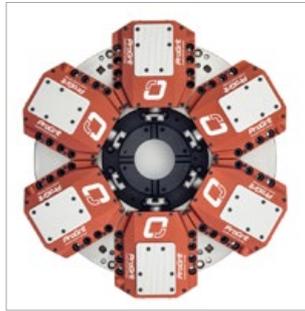
# POWDER METALLURGY REVIEW



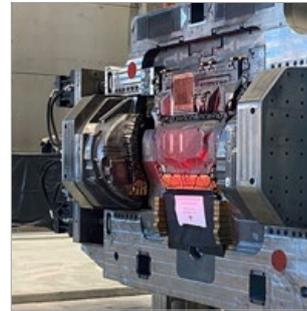
12



14



32



65



77

## Contents

### 53 Hot Isostatic Pressing as a Powder Metallurgy-based alternative to AM for large, near-net shape components

For decades, industries such as oil & gas have relied on Hot Isostatic Pressing (HIP) to produce large, corrosion resistant, near-net shape components from high-alloy materials.

Outside the PM industry, HIP is more widely recognised as a technology for the post-processing of AM parts than as a tried and tested powder metallurgical part manufacturing process in its own right. In this article, Jimmy Bovin, MTC Powder Solutions AB, Sweden, makes the case for HIP as the best, lesser-known alternative to Additive Manufacturing for large, near-net shape components. >>>



### 61 Backing the right horse? Safeguarding PM part usage in a new automotive industry

No matter our personal views on electrification, we can all agree that the automotive landscape, and with it, one of PM's leading consumer markets, is changing. Currently, much of our industry's focus is on how best to market PM's strengths as an EV-enhancing technology to the traditional 'Big 5' automakers. But is this strategy enough?

In this article, EV commentator Alex Voigt, with input from *PM Review's* Emily-Jo Hopson-VandenBos, compares Tesla's approach to that of traditional automakers, and asks whether the PM industry should keep its focus on those companies that have traditionally led the auto industry, or whether it is new relationships with flexible, innovative startups that will safeguard the future of Powder Metallurgy as a supplier to the automotive industry. >>>

**MADE IN  
GERMANY**

**DORST**  
TECHNOLOGIES

# EP32M

Servo-motorized CNC-Multi-Platen-Press for highest flexibility:  
Cross-pressing, Internal thread, Helical gear



Multi-level



Large installation space



High-resolution force control



Special applications



Highest precision & productivity



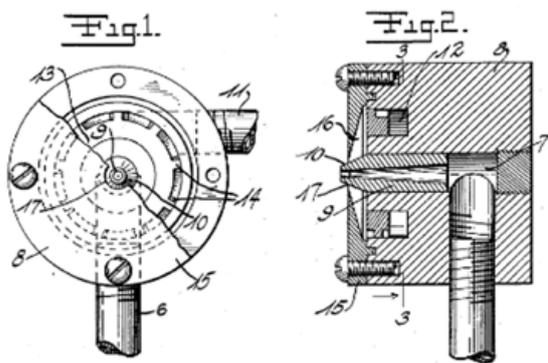
Encapsulated working area



## 71 How to make metal powders. Part 3: Understanding gas atomisation and gas atomised powders

In the third instalment of our four-part series on metal powder atomisation, atomisation experts Joe Strauss and John Dunkley explore gas atomisation. Gas atomisation has in recent years seen a major uptick in interest due to its use in the production of metal powders for Additive Manufacturing.

However, gas atomisation is nothing new; the concept was first patented more than 100 years ago, and powders produced by this method have a wide range of applications on a global scale, from the production of PM superalloy and MIM powders, to solders, spherical bronze powders for filters, brazing pastes, and more. >>>



## 85 Jiangxi Yuean Advanced Materials: The powder producer thriving in China's growing advanced manufacturing landscape

Formerly known as Yuelong Superfine Metal Powders, Jiangxi Yuean Advanced Materials is a leading Chinese producer of metal powders, including carbonyl iron powders (CIP) as well as powders produced by hybrid-water and gas atomisation. Now a listed company with major expansion plans in the pipeline, it was one of the first Chinese metal powder producers to have a significant presence on the international market.

In this article, Fei Tong, Sales Manager, reports on the company's development and plans for the future. >>>



## Regular features...

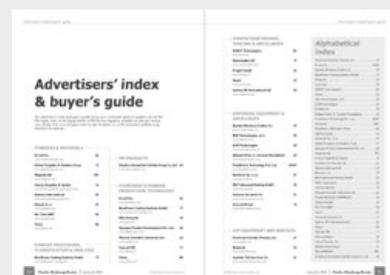
09 Industry news >>>

90 Advertisers' index & buyer's guide >>>

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

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

94 Industry events >>>





# PRODUCE PERFECTLY SPHERICAL POWDERS WITH INDUCTION PLASMA

We offer laboratory, pilot and industrial production spheroidization systems for a wide range of materials.

Our expertise and knowledge are available to support you from testing to industrial scale-up.

TEKSPHERO

15

TEKSPHERO

40

TEKSPHERO

80

TEKSPHERO

200

## PROCESS BENEFITS

Spheroidicity  
Flowability  
Tap density  
Purity

## FEATURES

Turnkey  
High throughput  
Industrial standards  
User friendly

Contact us  
**TEKNA.COM**

TEKNA  
WEBINAR  
SERIES

Subscribe to our mailing list  
[www.tekna.com/webinars](http://www.tekna.com/webinars)

# industry news

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

## Keystone Powdered Metal Company and Engineered Sintered Components merge

Keystone Powdered Metal Company (KPMC), St Marys, Pennsylvania, USA, and Engineered Sintered Components Company (ESC), Troutman, North Carolina, both affiliates of Sumitomo Electric Industries (SEI), announced the companies formally merged on March 31, 2022. The merged entity has retained the Keystone Powdered Metal Company name and will continue to serve the automotive, outdoor power equipment, and industrial equipment markets in North America.

Founded in 1927, KPMC has long been a player in the metal powder industry, responsible for many product innovations over its history. The company's headquarters and primary manufacturing facility is located in St Marys, Pennsylvania. Keystone Powdered Metal Company also has two satellite plants in Lewis Run, Pennsylvania, and Cherryville, North Carolina. Keystone was acquired by SEI in 2016 and has become the flagship for the North American powder metal production group.

ESC was established in 1989 as a joint venture between Sumitomo Electric and Eaton Corporation for

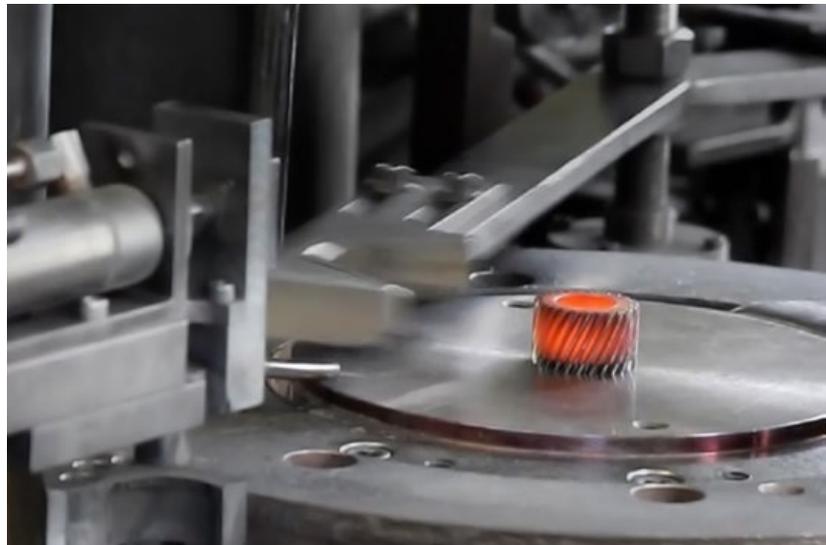
automotive valve train component manufacturing. Sumitomo went on to gain majority ownership and grew the business to become a leading supplier of powder metal components, specialising in machined products. It is located a short distance from the KPMC Cherryville facility.

The merger is intended to strengthen the product and process portfolio. "The synergies of the two

companies led us to the decision to pursue the merger," commented Michael Stauffer, KPMC president. "Today's KPMC product mix leans heavily toward large-tonnage highly engineered transmission components, while ESC is more focused on high-precision engine components. We believe our customers will derive significant value from this merger."

Marty Todd, ESC president, added, "Merging the complementary technical staffs will serve our customers well into the future."

[www.global-sei.com/usa/esc/](http://www.global-sei.com/usa/esc/)  
[www.keystonepm.com](http://www.keystonepm.com) ●●●



*Keystone has been responsible for many product innovations over its history, including this powder-forged helical pinion gear (Courtesy KPMC)*

## Advertisers' index & buyer's guide

### Looking for PM production equipment, metal powders, R&D support and more?

Discover suppliers of these and more in our new advertisers' index and buyer's guide, from page 90 to 92.



## Kymera International acquires titanium powder maker AmeriTi Manufacturing

Kymera International, a speciality materials company headquartered in Raleigh, North Carolina, USA, has acquired AmeriTi Manufacturing Company, Detroit, Michigan, USA. AmeriTi is a manufacturer of value-added ferrotitanium, titanium sponge, titanium powders and speciality forms. The terms of the transaction were not disclosed, however, AmeriTi's parts business, known now as TriTech Titanium Parts, was not included in the transaction.

"AmeriTi is a growing company led by a talented, dedicated employee base that culturally aligns with our

mission and objectives to be the leading manufacturer of speciality materials that shape the future," stated Barton White, CEO of Kymera. "We believe this is a synergistic acquisition that will give our combined company strong technical and commercial resources to help fuel our growth in the aerospace, medical, defence, and industrial markets."

AmeriTi produces titanium powder using the hydride-dehydride (HDH) process and is able to manufacture both commercially pure and alloyed titanium powder in a wide range of

particle sizes. The company is said to have the unique ability to supply enriched alloy powder. This includes enriching powder with alloying elements that are lost during post-processing steps. An example of this is an enriched aluminium version of Ti 6-4 to compensate for aluminium loss during Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing.

Bob Swenson, the owner of AmeriTi for the past twenty-five years, added, "The sale of AmeriTi to Kymera is an exciting next step for the business. Kymera and AmeriTi together will continue to build the product lines and grow into new areas. The combined business will be able to build on its titanium experience and knowledge, and maintain its strong customer focus and service."

Kymera International is owned by the private investment firm Palladium Equity Partners. "We are thrilled to help support the acquisition of AmeriTi, Kymera's fifth to date under Palladium's ownership, and second completed over the last three months," stated Adam Shebitz, a partner at Palladium. "The addition of AmeriTi will help to realise Kymera's five-year business plan to diversify into new, margin accretive, and growing end markets."

[www.kymerainternational.com](http://www.kymerainternational.com)  
[www.ameriti.com](http://www.ameriti.com) ●●●



*AmeriTi, a manufacturer of titanium powders, has been acquired by Kymera International [Courtesy Kymera International]*

## Melrose states GKN Powder Metallurgy division constrained by supply

Melrose Industries PLC, UK, parent company of GKN Powder Metallurgy, GKN Aerospace and GKN Automotive, has published a trading update covering January 1–April 30, 2022.

Trading for the group is said to be in line with expectations for the year. Consistent with industry trends, Melrose's Aerospace division is experiencing continued growth with like-for-like sales up 6%, while the Automotive and Powder Metallurgy divisions remain constrained by supply, with combined like-for-like sales down 4%, noted as signifi-

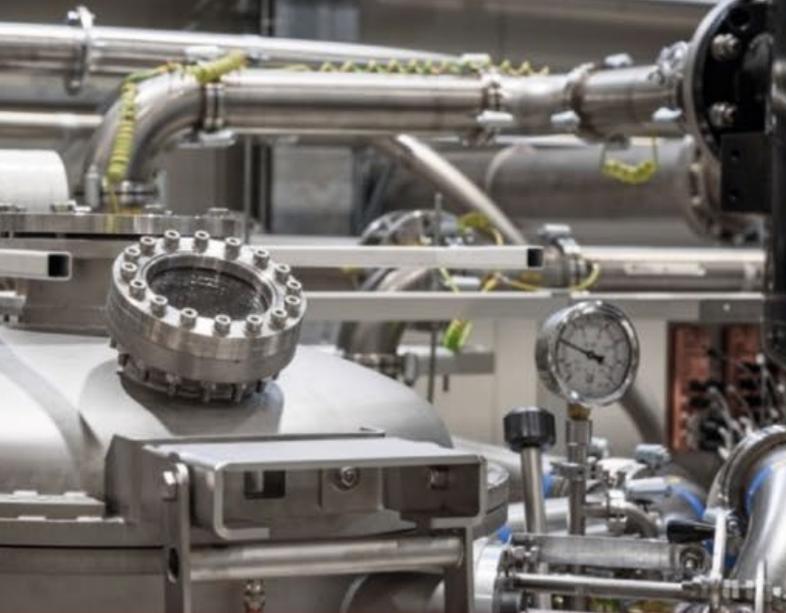
cantly below underlying consumer demand levels.

The Melrose Board is said to be confident that its continuing restructuring actions will ensure all its businesses are positioned to deliver their full potential as supply constraints ease. In addition, substantial progress is reported to have been made in recovering inflation and Melrose is reportedly confident the impact of inflation can be offset by measures it has taken. Melrose will be holding a GKN Aerospace Investor Day on June 8 to explain in

more detail the full potential for the business including growth and improvement opportunities, long-term cash flow dynamics and new sustainable technology.

"Your group continues to make good progress whilst dealing with the broader world challenges. We are increasingly seeing growth return to our Aerospace business, which is being rapidly well positioned for its future, and are confident of demonstrating the full quality of our largely restructured automotive businesses," stated Simon Peckham, CEO of Melrose Industries PLC. "We are well set to realise shareholder value as conditions improve."

[www.melroseplc.net](http://www.melroseplc.net)  
[www.gkn.com](http://www.gkn.com) ●●●



MADE IN ITALY

# VACUUM INDUCTION METAL ATOMIZER

## TMA: OPTIMIZED SOLUTION FOR DEMANDING POWDER METALLURGY

TMA is a family of metal atomizers designed for a wide range of powder production such as Stainless Steels, Nickel and Cobalt based, Non-Ferrous and Precious alloys and for many different applications, such as: Industrial, Chemical, Electronics and Additive Manufacturing (SLM and EBM).

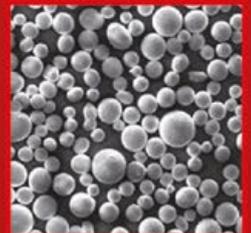
In order to cover this range, different plant architectures are involved, such as: Vacuum Gas-Atomizers (VIGA / EIGA) and Water Atomizers.

The shape and particle size distribution of the produced powder can be adjusted according to the customer needs.

Topcast TMA Atomizers are designed to easily control all the process variables, such as Gas/Water pressure and flow rate, metal temperature and flow through the nozzle.

For additional details please visit our website:

<https://www.topcast.it/en/products/metal-atomizers>



**Topcast**  
Engineering

**Topcast s.r.l.** Via Leopoldo di Toscana, 9-11  
52048 Loc. Alberoro / Monte San Savino (AR) Italy  
Tel. +39 0575 441341 - Fax +39 0575 441222  
info@topcast.it / [www.topcast.it](http://www.topcast.it)

## Miba reports sales increasing as it invests in future technology

Miba AG, Laakirchen, Austria, has reported its results for the 2021/22 financial year, seeing annual sales increase by €80 million (9%) to €971 million – returning to the level seen before the start of the pandemic. All business segments are reported to have grown, with the strongest growth, around 30%, achieved by the friction materials segment, which at €220 million contributes almost 25% to Miba's total sales. Miba's Power Electronics Group grew by about a quarter to annual sales of almost €70 million and Miba's Sinter and Bearing divisions were also able to expand their business compared to the previous year.

"The growth driver in the past fiscal year was once again our clear claim that Miba technologies contribute to greater energy efficiency as an important basis for sustainability and climate protection," stated F Peter Mitterbauer, CEO of Miba. "11% of our

sales already come from products for clean energy generation and transmission – driven strongly by our growth with technologies for wind energy, hydropower and for efficient power grids. For example, Miba offers a broad product portfolio for wind turbines and thus experienced unprecedented market demand last year. The same applies to our business with components for energy-efficient agricultural and construction machinery. And we are also utilising many opportunities around electrification and are growing – with our battery systems and battery technologies as well as with our broad product range for drives in electric vehicles."

Miba aims to grow by 50% by 2027 with products for greater efficiency and sustainability along the entire energy value chain. Contributing to greater energy efficiency with Miba products in such a wide variety of end

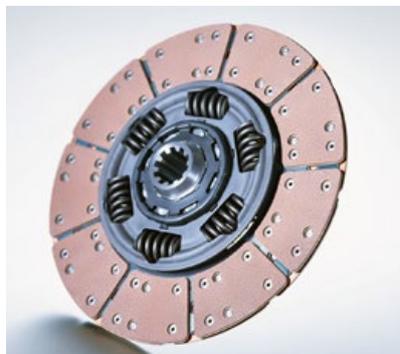
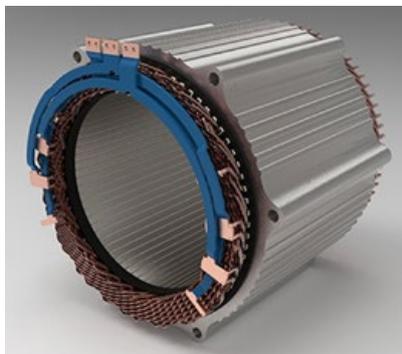
applications is at the heart of the 'Miba 100' growth strategy. It was presented in spring 2021 and describes how the company intends to grow by 50% by the 100<sup>th</sup> anniversary of its founding in 2027 – to annual sales of €1.5 billion.

In order to take advantage of these growth opportunities, Miba once again invested strongly in the future of the company and its employees in the past fiscal year, spending €85 million. With more than €40 million spent on research and development – which corresponds to a high R&D ratio of 4.2% – Miba placed a strong focus on its innovative strength in its usual manner. The company holds more than 400 patents; in the previous year alone, sixty-four new ones were added according to an evaluation by the Austrian Patent Office.

Miba began early to build up an extensive product portfolio for electrification – components for electric motors and electric drives, battery systems and battery components such as cooling technology, power electronics or fuse systems. Many of these products are now in series production or are about to be. Miba has already invested €60 million in building up its eMobility business, including new production facilities for power resistors in eVehicles commissioned in Styria in the past fiscal year. In Vorchdorf, the Miba eMobility team will shortly move into a new production and office site.

"We see great opportunities not only in the automotive industry, which is expected to grow strongly again in the medium term following the current challenges in the supply chains," concluded Mitterbauer.

[www.miba.com](http://www.miba.com) ●●●



Miba is continuing to invest in research and product development, including solutions for electric motors (left) and sintered clutch linings (Courtesy Miba)

## X-ray and CT systems supplier Yxlon to become Comet Yxlon

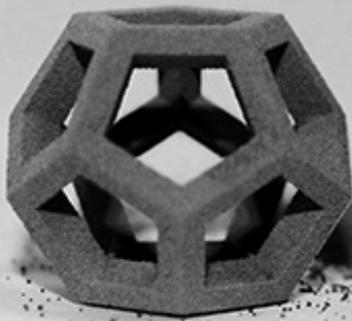
Yxlon International, Hamburg, Germany, has announced plans to change its name to Comet Yxlon, effective September 8, 2022. The new brand is said to underscore the company's long-standing affiliation with plasma and X-ray solutions provider Comet, based in Flamatt, Switzerland.

Yxlon develops, manufactures and markets high-end X-ray and CT system solutions for industrial environments, from R&D labs to production environments, with integrated services based on artificial intelligence and data analytics. It has been part of parent company Comet Holding AG, which unites a global

group of technology businesses under its umbrella, since 2007.

"The Comet Yxlon brand represents decades of X-ray expertise and a passion for making new things possible – in line with the motto 'Led by experience. Driven by curiosity'," stated Kevin Crofton, CEO of Comet Group and interim president of Yxlon. "The rebranding strengthens our presence and reaffirms our importance with Comet Group."

[www.comet-group.com](http://www.comet-group.com) ●●●



Security of supply  
High quality and purity  
Responsible sourcing  
Tolling services  
Recycling services

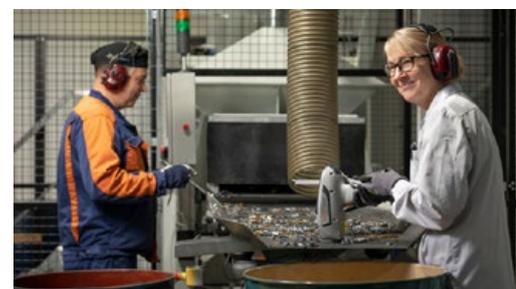
## Think Tungsten. Think GTP.

Whatever you create out of tungsten, be sure to start with the best powders on the market.

Whether for additive manufacturing, hard metals industry, oil/gas, tungsten metal, or tungsten heavy alloy applications, Global Tungsten & Powders offers the perfect powder blends. Our laboratories are equipped with the latest technologies allowing material measurements down to the atomic level.

Additionally, GTP recycles any tungsten containing scrap you may have on hand. Benefit from our long standing expertise, especially in utilizing the zinc process for the recycling of tungsten carbide in industrial scale.

Talk to our experts to see how we can help.



## Mercedes-AMG unveils concept of first sports EV with YASA axial flux motor

Mercedes-Benz has unveiled its view of an all-electric future for Mercedes-AMG, its high-performance brand, offering a glimpse of its first sports electric vehicle, the Vision AMG. The concept car features Mercedes-Benz's AMG.EA platform, which is currently under development in Affalterbach for the group's all-electric performance models, and includes an innovative axial flux motor developed by Mercedes-Benz's wholly-owned subsidiary YASA.

All of the drivetrain components used in the design of the Vision AMG are reported to have been developed from scratch, which includes the dedicated high-performance high-voltage battery and the drive technology. The axial flux motor developed by YASA, with its compact and lightweight design, is said to deliver substantially

more power than conventional electric motors. Mercedes-Benz announced the acquisition of YASA, a British-based manufacturer of ultra-high-performance electric motors in July 2021, securing access to its unique axial-flux technology.

"AMG is reinventing itself," stated Philipp Schiemer, CEO of Mercedes-AMG GmbH. "As was once the case with our founding fathers, there has been an amazing feeling of new beginnings here in Affalterbach for quite some time now. The course has been well and truly set for an electrified future, and we've set the bar high. That's because our customers expect something very special from all-electric cars. We have already well and truly proven our expertise in this regard with the SLS AMG Electric Drive, our own E PERFORMANCE hybrid technology and the first Mercedes-EQ derivatives."



The Vision AMG concept car (Courtesy Mercedes-Benz)

"With this study, we are now offering a first glimpse of how we are transferring the AMG DNA into the all-electric future, starting in 2025," Schiemer continued. "At AMG, we have always stood for that extra shot of emotion, driving fun, handling, ingenious aerodynamic features and other innovative solutions. And that's what we continue to stand for with our first BEV developed entirely in Affalterbach."

[www.mercedes-benz.com](http://www.mercedes-benz.com)  
[www.yasa.com](http://www.yasa.com)

## IMERYS GRAPHITE & CARBON

Premium carbon based powders for powder metallurgy.

**TIMREX®**  
 PRIMARY SYNTHETIC &  
 NATURAL GRAPHITE POWDERS

**ENSACO®**  
 CONDUCTIVE CARBON BLACKS

- ☑ Tailor made solutions with superior consistency with respect to: purity, crystallinity, particle size distribution and oversize control
- ☑ Imerys grades are ideally suited to powder metallurgy applications for electrical and hybrid vehicles

Contact us at [imerys.com](http://imerys.com)



## SSI Sintered Specialties changes name to DSB Technologies

SSI Sintered Specialties, LLC, a manufacturer of sintered metal components headquartered in Janesville, Wisconsin, USA, has changed its name to DSB Technologies. Following an extensive re-brand, the name change is intended to build on the company's recent technology expansion, which has seen investment in Powder Metallurgy, Metal Injection Moulding (MIM) and metal Binder Jetting (BJT) Additive Manufacturing technologies over the last year.

"This organisation has an impressive history and an even brighter future ahead," stated Paul Hauck, COO of DSB Technologies. "From the earliest days, we have operated with a drive for innovation. As our company and customer base continues to evolve, this rebranding embodies our commitment to the growth needed to be a prominent manufacturing partner."

For over forty years, DSB Technologies has collaborated with its customers as a metallurgical solutions partner for high performance Powder Metallurgy components. Under the name SSI Sintered Specialties, it operated as the sintered components division of a successful precision engineering organisation led by the company's current ownership. In 2019, SSI Sintered Specialties was separated from the organisation and took the opportunity to leverage its existing capabilities and expand the business into new technologies, applications, and markets.

"SSI was historically known as a conventional press and sinter business, but there is so much more at the core of our company," Hauck added. "Our new company name allows us to adopt new technology more freely and bring to light to the industry-leading talent and vast expertise we offer to our customers."

With a committed focus on growth, DSB Technologies is reportedly combining its present Powder Metallurgy and manufacturing knowledge with new technology and talent investments to continue designing and engi-

neering complex, functional, PM components.

The company houses what is believed to be North America's largest capacity of high temperature sintering furnaces in its 23,226 m<sup>2</sup> facility in Janesville, along with a fleet of over thirty-five presses, a vast range of secondary operations, a hands-free moulding cell and an in-house automation team.

[www.dsbtech.com](http://www.dsbtech.com) ●●●

[www.ultra-infiltrant.com](http://www.ultra-infiltrant.com)



# ULTRA INFILTRANT

## A SOLID LINE OF THINKING: SINTERING WITH A SOLID INFILTRANT



**YOUR WROUGHT/WIRE INFILTRATION SOLUTION.**  
 1868 Corniche Drive, Zionsville, IN 46077  
 888-ULTRA-55 . [privest@ultra-infiltrant.com](mailto:privest@ultra-infiltrant.com)

## Taniobis to invest €28M in facilities to enable production of tantalum powder

Taniobis GmbH, Goslar, Germany, an affiliate of JX Nippon Mining & Metals Corporation, reports that it will invest a total of €28 million to expand facilities for the manufacture of tantalum powder at its Map Ta Phut plant in Thailand. The investment will significantly increase its production capacity for tantalum powder, with operations expected to begin in 2025.

"Given present circumstances, demand for the product is projected to continue rising, and fulfilling this demand with existing facilities alone is likely to become difficult. Thus,

Taniobis has decided to sharply boost its production capabilities for the product," stated Kazuhiko Iida, CEO of Taniobis.

As well as augmenting overall production process capabilities for tantalum powder, the facility plan includes the construction of a new building for analysis work for the strengthening of quality control systems. Taniobis states that it will also build new development and trial facilities and strengthen systems to efficiently respond to customer needs.

[www.taniobis.com](http://www.taniobis.com) ●●●



*Taniobis plans to invest €28 million in its facilities to increase manufacturing of tantalum powder (Courtesy Taniobis GmbH)*

## Plansee high performance division joins Apple's 'Clean Energy Program'

Plansee HPM, the high performance materials division of Plansee Group, headquartered in Reutte, Austria, has joined Apple's Clean Energy Program and announced its plans to exclusively use electricity from renewable sources when producing Apple components from the end of 2022.

With this 'Clean Energy Program,' Apple intends to make its value-added chain greener. The company says it has doubled the use of renewables in its supply chain in the last year, equating to ten gigawatts of green energy. The target to be achieved in the coming years is sixteen gigawatts. The company, whose headquarters are

in Cupertino, California, USA, plans for its supply chain to be carbon neutral by 2030.

In an effort to make its production activities sustainable, Plansee is working to increase its use of recycled raw materials and increase its use of renewable energy for the manufacture of components for Apple devices.

"We are delighted to be joining Apple's Supplier Clean Energy Program and to work with them on new ideas for conserving resources, the circular economy, and reducing our carbon footprint," stated Wolfgang Köck, Plansee Group executive board member.

[www.plansee.com](http://www.plansee.com) ●●●

## Sandvik Materials Technology to be listed on Nasdaq Stockholm under new name Alleima

Sandvik AB, Stockholm, Sweden, has announced that following its recent Annual General Meeting, in accordance with the Board of Directors' proposal, it will distribute and list Sandvik Materials Technology (SMT) on Nasdaq Stockholm on August 31, 2022. SMT will be renamed Alleima at the day of listing.

"We are pleased to take the next step in the process to establish Alleima as a standalone listed company. Alleima will continue to develop its position as a market leader for advanced materials for the future," stated Andreas Nordbrandt, chairman of the board of directors of future Alleima.

Göran Björkman, Business Area Manager of SMT and future president and CEO of Alleima, added, "Sandvik's shareholders have today taken a historic and important decision. We have been looking forward to this and it gives us the strength to fully execute our strategy. Going forward we aim to drive profitable growth by capitalising on global megatrends playing in our favour, such as the transition towards more sustainable energy sources, energy efficiency, electrification, and medical growth to name a few."

The aim is to grow Alleima in several high-growth segments, such as industrial heating, medical, hydrogen and renewable energy and the chemical and petrochemical segment.

"Already today, we have a leading position in most of the segments in which we operate and sales in about 90 countries. We are a financial high-performer as well as a technical leader. As Alleima and a standalone company, we will be compared to peers in our industry," Björkman concluded.

[www.materials.sandvik](http://www.materials.sandvik) ●●●

AVAILABLE FOR  
HIGH-REACTIVE METALS  
AS ALUMINIUM OR  
MAGNESIUM

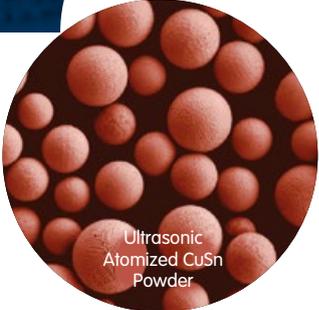
Gas Atomization  
Unit AUG 3000



Ultrasonic Atomizer  
AUS 500

# BLUE POWER: EQUIPMENT & EXPERTISE FOR YOUR METAL POWDER PRODUCTION

## DIFFERENT ATOMIZATION AND AIR CLASSIFICATION TECHNOLOGIES TO MEET YOUR NEEDS:



Ultrasonic  
Atomized CuSn  
Powder



Ultrasonic  
atomization



Inert gas  
air classification  
on AC 1000 G

- **GAS OR ULTRASONIC ATOMIZATION FOR SPHERICAL POWDERS WITHOUT ANY SATELLITES**  
Ideal for SLM, MIM and other Additive Manufacturing applications with the need for high quality powders with high purity, sphericity and wide range of reproducible particle size distribution.
- **WATER ATOMIZATION FOR MORE IRREGULAR POWDERS**  
Ideal for recycling/refining process, press & sinter process and others.
- **MAXIMUM PURITY BY OXIDATION-FREE PROCESSING**  
in the closed-chamber machine by means of de-gassing, vacuum and protective gas features
- **FOR A WIDE RANGE OF METALS AND FOR SMALL TO MEDIUM AMOUNTS**  
e.g. AUG series gas atomizers with temp. max. up to 2100° C, up to 180 kg bronze per cycle
- **AIR CLASSIFIER AC SERIES FOR METAL POWDER SEPARATION**
- **ALL UNITS DESIGNED FOR EASY HANDLING AND CLEANING, QUICK ALLOY CHANGE WITH MINIMUM CROSS CONTAMINATION**

DISCOVER OUR SOLUTIONS ON  
[www.bluepower-casting.com](http://www.bluepower-casting.com)

  
**BLUE POWER**  
CASTING AND POWDER  
PRODUCTION SYSTEMS





# THE POWDER MAKES THE DIFFERENCE.

**From concentrated brine to superiorly spray-dried Lithium powder with GEA.**

As world-leading specialist in powder engineering, we have developed exceptional Spray Drying Solutions that define and deliver superior quality powders to your exact specifications in the most energy-and-cost-efficient way.

Be it a powder, a granulate or an agglomerated product, GEA offers compact, single-line spray drying plants of any desired capacity. Our very own Nozzle or Rotary Atomizer technology allow us to cover a very wide size range.

## Epson Atmix to establish recycling facility for metal powder production

Epson Atmix Corporation, Aomori, Japan, an Epson Group company, has announced plans to invest several billion yen to build and equip a new metal recycling facility. The company will process used metals from within Atmix, as well as external sources, to use as raw material for the production of its fine metal powders.

Atmix produces a range of metal powders for a variety of manufacturing processes, including Metal Injection Moulding (MIM) and Additive Manufacturing. The company also produces magnetic powders for use in power supply circuits, as coils for IT equipment (e.g., smartphones), and for hybrid cars and electric vehicles.

The Epson Group has set a goal of becoming non-renewable resource-free by 2050. In addition to this, Atmix

believes it necessary to establish a closed-loop metal powder manufacturing ecosystem to address potential issues with the future supply of metals due to resource depletion and rising prices.

Atmix has stated that it plans to invest in an induction furnace for melting metals, refining equipment for removing impurities from metal, and a pig casting machine for forming ingots. The used metal will come from sources such as out-of-spec metal powder products in Atmix's manufacturing process, metal waste from its factory, metal scraps and used moulds and dies discharged by Epson and others.

Operations are scheduled to begin in 2025, and within three years Atmix expects recycled metal materials to meet about 25% of its total raw



*The new metal recycling facility will feed Epson Atmix's metal powder production operations, including its water atomisation line at the Kita-Inter Plant (pictured) in Hachinohe, Japan (Courtesy Epson Atmix)*

metal material needs. This new Atmix factory is positioned as the first step toward becoming 'underground resource-free' and is expected to be a crucial part of Atmix's efforts to develop a sustainable metal powders business.

[www.atmix.co.jp](http://www.atmix.co.jp)

**Visit us at ceramitec 2022:**  
Hall C1.111/212, from June 21 to 24



## The Future of Powder Compacting is **ELECTRIC**

Electrical powder presses from your solution partner

- Eco-friendly
- Low operational costs
- High precision
- Maximum productivity

[www.osterwalder.com](http://www.osterwalder.com)



**Pioneer.Partnership.Performance.**



**LARGE SCALE SINTERING OF PM PARTS**

DEBINDING - SINTERING - VACUUM CARBURIZING & QUENCHING IN A SINGLE MACHINE



**A Global Offer, One Supplier**

## Daido Steel introduces hot die steel-based powders for Additive Manufacturing

Speciality steel manufacturer Daido Steel, headquartered in Nagayo, Japan, has released hot die steel-based powders for Additive Manufacturing. DAP™-AM HTC™ (Daido Alloy Powder for Additive Manufacturing with High Thermal Conductivity) is a cobalt-free powder suitable for Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing, based on H13 steel.

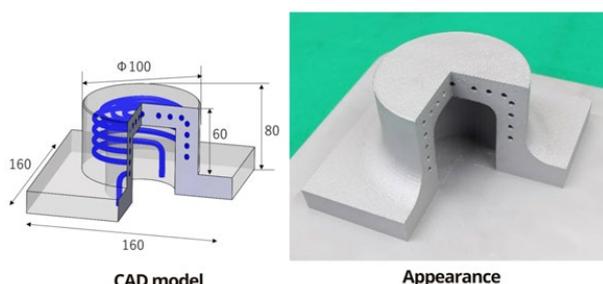
In the fields of aluminium die casting and plastic injection moulding, moulds have been additively manufactured using PBF-LB technology in order to allow more design freedom in cooling channels. Since PBF-LB uses lasers to melt and solidify metal powder in layers, thermal stresses can form in proportion to the size of the moulds.

Die steels like H13, with high hardness, are said to crack relatively easily during the Additive Manufacturing process. Another common option, maraging steel, is less likely to crack during moulding, but the thermal conductivity is lower than H13, meaning cracking may occur in the cooling channels. Another downside of maraging steel is that it contains cobalt, a substance that is regulated in Japan.

Daido Steel created DAP-AM HTC in an effort to mediate these issues. The powders are said to have conductivity 1.5 x greater than that of H13 and two times higher than maraging steel. With these attributes, DAP-AM HTC is said to contribute to shorter cycle times (due to lower mould temperatures) and improved mould lifespan (fewer heat cracks due to lessened thermal stress).

Several die-casting companies in Japan have evaluated moulds made from DAP-AM HTC and are said to have obtained favourable results. Daido Steel expects to continue the development of metal powders suitable for Additive Manufacturing machines and eventually expand the product lineup of the DAP-AM HTC series.

[www.daido.co.jp](http://www.daido.co.jp) ●●●



CAD model of an additively manufactured mould using DAP™-AM HTC40. Built with GE Additive's Concept Laser M2 machine (Courtesy Daido Steel)

# COMPACTING SOLUTIONS FOR EVERY NEED



As a result of many years in the Powder Metal field and over a century of experience in designing machinery for many industries, SACMI presses are technologically advanced yet simple, safe, and highly reliable.

**MPH** fully CNC hydraulic presses, suitable for high-speed cycles and continuous work shifts, grant extreme flexibility during the tooling and set-up stages; they offer outstanding energy efficiency and are the right choice for the compaction of multi-level parts of whatever powder.

The last-born **e-MP** full electric presses, besides their outstanding precision and productivity, find their perfect application in the hard metal market for the production of cutting tools and inserts, but also in the field of Technical Ceramics, thanks to their appreciated flexibility of operation. They can also be equipped with an integrated automation for part extraction and palletization, allowing a very easy and efficient control of the whole productive cell.

Thanks to the competences available within the Group, SACMI also supplies state-of-art furnaces for the Powder Metal Industry and versatile solutions for automation aiming at increasing output rates while ensuring maximum simplicity of operation.



# SACMI

Powder Metal Solutions



A recognized green  
technology

[www.sacmi.com](http://www.sacmi.com)

## Höganäs adds titanium powders for Additive Manufacturing

Sweden's Höganäs AB reports that it has added a range of titanium powders, specifically suitable for Additive Manufacturing applications, to its portfolio of metal powders. The new forAM® titanium-based alloys are reported to be designed for optimal performance and material efficiency in the Additive Manufacturing process.

The forAM grades available include Ti6Al4V (produced in grade 5 and grade 23) and CP-Ti (commercially pure titanium), and are reported to be suitable for Additive Manufacturing in many industry sectors.

Titanium has the highest strength-to-weight ratio of all known metals, explains Höganäs, which makes it ideal for a variety of applications, from car components to lightweight aerospace parts. It is also highly resistant to corrosion, and has high biocompatibility properties, making it well suited to customised medical implants.

In addition to its new forAM titanium powder range, Höganäs offers nickel-base and cobalt-base powders, as well as stainless steel and tool steel powders. The company also offers customer-specific grades.

[www.hoganas.com](http://www.hoganas.com) ●●●

## VBN Components names Farcco Tecnologia as Brazilian distributor

VBN Components, Uppsala, Sweden, has named Farcco Tecnologia as its distribution partner in Brazil. The collaboration will include sales representation, engineering support, and technical consulting for Vibenite® Additive Manufacturing metal powder feedstock and built parts within the Brazilian territory.

Through the partnership, Brazilian industries will now have local access to the Additive Manufacturing technology for producing what is reputedly the world's hardest steel, as well as cemented carbide Additive Manufacturing materials — the hybrid carbide Vibenite 480. Vibenite components can be produced in single units as well as in larger batches, and a customer can buy either manufacturing services or a Vibenite license to produce in-house.

"Brazilian companies are very interested in Additive Manufacturing as a pillar of industry 4.0," stated Fabio Sant' Ana, Director of Farcco. "The goal for the partnership with VBN is to give even more traction to the adoption of Additive Manufacturing through supportive resources and technical assistance, as well as the development of new products, applications, and more AM sites, making Additive Manufacturing increasingly common in Brazil."

Farcco is said to have extensive experience within the Brazilian and international Additive Manufacturing markets as a dealer for international manufacturers of Additive Manufacturing equipment and feedstock, as well as technological knowledge of the equipment and processes used for many materials. The company takes an active position in the development of new manufacturing processes by partnering with customers as well as by collaborating with national technology centres like INMETRO, HuBMA and many universities. Farcco is also an active participant of the national and international standards committees ABNT, ASTM and ISO, which establish technical and qualitative norms for Additive Manufacturing.

Johan Bäckström, CEO of VBN Components, added, "I am very glad to be partnering with such a well-established company as Farcco Tecnologia that will be able to support our customers in a good way. Brazil has many sectors that could benefit from the increased lifetime of Vibenite® components and the decreased CO<sub>2</sub> footprint that they offer, such as the energy, automotive and mining industries."

[www.vbncomponents.se](http://www.vbncomponents.se)

[www.farcco.com.br](http://www.farcco.com.br) ●●●

## Expanding the possibilities for size reduction.



**Union  
PROCESS®**

[www.unionprocess.com](http://www.unionprocess.com)

Mechanical Alloying • Flaking • Reactive Milling

## Phoenix Scientific Industries to supply HERMIGA atomiser to Elkem

Phoenix Scientific Industries Ltd (PSI), Hailsham, East Sussex, UK, has been awarded a contract to supply a HERMIGA 100/10 VI atomisation system to silicon-based advanced materials supplier Elkem SA, Oslo, Norway. The new atomiser will bring high-quality powder for research activities between Elkem and the Future Materials Norwegian Catapult Centre, a materials development and testing centre which aims to bridge the gap between the initial idea phase and pilot-scale production.

The HERMIGA 100/10 VI vacuum inert pilot series gas atomiser uses the same close-coupled die technology as PSI's production-scale systems. With unique geometry die designs, they are said to allow for consistent and reproducible production of high-quality spherical metal powders down to 10 microns median, where rapid solidification rates in the region of  $10^5$  to  $10^6$  Ksec<sup>-1</sup> are possible.

Elkem is one of the world's leading suppliers of silicon-based advanced materials, with operations throughout the entire value chain from quartz to speciality silicones, as well as speciality ferrosilicon alloys and carbon materials. With twenty-seven production sites and an extensive network of sales offices and agents around the world, Elkem has over 6000 skilled employees and significant R&D activities.

Future Materials Norwegian Catapult Centre offers a range of test facilities, competence and a professional network to develop sustainable advanced materials for existing and future product generations. It enables companies to develop, test and verify their products on an industrial scale.

[www.elkem.com](http://www.elkem.com)

[www.futurematerials.no/en](http://www.futurematerials.no/en)

[www.psiltd.co.uk](http://www.psiltd.co.uk) ●●●



Elkem SA has purchased a HERMIGA 100/10 VI atomisation system from PSI [Courtesy PSI Ltd]

GF Machining Solutions

+GF+

System 3R

## Tooling for Powder Compacting Technology

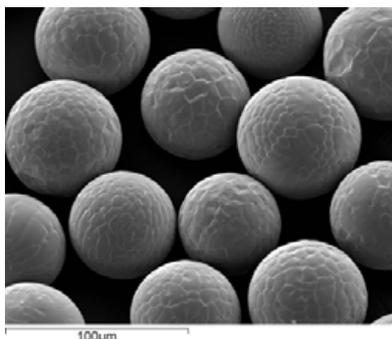
- + Simple, quick set-up
- + High accuracy
- + Low scrape rate
- + Maximal machine utilization
- + Increased productivity



GFMS, System 3R Int'l AB, Sorterargatan 1, S-162 50 Vällingby, Sweden,  
e-mail: [info.system3r@georgfischer.com](mailto:info.system3r@georgfischer.com), [www.system3r.com](http://www.system3r.com)

## Equispheres and Taiyo Nippon Sanso Corporation enter strategic partnership

Equispheres, Inc, Ottawa, Ontario, Canada, has signed a strategic partnership agreement with Taiyo Nippon Sanso Corporation (TNSC), Tokyo, Japan, which will see the companies collaborate to improve the economics and quality of additively manufactured parts in the Japanese market.



*Equispheres unique aluminium alloy powder particles magnified to 100 µm (Courtesy Equispheres Inc)*

Equispheres produces specialised powder with unique attributes for Additive Manufacturing that are said to be capable of achieving three times faster build rates than legacy aluminium powders. TNSC is a provider of gases and related welding solutions at its AM Innovation Centre.

“Their expertise in metal Additive Manufacturing, company resources and deep connections to the Japanese market will accelerate the adoption of our material in the marketplace, with an emphasis on the automotive industry,” stated Kevin Nicholds, CEO of Equispheres.

Tadaharu Watanabe, Senior General Manager of Innovation Business Division (TNSC) commented, “We are very impressed with the quality of the Equispheres powder and view it as best-in-class for its ability to print high quality parts at a reduced cost. TNSC plans to offer

the powder and our deep knowledge of its application along with our other integrated Additive Manufacturing services to better serve the AM industry in Japan.”

The relationship between the companies was established after a year-long analysis of Equispheres powder by TNSC. They plan to collaborate on R&D projects to develop enhanced applications for the powder and provide further value to the industry. Material sales and engineering support for North America and Europe will continue to be handled directly by Equispheres.

“TNSC has a history of seeking out best-in-class technology, and we’re very proud that they have added us to their Additive Manufacturing portfolio. TNSC has the skills and the knowledge to represent and support our aluminium powders, and the company is already deeply integrated with manufacturers and the automotive sector in Japan,” Nicholds concluded.

[www.equispheres.com](http://www.equispheres.com)

[www.tn-sanso.co.jp](http://www.tn-sanso.co.jp) ●●●

## Norsk Titanium targets \$150 million sales in 2026

Norsk Titanium AS, Hønefoss, Norway, has published its annual report for 2021, reporting the company’s total revenue and other operating income in the year to be \$5.3 million, up from \$1 million in 2020. Total loss before tax was \$16.1 million in 2021, compared to a loss of \$42.8 million in 2020, and net loss after tax was \$16 million, down 63% from the \$42.9 million loss in 2020. Operating costs and EBITDA operating expenses amounted to \$22 million in 2021, a 22% decrease from \$28.3 in 2020.

Norsk Titanium stated that there were two main drivers behind this decrease: the reduction of general operating expenses, including litigation expense as a result of settlement of a claim, and reduction of salary and personnel expenses as part of the organisational restructuring in 2020 necessitated by COVID-19 impacts on both its supply chain and end markets.

In total, the net change in cash and cash equivalents was \$21.3 million, and 2021 ended with a cash balance of \$22.9 million compared to \$2.2 million at the end of 2020. The cash balance at year end is expected to fund the operations through 2022, however, the company states it will continue to raise capital to fund operations to reach its long-term goals

2021 was said to have been an eventful year for Norsk Titanium. In addition to delivering parts to its commercial aerospace customers, the company expanded its product offering to the defence industry in the US and select industrial groups. It also continued to achieve 100% on-time deliveries to Tier-1 Boeing suppliers. The software development kit, RPD Builder™ is reported to be at the forefront of the company’s expansion into the industrial and defence markets, used to produce and deliver

parts for Hittech, the company’s first industrial customer, as well as parts for a US defence prime contractor.

The company stated that it will continue to raise additional capital to fund ongoing development and production activity until such time as revenue from operations can support the business and reiterates its target to generate \$150 million in sales revenues in 2026.

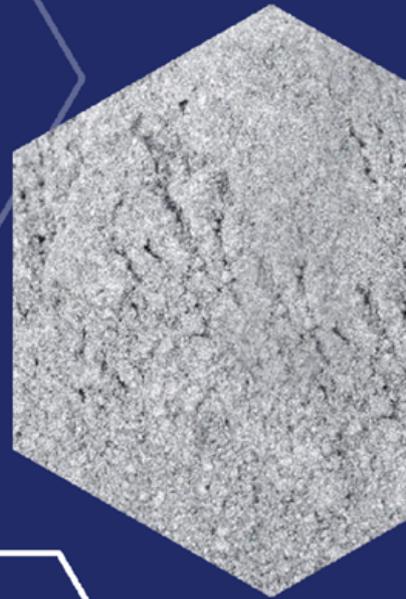
“I am immensely proud of the fact that while our growth may have slowed as a result of the global pandemic, it has never stopped,” Michael J Canario, CEO of Norsk Titanium, commented. “We proved that we are nimble as we adjusted our strategy. We ended 2021 actively working with global Tier-1 customers across industries and application complexities, all in different stages of RPD technology adoption. I am excited to see expansion of our capabilities into new markets while continuing our progress in commercial aerospace and look forward to building on these efforts in 2022 and beyond.”

[www.norsktitanium.com](http://www.norsktitanium.com) ●●●

# GLOBAL LEADERS IN ADDITIVE MANUFACTURING AND POWDER METALLURGY

---

Aluminum  
Copper  
Titanium  
Tantalum  
Niobium  
Master Alloys



**Kymera**  
INTERNATIONAL

To learn more about what we do, visit:

[www.kymerainternational.com](http://www.kymerainternational.com)  
[info@kymerainternational.com](mailto:info@kymerainternational.com)

## KIMS researchers develop rare-earth-reduced permanent magnet

Researchers from the Department of Magnetic Materials in the Powder Materials Division at the Korea Institute of Materials Science (KIMS), a government-funded research institute under the Ministry of Science and ICT, have reportedly succeeded in developing rare-earth-reduced permanent magnet that can achieve the commercial magnet (grade 42) level of performance while reducing the amount of neodymium (Nd) rare earth by approximately 30%.

In order to develop a neodymium-reduced permanent magnet, the content of cerium (Ce), an inexpensive element, has to be increased, instead of reducing the content of neodymium. Until now, with the increased content of cerium, it was not able to prevent the deterioration of the magnetic properties. The research team focused on clarifying the cause and mechanism of the deterioration of the

magnetic properties caused by the increased cerium content, and are said to have successfully solved the problem by controlling atomic-scale microstructure.

The researchers discovered that unnecessary magnetic particles were formed in the existing manufacturing process. They improved the microstructure of magnets and enhanced magnetic properties to prevent the formation of unnecessary magnetic particles by suppressing the atomic diffusion of them. They also applied the melt-spinning method and the hot-deformation method, which have very fast cooling velocity compared to the conventional process, to the manufacturing process of rare-earth-reduced precursors and permanent magnets, respectively.

As a result, they succeeded in optimising the microstructure of the magnet by suppressing the formation

of unnecessary magnetic particles. In addition, they were able to improve the residual magnetism and coercive force. As the residual magnetism and coercive force are in a trade-off relationship, the technology that improves both properties is seen as particularly useful and valuable.

Dr Kim Tae-Hoon, a senior researcher at KIMS who co-lead the research team, commented, "When the technology is commercialised, it will simultaneously solve the resource problems and material, parts, and equipment issues of the domestic rare earth permanent magnet material market. This is only the beginning. With further research in the future, we will spare no effort to lead the development of the domestic rare earth permanent magnet industry."

The results were published in *Scripta Materialia* in a paper titled 'High-performance Ce-substituted (Nd<sub>0.7</sub>Ce<sub>0.3</sub>)-Fe-B hot-deformed magnets fabricated from amorphous melt-spun powders'.

www.kims.re.kr ●●●

### Clamping, Measuring, Tooling and Multi Axial Compaction Systems Up to 1000 tons Compaction Force



ProGrit – Your global technology partner for powder compaction

ProGrit GmbH · Kastellstrasse 6 · 8623 Wetzikon / Switzerland  
Phone +4144 8445426 · [progrit@progrit.com](mailto:progrit@progrit.com) · [www.progrit.com](http://www.progrit.com)

**ProGrit**  
Innovative Production Technology

## World PM2022 Congress & Exhibition to showcase the global PM industry

The technical programme for the World PM2022 Congress & Exhibition, organised and sponsored by the European Powder Metallurgy Association (EPMA), has been published and is now available to view online. Taking place in Lyon, France, October 9–13, 2022, the international event will feature a comprehensive programme of oral and poster presentations, as well as an exhibition showcasing the latest developments from the global Powder Metallurgy supply chain.

Held in Europe once every six years, the World Congress is an essential destination for the international PM community to gather and discover the latest technology innovations, as well as meet suppliers, producers and end-users.

"World PM2022 offers a unique opportunity to share the latest trends in Powder Metallurgy. The extensive technical programme provides you access to the latest results in key PM areas and the exhibition showcases the latest developments from the global PM supply chain. On top of this, World PM2022 offers a lot of networking opportunities," stated Ralf Carlström, EPMA president.

The all-topic technical programme includes sessions covering Press & Sinter Powder Metallurgy, Metal Injection Moulding, Hot Isostatic Pressing and metal Additive Manufacturing. It also focuses on powder production technologies, materials, post processing and end-use applications.

A number of awards will also be presented during the event, including the PM Component Awards and Distinguished Service Awards, along with technical paper awards.

Early registration discount is available before September 8. [www.worldpm2022.com](http://www.worldpm2022.com)

## Hagen Symposium programme

The 40<sup>th</sup> Hagen Symposium on Powder Metallurgy, organised by the Fachverband Pulvermetallurgie (FPM), will take place in Hagen, Germany, from November 24–25, 2022. The German-language event will include presentations on a wide range of PM technologies, as well as discussions on how Powder

Metallurgy is a key technology for innovative system solutions.

The winner of this year's Skaupy Award, to be presented during the symposium, is Dr U Schleinkofer from Ceratizit Austria GmbH. In his opening Skaupy lecture, Dr Schleinkofer will discuss carbides and coatings.

In addition to the symposium, an exhibition will bring together industry suppliers and social events will offer networking opportunities.

[www.pulvermetallurgie.com](http://www.pulvermetallurgie.com)

### NOVELTY ON THE TOOL MATERIAL MARKET – DEC MATERIAL MADE BY PPC

**PPC: PULSE PLASMA COMPACTION TECHNOLOGY**  
**DEC : DIAMOND ENHANCED CARBIDE**

**DEC** is based on the latest advances in material engineering to provide toolmakers with material with **VERY HIGH WEAR RESISTANCE** and an excellent **PERFORMANCE/PRICE RATIO**.

Thanks to the enrichment of tungsten carbide with diamond, using **PPC** technology, **DEC** material **EXCEED THE LIFETIME** of conventional cemented carbide tools many times, giving way only to **PCD** tools but offering **COMPETITIVE PRICE** in return.



**GENICORE PURSUE FURTHER PPC TECHNOLOGY DEVELOPMENT WHICH CURRENTLY ASSURES:**

- DEC material continuous production method – additionally increasing performance/price ratio.
- Near net shape sintering – limiting necessary machining.
- Functionally-graded materials – designed for special applications.

Due to the wide range of possibilities for shaping **DEC** microstructure and thus its properties, the advantages of **DEC** have already been proven in many applications, including **WOODWORKING, MINING, CERAMIC PROCESSING or ROAD SURFACE MILLING**.

The project is partly funded by the European Union no POIR.01.01.01-00-0945/17 under Smart Growth Operational Programme, Measure 1.1. R&D projects of enterprises, Sub-measure 1.1.1 Industrial research and development.



**GeniCore**  
Genius of the Core

GeniCore Sp. z o.o.  
ul. Wolczynska 133, 01-919 Warsaw, Poland  
Tel/fax: +48 22 857 04 77; mobile: 506-329-231  
e-mail: [genicore@genicore.pl](mailto:genicore@genicore.pl)

[www.genicore.eu](http://www.genicore.eu)

## New metal powder atomiser in operation following Swerim and Kanthal investment

Swedish heating technology company Kanthal, part of the Sandvik Group, and metals research institute Swerim, based in Luleå, Sweden, report that their ultra-



*The atomisation unit for the production and development of metal powder (Courtesy Swerim/Kanthal/Anneli Nygård)*

modern atomising equipment designed for the production and development of metal powders is now operational following a previously announced joint investment of €2 million.

With a high degree of flexibility, the new equipment is specially designed for the research and development of both materials and the atomisation process for Additive Manufacturing and Powder Metallurgy applications. It is possible to atomise powder charges of up to 85 kg, suitable for AM, Metal Injection Moulding (MIM), surface coating and Hot Isostatic Pressing (HIP).

Swerim and Kanthal's investment is said to be a result of the increased demand for research surrounding materials and process development within Additive Manufacturing and Powder Metallurgy sectors. The partnership will see a long-term collaboration, whereby Kanthal will gain access to Swerim's expertise in Powder Metallurgy, Additive Manufac-

turing of metal products, advanced structural analysis, testing and modelling. Swerim will have the opportunity to build further on knowledge within these areas.

"This investment brings unique opportunities for customised development within Additive Manufacturing and it means that we can bring new materials to the market faster," stated Dilip Chandrasekaran, Head of R&D at Kanthal. "Cooperation with Swerim also gives us the prerequisites for conducting world-class R&D within a strategic area for Kanthal and Sweden."

Annika Ströndl, manager of powder materials and Additive Manufacturing at Swerim, commented, "It's fantastic that metals research institute Swerim and Kanthal are together investing 20 million kronor in a state-of-the-art atomiser unit. This has enabled a unique platform for R&D activities focussing on alloying and powder development for all of Sweden. The fact that we are investing together with the industry just goes to show that Swerim is an attractive research partner within powder and alloying development."

[www.kanthal.com](http://www.kanthal.com)

[www.swerim.se](http://www.swerim.se) ●●●

## Ceratizit acquires remaining shares in Stadler Metalle

Ceratizit Group, headquartered in Mamer, Luxembourg, has taken over the remaining 50% of shares in Stadler Metalle, Türkheim, Germany, becoming sole owner of the company after an initial investment in 2019. Stadler Metalle specialises in trading and processing secondary raw materials; this company was the most important supplier of these materials to Ceratizit for the production of tungsten and tungsten carbide powders.

"Stadler Metalle has become an important building block in our raw material supply chain over the

past three years, and has helped us to become independent of raw materials from China and crisis regions," stated Andreas Lackner, executive board spokesman.

The use of secondary raw materials from recycling not only helps to secure the supply chain, it is also sustainable; 75% less energy is required to use recycled cemented carbide than to process ore.

While the group does still utilise necessary primary raw materials, they are exclusively from certified western mines.

### Change in Stadler management

Thomas Wenger has taken over the management of Stadler from Managing director and founder Gabriele Stadler, who has retired alongside her husband after the successful navigation of integration with Ceratizit.

Prior to this appointment, Wenger worked in purchasing and sales at Stadler Metalle since 2010, and had previously worked for ten years in strategic purchasing at two other companies in the tungsten industry.

Both sides have agreed not to disclose the financial details of the transaction.

[www.stadler-metalle.de](http://www.stadler-metalle.de)

[www.ceratizit.com](http://www.ceratizit.com) ●●●



## Think of us as drivers education

**We've got one mission, to support as many metal part makers in the MIM and Metal AM industry as possible.**

Our team of processing experts utilize 20+ years of metal part making experience to share all our knowledge and help you overcome challenges, develop better processes and become successful metal part makers. We help develop real world, practical solutions based on many lessons learned along our journey. Being the ONLY debind and sinter service provider with full sized production equipment, we are honored that we have been able to support every industry currently utilizing MIM and Metal AM. **DSH is the only source for the best process support, toll processing and educational resource for your MIM and Metal AM applications.**

**Services offered: Remote Process Engineering, Small/Large Toll Processing, R+D projects, Educational Support on Total Process Management.**



**Your Partner in MIM/AM**

## Metal Powder Emergence offers metal powders and consultancy services

Metal Powder Emergence Ltd (MPE), headquartered in London, UK, is a recently established business providing gas atomised metal powders for Additive Manufacturing, as well as Metal Injection Moulding (MIM), Hot Isostatic Pressing (HIP) and cold/thermal spray applications.

Before founding MPE, Dr Gordon Kerr, the company's CEO, spent ten years at Phoenix Scientific Industries (PSI) where he worked with customers and collaborators developing VIM gas atomised powders for a range of applications and sectors.

"My experience over the past ten years has shown that it's possible to supply high-quality additive metal powders at a cost which is more closely aligned with the client's needs," stated Kerr.

MPE is currently working with a key business partner to provide cost-effective, high-quality metal powders

which are manufactured in accordance with ISO 9001. The powders are melted under a vacuum, which provides clean, free-flowing powders with high sphericity, vital for many AM processes.

"Generally, lead times are shorter compared to many other powder providers. All powders are re-qualified using 3<sup>rd</sup> party independent UK analytical service test houses which are also ISO 9001 compliant," added Kerr.

Established alloy powders based on aluminium, cobalt chrome, copper, titanium, nickel superalloys, stainless steels (316L, 17-4PH) are available, as well as the supply of bespoke novel alloy compositions. Technical and manufacturing consultancy is offered to assist in the development of powder alloy compositions tailored to meet clients' needs.

With a PhD in Chemistry from Heriot-Watt University in Scotland,

Kerr has played a key role in European and UK funded projects with Innovate UK, Faraday and NATEP/ATI. He has previously held Managing Director positions and delivered growth within high-technology businesses, developing and implementing strategies to address various market and customer needs, as well as driving teams to common goals.

MPE can take a product from R&D scale to full-scale production manufacturing utilising marketing and sales expertise in order to meet a range of market needs. Kerr is primarily focused on developing novel AM materials for applications such as nanotechnology, responsive and smart materials for markets such as aerospace, marine, battery applications and space exploration.

MPE recently collaborated on new projects and applied for UK grant funding with a leading UK University in Materials Science and two well-established UK organisations.

[www.metalpowderemergence.com](http://www.metalpowderemergence.com)

UPGRADE TO A  
**RELIABLE  
PUMP** WITHOUT  
REPLACING YOUR  
CURRENT SYSTEM.



**A**t NLB, we know a reliable pump is critical to keep your atomization system in operation. With 50 years of experience engineering reliable pumps up to 2,760 bar (40,000 psi). Our pumps can easily integrate into your control center using your current system and produce your ideal particle size. To further diminish down-time, NLB has parts and service nearby, ready when you are.  
**Call us today to learn more!**



**NLBCORP.COM**  
US (800) 441-5059  
Europe +44 7391 745 119

## OWL offers Hot Isostatic Pressing and Additive Manufacturing services

OWL Additive Manufacturing GmbH, Aachen, Germany, is now offering a range of Hot Isostatic Pressing (HIP), Powder Metallurgy and Additive Manufacturing services. The company was EN9100:2018 and ISO9001:2015 certified in August 2021, and works within the aerospace, motorsport, mechanical engineering and medical technology sectors.

The HIP process is used to improve a wide range of products, including castings, additively manufactured parts, near net shape parts, ceramics, Powder Metallurgy, sintered and metal injection moulded parts.

When components are treated with the HIP process, internal cavities and micro-porosities are eliminated through a combination of plastic deformation, flow and diffusion bonding of the material. The HIP process enables improved fatigue properties, greater tensile strength, higher impact strength and an overall reduction in the variation in mechanical properties.

As well as HIP services, OWL offers Additive Manufacturing services from prototypes through to serial production. It also offers FEM and topology analysis and optimisation, producing components in a wide range of metals.

[www.owl-additive-manufacturing.com](http://www.owl-additive-manufacturing.com) ●●●



OWL has developed its own HIP cycles and protocols (Courtesy OWL Additive Manufacturing)

## EPMA Young Engineers Days

Registration is now open for the European Powder Metallurgy Association's Young Engineers Days 2022, taking place October 11–12 in Lyon, France, alongside the World PM2022 Congress & Exhibition.

Aimed at helping to foster and develop the next generation of PM engineers, the programme includes lectures on Powder Metallurgy, a networking dinner, a tour of the exhibition and a site visit at INSA Lyon (Institut National des Sciences Appliquées). The event will be of particular interest to those studying a subject related to PM, such as chemical engineering, mechanical engineering, materials science, etc.

[www.youngengineers.epma.com](http://www.youngengineers.epma.com) ●●●



**Sunrock Ceramics**  
Industrial High-Temperature Solutions

2625 S. 21st Ave Broadview, IL 60155 (708) 344-7600

**Sunrock Ceramics specializes in high alumina industrial ceramics for the most severe sintering applications in the powder metallurgy and technical ceramics markets.**

**Broad product offering for the unique demands of the PM and MIM industries**

- Pusher plates for rapid cycle hydrogen atmosphere pusher furnaces
- Setter tiles and other sintering trays
  - Thin profiles
  - Specialty contoured surfaces
- Wide assortment of press tooling
- Casting available for more complex shapes

**Serving worldwide PM markets with fast turnaround**

- Products presently in service in Europe, Asia & U.S.
- Fast leadtimes reduce in-house stocking levels

**Contact us today to learn more.**  
**USA: 01 708 344 7600**  
**[dthurman@sunrockceramics.com](mailto:dthurman@sunrockceramics.com)**



**[www.SunrockCeramics.com](http://www.SunrockCeramics.com)**

## ProGrit launches multi-axial compaction system

ProGrit, Wetzikon, Switzerland, has launched a complete multi-axial compaction system intended for the economical, high-precision manufacturing of complex parts. The new system supports the production of complex geometries by cross hole, closed die, open die and split die.

The core technology is the split die with the adjustable mechanical stops in the centre of the multi-axial compaction system. These mechanical

stops are integrated into the die body and adjustable in steps of 0.001 mm from above. The die body guides the die segments and is positioned and screwed to the vertical press axis by the SCS K cones and the changeable die plate MCS C. The die segments are pressed against these mechanical stops and build the die cavity. ProGrit designs and delivers the whole powder compaction tool set for the multi-axial compaction process.



Multi-axial compaction system in fourfold and sixfold application (Courtesy ProGrit)

The adjustment of the mechanical stops can be done outside of the press on a CMM, inside the press by the measurement system MAS-xi or the usage of the upper punch. The die body with adjustable mechanical stops is available for twofold to sixfold arrangements and could be also used without these stops in a closed loop process. The movement and positioning of the die segments will be done by electrical drive units. The die segments are moved and positioned by electrical drive units. There are different sizes of electrical drive units with forces of six tons up to thirty-five tons available. The electric drive units are characterised by their compact design combined with very high forces up to thirty-five tons, positioning accuracy and piezoelectrical force measurement.

Due to the sensors inside the electrical drive units, the ideal position of the die segments will be detected by a fully automatic auto setup cycle. The electrical drive units can be integrated in any press and press control. For standalone applications, ProGrit provides complete control for the electrical drive units with all necessary software features and a small expert system for optimising the multi-axial compaction process. The connection between the axis of the electrical drive unit and the die segments is done by a quick coupling system, operated from the top.

[www.progrit.com](http://www.progrit.com) ●●●

## Ametek SMP appoints John Sinks as division vice president

Ametek Specialty Metal Products (SMP), Colleagueville, Pennsylvania, USA, has appointed John Sinks as division vice president and Business Unit Manager. In this new role, Sinks will be leading and overseeing the five Ametek SMP businesses around the world.

Sinks holds a bachelor's degree in Industrial Engineering from Purdue University in West Lafayette, Indiana, and a master's degree in Business Administration from The Kellogg School at Northwestern University

in Evanston, Illinois. He brings experience from his previous senior executive positions within the engineering and manufacturing sectors.

"Joining Ametek SMP is an exciting challenge that I am looking forward to taking on immensely," stated Sinks. "The quality metal products and talented teams within our business enable us to build on our leading reputation for high performance and excellent customer service."

Tom Matway, vice president and General Manager of the Engi-

neered Materials, Interconnect and Packaging division at Ametek, commented, "We are pleased to welcome John to the Ametek SMP team. His extensive leadership experience and technical knowledge will help drive continued growth of our business unit and secure our ongoing success around the world."

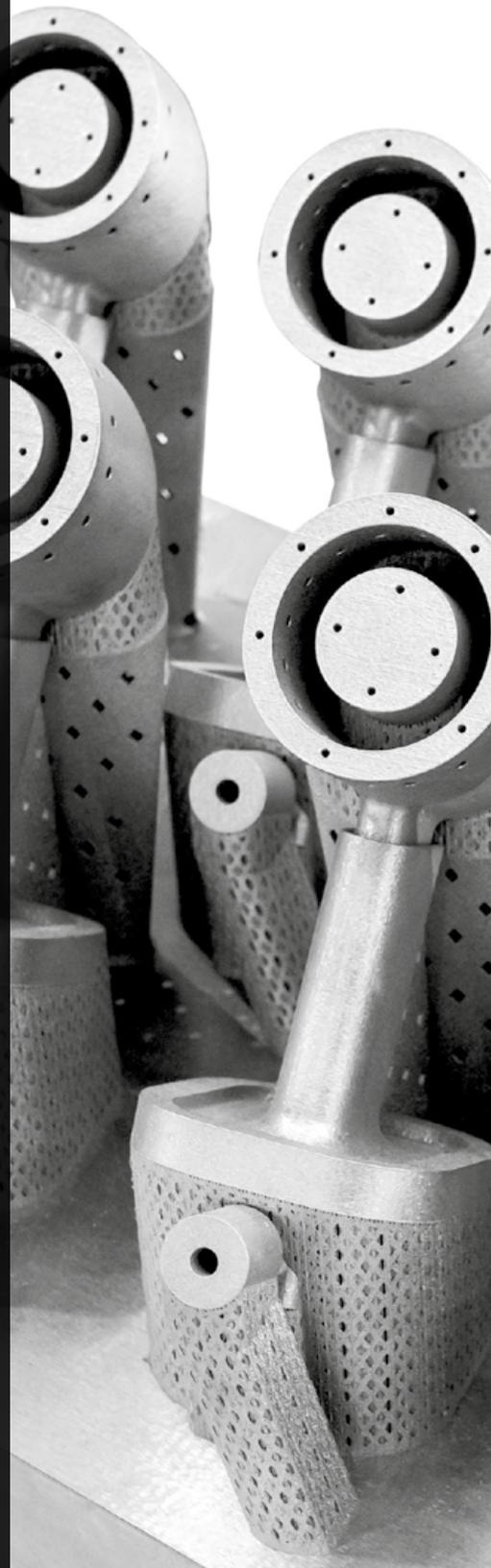
Ametek SMP is a manufacturer of speciality metal powders, precision metal tubing, high purity metal strip, ultra-thin foil, and shaped wire. The five businesses that make up Ametek SMP are Hamilton Precision Metals, Ametek Eighty Four, Ametek Wallingford, Superior Tube, and Fine Tubes.

[www.ametekmetals.com](http://www.ametekmetals.com) ●●●

# ADDING VALUE TO ADDITIVE MANUFACTURING

Bodycote provides a complete service solution for metal parts built by the additive manufacturing process, including stress relief to minimise distortion and residual stress, EDM to prepare the component for hot isostatic pressing (HIP), heat treatment or HIP to remove microporosity, and associated quality assurance testing.

- Reduction in rejection rates and inspection costs
- Fatigue properties on par with wrought material
- Significant improvement in fatigue strength, fracture toughness, and tensile ductility
- 100% reduction in porosity possible
- Improved machined surfaces and consistency in properties
- Improved microstructure



the **partner of choice** for additive manufacturing

heat treatment | metal joining | hot isostatic pressing | surface technology

[www.bodycote.com](http://www.bodycote.com)

**Bodycote**

## 6K Additive reports life cycle assessment results for AM powder production process

6K Additive, a division of 6K, headquartered in North Andover, Massachusetts, USA, has reported the results of an independent life cycle assessment (LCA) of its metal powder production process for Additive Manufacturing. The assessment was completed by sustainability and energy firm Foresight Management, Grand Rapids, Michigan, USA, and is said to be the first LCA of a powder for Additive Manufacturing ever completed.

The assessment sought to compare the quantifiable environmental impacts between traditional metal powder production methods and 6K Additive's proprietary UniMelt® process. 6K Additive states that the results show the UniMelt process significantly reduces environmental impact in the key areas of energy usage and global warming, potentially helping 6K Additive customers lower their carbon footprint using metal Additive Manufacturing.

6K Additive produces Additive Manufacturing powder made from sustainable sources and its UniMelt system is said to be the only microwave production-scale plasma with a highly uniform and precise plasma zone offering



6K Additive's LCA results show that its UniMelt metal powder production for the Additive Manufacturing process reduced environmental impact (Courtesy 6K Additive)

zero contamination. UniMelt is capable of high throughput production of advanced materials including nickel 718/625, titanium 64 grade 5/23, copper 18450/GRCop, stainless steel 316/17-4, refractories such as tungsten and tantalum.

Frank Roberts, 6K Additive president, stated, "This assessment goes a long way in revealing how the UniMelt process exceeds traditional metal powder processing in environmentally important ways, while also pointing to the inefficiencies of atomisation that currently plague AM material production. Sustainability is at the core of who we are at 6K Additive and providing our customers with quantifiable numbers related to the environment helps them move closer to zero carbon manufacturing with AM."

Foresight Management conducts life cycle assessments on products for companies to help them understand the impact their processes have on a global environmental scale. Its methodology includes primary and secondary data, as well as using professional GaBi software to provide data detailing the environmental impact of sourcing, refining, and processing.

"This is a cradle-to-end user assessment of the UniMelt technology," commented Brad Van Valkenburg, Sustainability Manager at Foresight. "We studied all known industrial processes from raw material acquisition and processing up through manufacturing and customer distribution. This assessment focused on nickel and titanium powders, both of which saw significant advantages when made using UniMelt process. The nickel results showed the UniMelt required 91% less energy and reduced carbon emissions by 92% and the titanium results showed the UniMelt, required at a minimum, 74% less energy and reduced carbon emissions by 78%."

6K Additive explains that organisations are starting to look to their suppliers to offer statistics that help them with their sustainability journey. Many companies are now asking for hard facts to back up sustainability claims and this study provides 6K Additive customers with information that may help them advance their Additive Manufacturing initiatives.

[www.6kinc.com/6k-additive/](http://www.6kinc.com/6k-additive/) ●●●

INTEGRATED  
INDUCTION  
ALLOYING  
AND ATOMIZATION  
SYSTEMS



Arcast

Arcast Atomizers are custom built and competitively priced to meet the growing demand to produce high quality, low cost, technically advanced metal powders fulfilling the requirements of today's pioneering manufacturing processes.

We can supply machines to atomize titanium alloys, super alloys, refractory and reactive metals, and ferrous and non-ferrous alloys in high vacuum purged vessels with inert gas replacement atmospheres.

We have installed machines all over the world, from 1 kg research furnaces to 1000 kg production units.

[www.arcastinc.com](http://www.arcastinc.com)

## Mott Corporation expands market reach with acquisition of ASCO Filtri

Mott Corporation, Farmington, Connecticut, USA, has acquired ASCO Filtri, headquartered in Binasco, Italy, its longtime strategic partner in Europe and a manufacturer of filtration solutions for a wide range of markets. The move is expected to expand the companies' international presence, offering the ability to manage and deliver critical filtration projects and products globally.

ASCO Filtri will operate under 'ASCO Filtri: A Mott Company' and will retain its team and locations. Ennio Michelini, Managing Director, and Massimo Mascheroni, General Manager, will join the Mott leadership team and will continue to manage ASCO Filtri business.

"Being part of Mott Corporation extends ASCO Filtri's global reach and increases the range of solu-

tions we can offer to our customers," stated Michelini. "I've known and admired Mott for many years and this formal combination is a natural evolution of our partnership to better service customers."

The combination results in a filtration and fluid control company offering an extensive material selection in key markets, including semiconductors, life sciences, clean energy, oil & gas, petrochemicals, chemicals, water purification, and aerospace & defence. Mott's expanded product selection will now include reusable and disposable porous metal, ceramic, and polymer filters, as well as a wide range of complementary offerings such as spargers, coalescers, and skids.

Boris Levin, CEO of Mott, added, "The acquisition of ASCO Filtri, our



*Mott manufactures standard sintered metal filter cartridges in a broad range of materials and sizes (Courtesy Mott/ASCO)*

long-term partner in Europe, Middle East, and Africa creates proximity to our global customers and expands our products and design capabilities. We have worked as a close partner with ASCO Filtri for quite some time and have always been impressed by the quality of their people, technical capabilities, and strong product offering – all of which are quite complementary to Mott."

[www.mottcorp.com](http://www.mottcorp.com)

[www.ascofiltri.com](http://www.ascofiltri.com) ●●●

*speed up your production*

- additive manufacturing*
- technical ceramics*
- powder metallurgy*
- hard metals*

[www.mut-jena.de](http://www.mut-jena.de)

- high vacuum, inert gas, hydrogen*
- benchmark for cleanest atmosphere*
- combined debinding & sintering furnace*
- from laboratory scale to high volume production*

**MUT** ADVANCED HEATING

## Tekna Advanced Materials achieves ISO 13485 certification

Tekna Holding AS, Sherbrooke, Quebec, Canada, has announced that its Advanced Materials division has achieved ISO 13485:2016 certification. This certification is an internationally agreed standard that outlines the requirements for a quality management system specific to the medical devices industry.

The certification process took approximately a year and involved an audit of the company's manufacturing site by Intertek Group Plc, HR practices, purchasing procedures, equipment maintenance and laboratory. The certification is valid until February 2025.

"This marks a milestone in Tekna Additive Manufacturing's advancement in the medical market, securing our position within the global medical supply chain as a supplier of safe, high-quality powders for medical devices, such as implants and X-ray collimators," stated Luc Dionne, CEO, Tekna. "We're very proud of our team for successfully completing the rigorous process to receive ISO 13485:2016. This designation is a testament to the high standards and commitment to quality all the way through the Tekna organisation."

Material sales to the medical sector were said to have represented

10% of the total material sales of Additive Manufacturing in the fourth quarter of 2021, and the growth rates are forecast to accelerate in 2022.

"We see that the medical sector is steadily recovering from the COVID-19 pandemic. It is an important industrial sector for Tekna and we expect the ISO 13485 Certification to accelerate our market penetration by facilitating our product qualification, providing further momentum in a favourable market environment," Dionne added.

Currently, Tekna is in the process of obtaining ISO 17025 Certification for its testing laboratory in order to prepare for Nadcap certification later this year.

[www.tekna.com](http://www.tekna.com) ●●●

## IperionX & MRL partner for domestic US titanium powder supply

Titanium metal powder provider IperionX Ltd, Charlotte, North Carolina, USA, has entered into an agreement with Materials Resources (MRL), Dayton, Ohio, to qualify and demonstrate the performance of IperionX's Ti6Al4V powders for aerospace parts produced by Additive Manufacturing. This testing will take place under an MRL project with the US Navy to test titanium flight-critical metal replacement components for the US Department of Defense (DoD).

Currently, the US is entirely import reliant for the production of primary titanium metal (titanium sponge). Given the lack of domestic production capacity, and that the US no longer maintains titanium sponge in the National Defense Stockpile, downstream titanium producers are almost entirely dependent on non-US sources of titanium. This presents the possibility that, in a national emergency, US production of titanium components would be curtailed as a result of being denied access to imports of titanium sponge.

To date, only Japan, Russia and Kazakhstan have titanium sponge plants certified to produce aero-

space rotating-quality sponge that can be used for aerospace engine parts and other sensitive aerospace applications, with Russian company VSMPO-AVISMA being the largest titanium supplier for parts used on Boeing 737, 767, 787, 777 and 777X aeroplanes.

Ayman Salem, MRL's founder and CEO, stated, "Having a domestic supplier of titanium alloys for Additive Manufacturing can address a major challenge in the supply chain. Demonstrating the repeatability and reproducibility of properties in flight-critical components will close the loop from powder to fatigue performance. The planned use of MRL's integrated computational adaptive Additive Manufacturing (iCAAM) tools, machine learning, and in-situ NDE sensors will produce crucial information on the behaviour of the material while keeping records of the pedigree for use in the qualification process."

IperionX supplies titanium powders from its fully operational pilot facility in Utah.

[www.icmrl.net](http://www.icmrl.net)

[www.iperionx.com](http://www.iperionx.com) ●●●

## Short course on Atomisation for Metal Powders to return in October

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

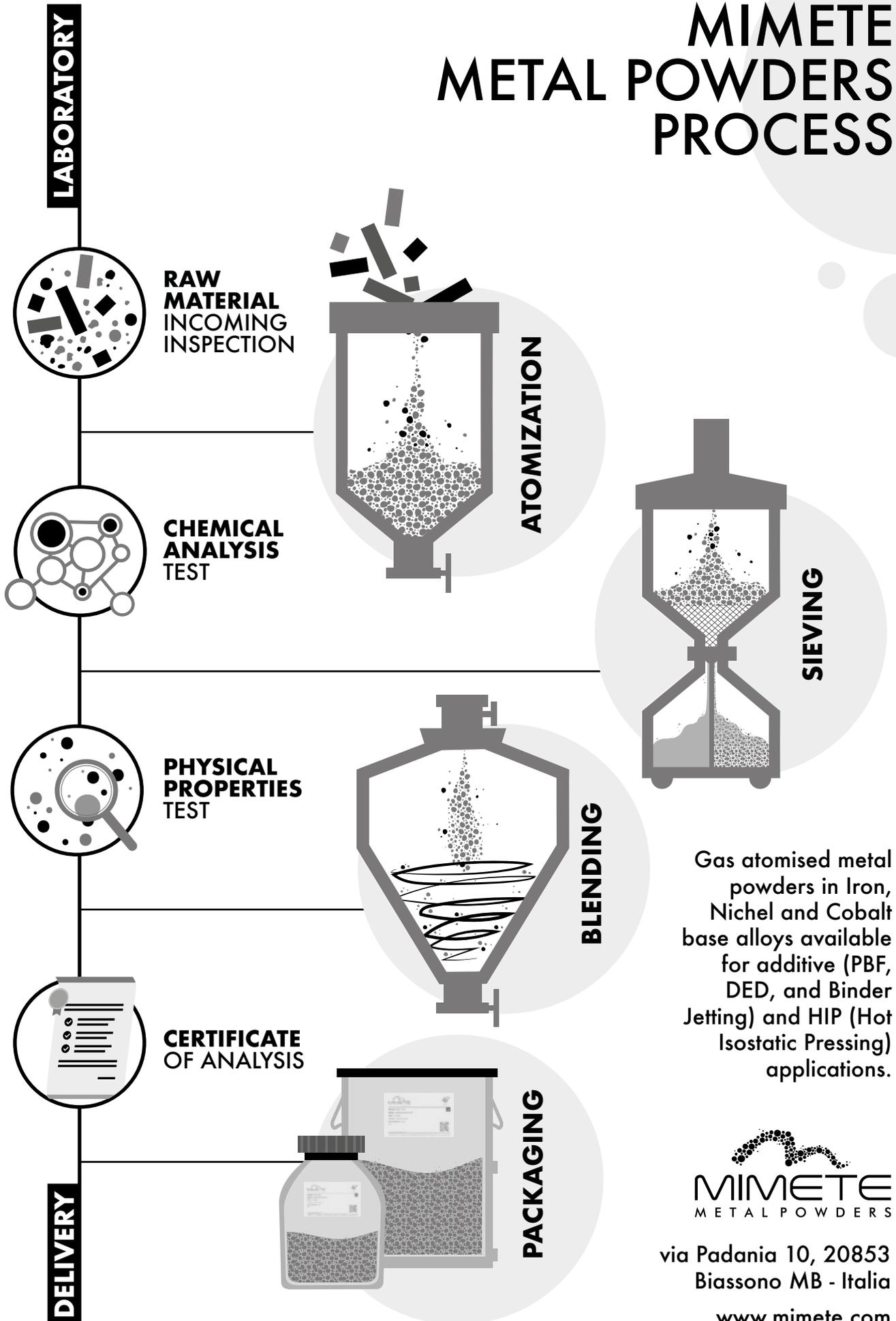
The two-day course will consist of presentations from Atomising Systems' John Dunkley, Chairman; Dirk Aderhold, Technical Director and Tom Williamson, Research & Development Manager, as well as Andrew Yule, Emeritus Professor at the University of Manchester.

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

[www.atomising.co.uk](http://www.atomising.co.uk)

[www.cpfresearch.com](http://www.cpfresearch.com) ●●●

# MIMETE METAL POWDERS PROCESS



Gas atomised metal powders in Iron, Nichel and Cobalt base alloys available for additive (PBF, DED, and Binder Jetting) and HIP (Hot Isostatic Pressing) applications.

**MIMETE**  
METAL POWDERS

via Padania 10, 20853  
Biassono MB - Italia

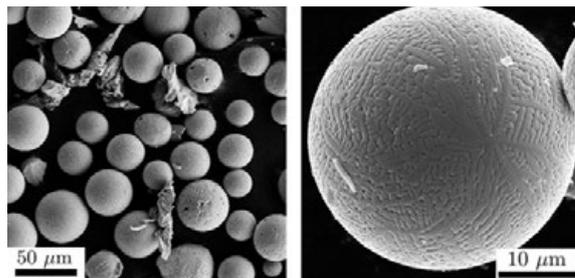
[www.mimete.com](http://www.mimete.com)

## Researchers develop abrasion-based process for producing metal powders for AM

A team of researchers at the Indian Institute of Science (IISc), led by Koushik Viswanathan, Assistant Professor at the Department of Mechanical Engineering, have reportedly identified an alternative technique to produce metal powders for Additive Manufacturing by using an abrasion-based process.

Metal powders used for Additive Manufacturing are predominantly produced using atomisation. However, despite its widespread use, explains the IISc researchers, atomisation returns poor yield, is relatively expensive and limited in the types of materials. The alternative technique developed by the researchers is said to side-step these problems.

In the metal grinding industry, the material removed - known as swarf - is often discarded as a waste product. It is commonly stringy in shape, like metal chips, but can also include perfectly spherical particles. Scientists have long theorised that these particles go through a melting process, which results in the spherical shape. But this raises some interesting questions, such as whether the heat from the grinding causes the melting, or if there is actually any melting at all?



SEM of metal powders produced using the abrasion-based process, showing distribution of powder sizes (left). The typical single powder particle (right) is approximately 30-50 µm in diameter (Courtesy Laboratory for Advanced Manufacturing & Finishing Processes (LAMFiP), IISc)

Viswanathan’s team has shown that these powder metal particles do indeed form as a result of melting due to high heat from oxidation, in an exothermic reaction at the surface layer. The team refined this process to produce large quantities of spherical powders, which are further processed to be used as stock material in Additive Manufacturing. The study is said to illustrate that these powder particles perform just as well as commercial gas atomised powders, when used in metal Additive Manufacturing.

Priti Ranjan Panda, a PhD student at IISc’s Centre for Product Design and Manufacturing and one of the authors of the study, commented, “We have an alternative, more economical and inherently scalable route for making metal powders, and the quality of the final powders appear to be very competitive when compared with conventional gas atomised powders.”

Regarding the applications of their findings, Viswanathan added, “There has been significant recent interest in adopting metal AM because, by nature, it enables significant customisation and allows design freedom. However, the large cost of stock metal powders has been the stumbling block. We hope that our work will open new doors to making cheaper and more accessible metal powders.”

Harish Singh Dhama, a PhD student at the Department of Mechanical Engineering and co-author of this study, noted, “Reducing the cost of the AM process (via economical powders) can widen the range of materials in situations such as manufacturing of biomedical implants, which could become cheaper and more accessible.”

The researchers reported that making metal powder using abrasion also has potential in other high-performance applications such as in aircraft engines, where a high degree of specification is required.

The full paper titled ‘Production of powders for metal Additive Manufacturing applications using surface grinding’, by Harish Singh Dhama, Priti Ranjan Panda, and Koushik Viswanathan, was published in *Manufacturing Letters*, Volume 32, 2022, ISSN 2213-8463

iisc.ac.in ●●●

**Failure Analysis**  
**Materials Characterization**  
**Materials Testing**  
**Materials Selection and Application**  
**New Process Development**  
**New Materials Development**  
**Process Improvement and Optimization**  
**Establish Materials Laboratories**  
**Establish Heat Treat and Other Processing Plants**  
**Materials Training and Technical Document Preparation**

[www.ecomatech.com](http://www.ecomatech.com)

**Dr. R.K. Viswanadham (Vis)**  
 Owner  
 Houston, Texas  
 Ph: 832-523-1056  
 Email: rkvis@ecomatech.com

## Tekna releases 2021 annual report, sees 22% growth in revenue

Tekna Holding AS, Sherbrooke, Quebec, Canada, has released its 2021 annual report, recording revenue of CAD \$26.8 million, up from CAD \$22 million in 2020, representing a 22% growth.

Luc Dionne, CEO of Tekna, commented, "2021 was a transformational year for Tekna Holding, marked by the listing of the company, major contracts awarded by industry-leading international companies such as LG Chem and Airbus, and the initiation of a multi-million-dollar capacity increase programme to deliver on accelerating growth. We closed the year with a record-high order intake of CAD 20 million, which provides us with great momentum going into the new year."

EBITDA was CAD -\$8.7 million compared with CAD \$0.3 million in 2020. Adjusted EBITDA net of non-

recurring charges was CAD -\$4.6 million in 2021 compared to CAD \$2.2 million in 2020. Tekna had a loss for the period of CAD \$14.1 million, compared to a loss of CAD \$5.3 million in 2020. Profit from continuing operations in 2021 was CAD -\$12.5 million (CAD -\$8.3 million adjusted for non-recurring expenses) compared to CAD -\$2.9 million in 2020.

Net cash from operating activities was CAD -\$13.9 million in 2021, compared with CAD \$1.8 million in 2020, with higher operating costs and non-recurring charges being the main contributors. Net cash used for investing activities in 2021 was CAD \$28.4 million, reflecting the purchase of shares in subsidiaries and investments in property, plant and equipment as well as intangible assets. Net cash from financing activities is mainly related to the issue

of new shares and repayment of debt owed to a shareholder.

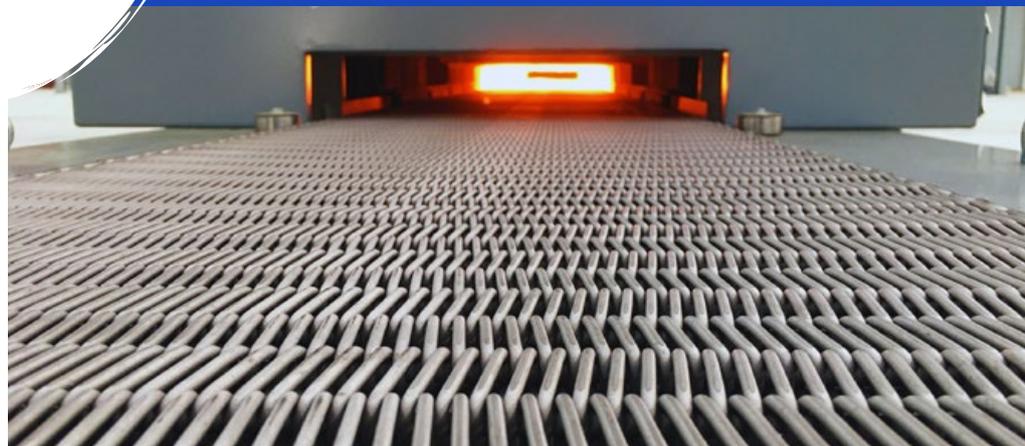
"Taken together, the events of 2021 marked the start of a new and exciting chapter for Tekna, propelling us forward in our vision of taking a leadership position in three multi-billion-dollar markets: Additive Manufacturing, Printed Electronics and Energy Storage," Dionne added. "We will do so while stepping up our sustainability efforts. To this end, we have produced our first sustainability report. The report describes our approach and performance on our most material environmental, social and governance issues for the 2021 financial year. It is an important step in making our work on sustainability more transparent, in line with reporting standards, and more importantly, relevant to the world."

The company also published its 2021 Sustainability Report. Both reports are available via the company website.

[www.tekna.com](http://www.tekna.com)



LOOKING TO EXTEND THE LIFE OF YOUR WIRE BELTS?



+ 34 938 01 15 40

info@codinametal.com

www.codinametal.com

YOUR MESH BELT GLOBAL SUPPLIER



St. Joan Baptista, 57  
08789 La Torre de Claramunt  
Barcelona, Spain

## Gränges launches low CTE aluminium alloy powder for aerospace and automotive applications

Gränges Powder Metallurgy, headquartered in Stockholm, Sweden, has launched its first aluminium alloy for Laser Beam Powder Bed Fusion (PBF-LB) Additive Manufacturing, the S220 AM from its DISPAL® family of high-performance aluminium. The alloy's properties are said to be comparable to steel, but at a third of its weight, making it well suited to industries such as aerospace and automotive.

The S220 AM alloy has a high silicon content, characterised by low density and low coefficient of thermal expansion (CTE). Due to the fine silicon particles being evenly distributed in the matrix structure, the material is said to possess good wear and friction properties.

"I am not aware of any other alloy on the AM market that has such a low CTE," stated Greta D'Angelo, Business Development Manager at Gränges Powder Metallurgy. "In the past, we had many success stories of customers



Gränges Powder Metallurgy has entered into the Additive Manufacturing market with its S220 AM (Courtesy Gränges Powder Metallurgy)

replacing steel and carbon fibre applications with the conventional DISPAL S220. Now, we are excited to offer the same material for Additive Manufacturing, giving our customers the opportunity to take advantage of even more geometrical freedom in the design of their next-generation products."

A low CTE is said to be crucial in applications that require extreme precision under high loads and high temperatures, such as linear technology and robotics. It is also a critical attribute in optical applications in the space industry, where a low CTE helps enable high precision communication at large distances.

Gränges Powder Metallurgy has experience in manufacturing aluminium powders that goes back over thirty years. The DISPAL S220 material was invented and commercialised in the 1980s as part of a larger family of alloys, so while the material itself is not new, its use in Additive Manufacturing marks the company's entrance into the technology.

DISPAL S220 AM powder is currently not commercially available, however Gränges offers an Additive Manufacturing service via a global network of trusted partners. The service is not limited to the manufacturing of the components, but also offers support with part selection, development, engineering and quality assurance.

"We want to support our customers through the whole process, and deliver finished components of high quality, be that prototypes or serial production," D'Angelo continued. "We are aware that onboarding a new material can be a daunting process, especially for a new technology like AM, therefore we take care of that part for our customers so that they don't have to worry about it."

Gränges Powder Metallurgy is working to develop a wide portfolio of both Additive Manufacturing aluminium powders and specialised additively manufactured aluminium alloys. More alloys are already reported to be in the pipeline, and are expected to be released before the end of the year.

[www.granges.com/additive](http://www.granges.com/additive) ●●●

**ALPHIE®**  
3D Tumbler Mixer  
ISO 9001:2015 Certified Company

MADE  
IN  
INDIA

### Highest Mixing Homogeneity

For PM, MIM & Metal Powder Applications




- Fixed / Removable Mixing Drum Design
- Available from 3 Ltr to 3000 Ltr
- Customers in 37 countries
- Mixing without blade / agitator shaft



**HEXAGON PRODUCT DEVELOPMENT PVT LTD**

☎ +91 92271 27517 ✉ [info@alphiemixer.com](mailto:info@alphiemixer.com) 🌐 [www.alphiemixer.com](http://www.alphiemixer.com)



AMERICAN ISOSTATIC PRESSES, INC.

WWW.AIPHIP.COM  
1-800-375-7108

SERVING THE WORLD  
**HOT ISOSTATIC PRESSING  
EQUIPMENT & SERVICES**

**5** LOCATIONS USA & EUROPE



**100+**

APPLICATIONS, MATERIALS, AND INDUSTRIES FOR ISOSTATIC PRESSING

Additive Manufacturing

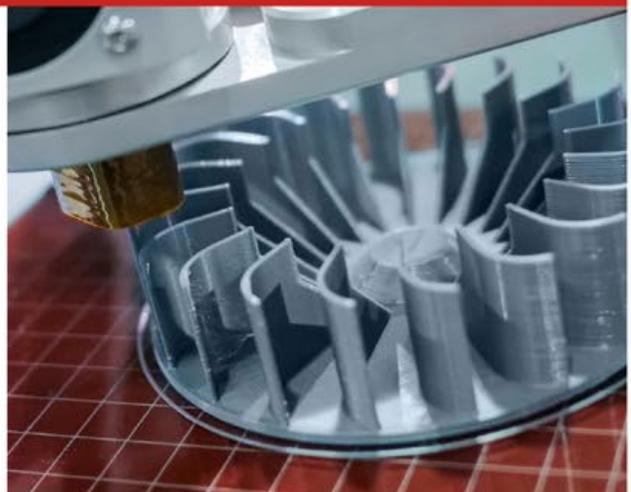
Aerospace & Turbines

Medical Parts

Oil & Gas Drilling, MIM

## OUR BUSINESS

is a network of companies with 25+ years in the isostatic pressing industry. We design and manufacture research and full scale production units. In addition, we run our own units in service of the production and research hot isostatic pressing markets.



## Uniformity Labs releases Ti64 Grade 23 titanium alloy powder

Uniformity Labs, Fremont, California, USA, has released its new titanium alloy Ti-6Al-4V powder for Laser Beam Powder



*Ti64 offers a high strength-to-weight ratio and is ideal for high-performance applications (Courtesy Uniformity Labs)*

Bed Fusion (PBF-LB) Additive Manufacturing. The material offers a high strength-to-weight ratio and is biocompatible, making it ideal for medical and high-performance applications, including performance automotive and aerospace components.

Ti64 Grade 23 is an alloy of titanium, aluminium, and vanadium, said to exhibit best-in-class mechanical performance, surface roughness, and uniformity across the build bed, in parallel with greatly improved throughput. Typical builds are reported to deliver an average of 99.96% density in the as-printed state and are 1.5 x to 2 x faster, depending on machine and part geometry, as compared to the same builds performed at the same layer thickness using

standard powder and machine parameters.

“The application of Uniformity Ti64 Grade 23 delivers material properties excellence and repeatability for our customers who require parts that perform to the highest standard in extreme conditions,” stated Uniformity founder and CEO, Adam Hopkins. “Our powders deliver robust mechanical properties, low surface roughness, and high print yield, in addition to substantially increasing machine throughput.”

The availability of this powder follows the recent announcement of a Uniformity collaboration with AddUp, targeted to maximise the productivity of Uniformity’s Ti64 Grade 23 ELI alloy using AddUp’s FormUp350 PBF-LB AM machine. This partnership targets regulated healthcare and aerospace production using metal Additive Manufacturing technologies.

[www.uniformitylabs.com](http://www.uniformitylabs.com) ●●●

## SAS Sinterizzati obtains IATF certification

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

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

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

[www.sassinterizzati.com](http://www.sassinterizzati.com) ●●●

## Almonty collaborates with South Korean government to strengthen rare earth supply

Almonty Industries Inc, headquartered in Toronto, Canada, has signed a Memorandum of Understanding (MoU) with Korean Mine Rehabilitation and Resource Corporation (KOMIR) and rare metal recycler Hannae For T Co, Ltd, in an effort to strengthen the South Korean domestic supply chain through the joint promotion of rare metals recycling (e.g., tungsten and molybdenum).

KOMIR is the government agency responsible for national resource security, including developing overseas mining and processing capacity to supply the Korean market. One of the organisation’s strategic objectives is to upgrade the country’s access to critical minerals. This will be supported by Hannae, which has developed proprietary technology to extract metals such as tungsten, vanadium, and titanium from waste SCR catalysts.

“Security of supply by global leading economies of strategic and

rare metals such as tungsten has been a theme that has grown in importance over recent years,” stated Lewis Black, president and CEO, Almonty. “More than 83% of the supply of tungsten is produced by China. Once our flagship Sang-dong Tungsten Mine is in production from late 2022/early 2023, it will be the largest tungsten mine outside of China. Given South Korea is the largest per-capita user of tungsten globally, it is no surprise that KOMIR, the Korean Government Agency responsible for national resource security – and other global leading companies such as Hannae – are keen to work with Almonty.”

The MoU will remain in effect for two years and can be extended by agreement between the parties before the expiration. The agreement can be terminated by notifying the other party.

[www.almonty.com](http://www.almonty.com) ●●●



## YK05A/KD10A-NEWLY DEVELOPED GRADES OF CEMENTED CARBIDE SPHERICAL BUTTONS FOR HIGH AIR PRESSURE DTH BITS

### 1. Definition and application

Through the application of Nanoparticle Enhancement Technology, the YK05A/KD10A grade is improved by 30% in comprehensive performance on the basis of YK05. It's suitable for high air pressure cemented carbide spherical buttons products for rock drilling in ultra-hard rock formations with rock formation hardness of f15-20. 2.

### 2. Core technology and solving key problems of customers

The YK05A/KD10A grade is an upgraded version of the YK05 grade, which improves the wear resistance by 20% and the fracture toughness by 10% on the basis of YK05. It can cope with mining tasks under various complex geological environment conditions, and can solve the key problem of carbide buttons crushing in the customer's excavation process.

Grade	Co %	Density (g/cm <sup>3</sup> )	Hardness (HV30)
YK05A	6	14.90	1520
KD10A	6	14.92	1580
YK05	6	14.90	1440

Recommended specifications: Cemented carbide spherical buttons with a diameter of Φ10 or more.

The service life is 30% higher than that of YK05.

- a. KD10A recommended application areas - High Air Pressure DTH Bits!
- b. YK05A recommended application areas - Extra Large Diameter DTH Hammer Gauge Buttons.

### BRIEF INTRODUCTION OF SURFACE TREATED MINING TRI-CONE DRILL BITS CARBIDE BUTTONS GRADE

Grade	Co %	Density (g/cm <sup>3</sup> )	Hardness (HVA)
KD30A	10	14.50	89.2
KD40E 1	10	14.49	88.2

Recommended Applications: Apply to carbide buttons for mining tri-cone drill bits with high wear resistance and high toughness requirements



## Zhuzhou Cemented Carbide Works Import & Export Company

ADD: 4/5F Diamond Building, Diamond Road, Hetang District Zhuzhou Hunan China 412000

Phone: +86-731-22968649 / 28264123 +86-731-28264007 / 28265206

E-mail: [zccc@chinacarbide.com](mailto:zccc@chinacarbide.com)

Website: [www.chinacarbide.com](http://www.chinacarbide.com)



**Phoenix  
Scientific  
Industries Ltd**

**Advanced Process Solutions**

## High throughput **ContiPour®** gas atomisation systems

For the  
production of  
metal powders



PSI provide  
excellence in rapid  
solidification systems  
to the worldwide AM,  
SLM, HIP and the  
renewables industries



**PSI Limited - Apex Business Park  
Hailsham - East Sussex - BN27 3JU - UK  
Tel: +44 (0)1323 449001  
info@psiltd.co.uk - www.psiltd.co.uk**

## Elmet Technologies expands scope of accredited practices

Elmet Technologies Inc, Lewiston, Maine, USA, reports that it has expanded the scope of its accredited practices at its analytical laboratory, having gained A2LA-accreditation for technical competence in the field of mechanical testing.

In addition to the A2LA-accreditation, this lab is also accredited in accordance with the recognised International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories. This demonstrates technical competence for a defined scope and the operation of a laboratory quality management system.

The lab's accredited practices have included tensile testing, density testing, hardness testing (Rockwell and Vickers

microhardness), as well as microstructure analysis and grain size measurements. Practices now covered by the ISO 17025 scope include chemical composition analyses using optical emission spectroscopy (ICP-OES) and carbon & gas analysis in metals using combustion analysis.

Elmet Technologies is a global leader in high-performance tungsten and molybdenum refractory metal product manufacturing and machining services. Its refractory metals expertise covers a range of pure metals (W and Mo) and alloys (TZM, MoLa, MoTa, WHA, WK, HCT) and serves a number of industries including defence, lighting, electronics, semiconductor, thin-film, automotive, aircraft and medical.

[www.elmettechnologies.com](http://www.elmettechnologies.com) ●●●

## Pometon showcases its iron-base powders for brake applications

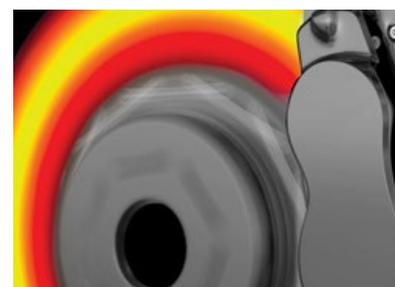
Pometon S.p.A., headquartered in Maerne, Venice, Italy, showcased its range of iron-base alloy powders for brake applications at EuroBrake 2022, which took place May 17–19. Organised by Fisita, the event included over ninety technical presentations, panel discussions and keynote presentations addressing braking technology.

During EuroBrake, Pometon highlighted its Brakealloy iron-base alloy powders, developed through a multi-year R&D programme in collaboration with brake pad producers and research centres. The range of materials is designed for Cu-free brake pads and shares a common basic concept but different thermomechanical properties.

This translates into distinct behaviours during braking action, reportedly enabling more optimised performance and comfort.

The water atomised iron powders are currently available in three compositions. Brakealloy Z is an alloy of iron and zinc, Brakealloy S is an alloy of iron and tin and Brakealloy SB is an iron, tin and bismuth (Sn/Bi) alloy. All are suited to both organic and sintered brake applications.

[www.pometon.com](http://www.pometon.com) ●●●



*Metal powder is used in brakepads and clutch discs in order to optimise the friction coefficient and thermal dispersion [Courtesy Pometon]*

## Schunk develops quiet Powder Metallurgy gears for e-mobility

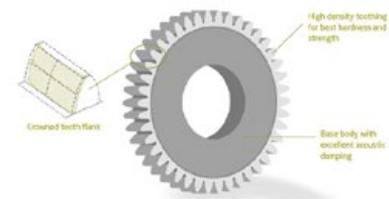
The Schunk Group, headquartered in Heuchelheim, Germany, reports it has developed a new Powder Metallurgy process that produces gears with a noise dampening effect, whilst reducing weight and cost. This process is discussed in more detail in the white paper, 'Silent Gears – low-noise gears for quiet e-mobility,' published on Schunk's website, explaining how customers can benefit from the material, design and production advantages of its Powder Metallurgy gear process.

"Our process offers the unique possibility of combining several – normally incompatible – properties in one gear," stated Johannes Heyde, Project Manager – Innovation at Schunk Group. "The result is components that have different properties in terms of geometry and material in different

areas. For example, a very hard and strong toothing area to reduce wear, and a main body with excellent damping behaviour."

The new process utilises the porous structure of the Powder Metallurgy gear to dampen sound and produce less noise. Heyde stated that while there can be concerns from customers about the resultant gears' strength, studies are said to have shown that Schunk's post-compaction process stage results in materials that equal the strength of conventionally forged materials.

When compared to conventional manufacturing, and dependent on size and complexity, the process is reported to be profitable for volumes of around 30,000 for large parts, or around 100,000 for smaller parts. Parts can weigh as little as a few grams and can range in diameter from 5-300 mm.



Schunk's noise-dampening PM gear production process (Courtesy Schunk Group)

"With our manufacturing process, we consume 60% less energy overall," Heyde added. "This makes Powder Metallurgy one of the green technologies, because we don't have to use any primary raw materials for powder production. In addition, we use almost 100% of the material, because no more chips are produced, as is the case with subsequent mechanical processing. As a result of the efficiency of the entire process, not only do our customers benefit from performance-enhanced quiet gears, but so does the environment."

[www.schunk-group.com](http://www.schunk-group.com)

## MESH BELT SINTERING FURNACES

+ SINTER HARDENING



info@fluidtherm.com

## Fredrik Spens named president of Gränges Europe

Aluminium technology company Gränges, headquartered in Stockholm, Sweden, has announced Fredrik Spens as its new president for Gränges Europe, as well as member of Gränges' Group Management Team. Spens succeeds Jörgen Rosengren, who held the position on an interim basis.

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

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

[www.granges.com](http://www.granges.com) ●●●

## Ipsen appoints Navid Gamerschlag to Vacuum Furnace Sales Management

Ipsen USA, Cherry Valley, Illinois, USA, has announced that Navid Gamerschlag will be acting in the role of European Sales Manager – Vacuum Technology. Based out of Cologne, Germany, Gamerschlag will be responsible for promoting Ipsen vacuum equipment within Europe. He will work alongside Ipsen's European based sales representatives to bolster vacuum furnace sales and support.

Gamerschlag was most recently the Sales Manager for a global manufacturer of induction heat-treating equipment. Prior to that, he served as Regional Sales Manager for Ipsen Germany, where he was responsible for promoting Ipsen products and services in multiple international regions. He holds a Dipl-Ing in Mechanical Engineering from the University of Applied Sciences, Cologne.

"We are excited to welcome Navid back in this important sales management role," stated Patrick McKenna, president and CEO of Ipsen USA, Ipsen's Vacuum Technology Excellence Center. "With global demand for Ipsen furnaces continuing to accelerate, his return to Ipsen comes at an ideal time."

Gamerschlag added, "Being back at Ipsen feels like coming home to family. I am looking forward to collaborating with my colleagues with a big focus on customer-centricity – this means continuing to build relationships with our customers and earning new business. We can best serve our customers by understanding their needs and use that feedback to drive our products and service offerings."

[www.ipsenusa.com](http://www.ipsenusa.com) ●●●

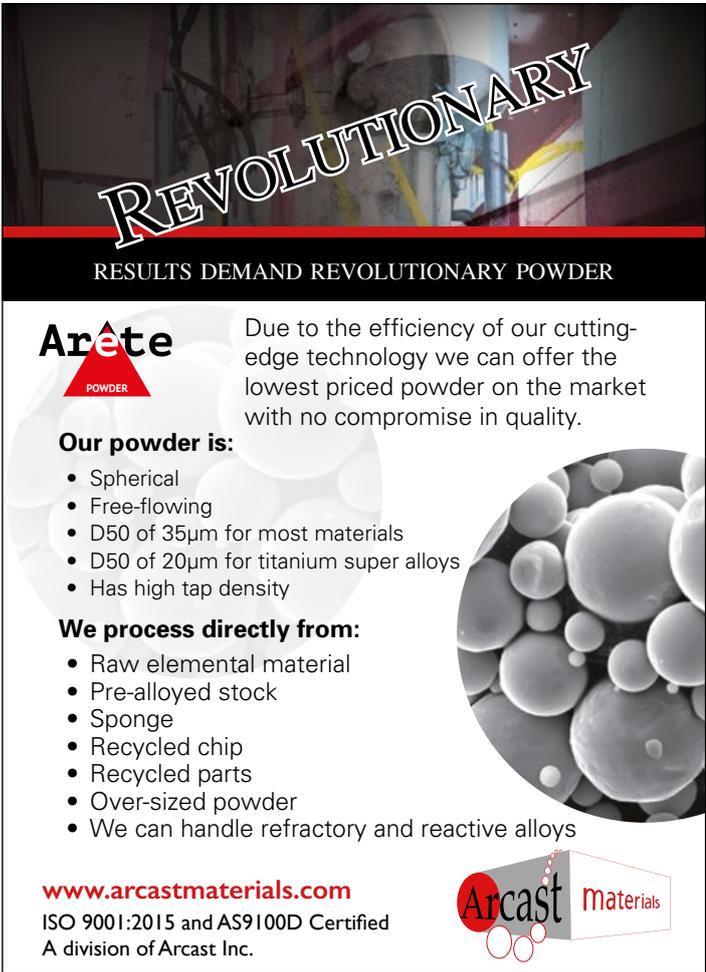
## Lauffer confirms dates for its technology forum

Marking the company's 150<sup>th</sup> anniversary, Maschinenfabrik Lauffer GmbH & Co. KG, Horb, Germany, has announced that its Technology Forum @ Lauffer Pressen is scheduled to take place on September 21–22, 2022, at its facility in Horb.

As part of the forum, the company intends to present developments from all of its business areas, including powder, laminating & forming technologies and plastics & transfer moulding. In an accompanying series of lectures, with leading industrial partners from the metal and electrical industry, relevant topics will include the transformation in the automotive industry and the digitisation of business and products, as well as the pursuit of more energy efficiency and emission reduction.

During the two-day event, the company's entire sales and service team will be on-site for questions.

[www.lauffer.de](http://www.lauffer.de) ●●●



**REVOLUTIONARY**

RESULTS DEMAND REVOLUTIONARY POWDER

**Arête**  
POWDER

Due to the efficiency of our cutting-edge technology we can offer the lowest priced powder on the market with no compromise in quality.

**Our powder is:**

- Spherical
- Free-flowing
- D50 of 35µm for most materials
- D50 of 20µm for titanium super alloys
- Has high tap density

**We process directly from:**

- Raw elemental material
- Pre-alloyed stock
- Sponge
- Recycled chip
- Recycled parts
- Over-sized powder
- We can handle refractory and reactive alloys

[www.arcastmaterials.com](http://www.arcastmaterials.com)  
ISO 9001:2015 and AS9100D Certified  
A division of Arcast Inc.

**Arcast** materials

## Fraunhofer IFAM names Prof Thomas Weissgärber as its new director

Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Dresden, Germany, has appointed Prof Dr-Ing Thomas Weissgärber as its new director. Since April 1, Prof Weissgärber also holds the professorship of Powder Metallurgy at the Institute of Materials Science in the Faculty of Mechanical Engineering at Technische Universität Dresden.

Prof Weissgärber has been associated with the Dresden site of Fraunhofer IFAM for many years. During his career as a group and department head, as well as deputy and most recently interim head of the institute, he has conducted research in various areas of Powder Metallurgy. Within his work at the Innovation Center Additive Manufacturing (ICAM), he has established a knowledge base in the field of

powder-based Additive Manufacturing.

"Fraunhofer IFAM is one of Europe's most important independent research institutes in the fields of adhesive technology, surfaces, shaping and functional materials. Its products and technologies primarily address industries of particular importance for the future viability of the economy, including energy technology, mobility and life sciences," stated Prof Reimund Neugebauer, President of the Fraunhofer-Gesellschaft. "I am extremely pleased that Prof Thomas Weissgärber is now at the helm. He is a long-standing leader who has made a significant contribution to developing Fraunhofer IFAM into one of the leading applied research institutes in the field of powder metallurgical technologies and materials."

For a number of years, Prof Weissgärber has been helping to establish a close link between science and applied research, holding lectures on the topics of materials in energy technology, Powder Metallurgy and sintered materials, as well as thermophysical properties and high-temperature behaviour. Through the professorship for Powder Metallurgy, Sintering and Composite Materials at TU Dresden, he intends to further strengthen this alliance in the future.

"I consider my new role as a motivation to continue to develop and expand existing competences at Fraunhofer IFAM, and, together with my team, to use the excellent know-how, particularly in materials, Powder Metallurgy and Additive Manufacturing for innovative, future-proof developments in order to generate optimum solutions in core areas such as energy technology, mobility and medical technology," stated Weissgärber.

[www.ifam.fraunhofer.de](http://www.ifam.fraunhofer.de) ●●●

## HIGH TEMPERATURE PUSHER SINTERING FURNACES



also...  
WIRE MESH BELT  
WALKING BEAM



[info@fluidtherm.com](mailto:info@fluidtherm.com)

PM  
MIM  
HEAVY & HARD METAL

## SCREAM project to establish recycled rare earth source for sintered magnets

The Secure Critical Rare Earth Magnets (SCREAM) project is a £3.4 million UK Research and Innovation (UKRI)-funded project which aims to establish a domestic source of rare earth magnets. As the UK has no sources of primary rare earths, the project will look to establish a steady stream of recycled rare earth magnets to ensure the security of these materials in the UK industry.

Project partners include the University of Birmingham, HyProMag, Bowers & Wilkins, European Metal Recycling, GKN Automotive, Jaguar Land Rover and Mkango Rare Earths UK Ltd.

SCREAM will recover NdFeB magnets from end-of-life components through a variety of techniques,

including the Hydrogen Processing of Magnet Scrap process (HPMS). This patented process for extracting and demagnetising NdFeB alloy powders from magnets embedded in scrap was originally developed within the Magnetic Materials Group at the University of Birmingham, UK, and subsequently licenced to HyProMag, also of Birmingham. Researchers from the Birmingham Energy Institute hope to work with SCREAM partners to develop a semi-continuous version of the HPMS process.

Resultant rare earth metals will be processed from the alloys into sintered magnets on a production line at the Tyseley Energy Park in Birmingham. These will then be independently qualified for magnetic,

corrosion and mechanical performance, before undergoing testing in a variety of applications including loudspeakers, retaining clips, a magnetic separator and an automotive drive motor.

“As HyProMag moves forward in the manufacturing of recycled magnets, the ability to demonstrate our products in a range of applications with different demands is crucial,” stated Nick Mann, Operations General Manager of HyProMag. “We are delighted to be working with such a talented consortium, to deliver premium products engineered to the highest standards and in doing so forge future relationships. This project will push our magnet making to new levels and prove our ability to offer an alternative to current supply routes.”

Gordon Day, Managing Director, GKN Automotive Innovation Centre, added, “This leading research project which brings together key industry leaders across multiple sectors is vital to ensuring a secure and sustainable supply chain for next-generation electric powertrains. Rare earth magnets are a key component of electric motors and developing a robust solution for recovering and reusing them will help us reduce our environmental impact in the future.”

[www.birmingham.ac.uk](http://www.birmingham.ac.uk)

[www.hypromag.com](http://www.hypromag.com)

[www.bowerswilkins.com](http://www.bowerswilkins.com)

[uk.emrgroup.com](http://uk.emrgroup.com)

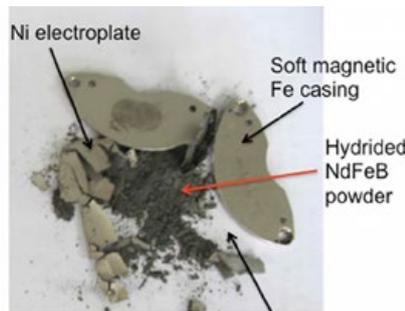
[www.gknautomotive.com](http://www.gknautomotive.com)

[www.jaguarlandrover.com](http://www.jaguarlandrover.com)

[www.mkango.ca](http://www.mkango.ca) ●●●



Voice coil assembly extracted from hard drive



Voice coil assembly after HD process

SCREAM will recover NdFeB magnets from end-of-life components through a variety of techniques, including the HPMS process developed by HyProMag and demonstrated above (Courtesy HyProMag)

## Dr Frank Petzoldt leaves Fraunhofer IFAM after thirty-eight years

After over three decades with the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM), Dresden, Germany, Prof Dr-Ing Frank Petzoldt has announced his retirement.

Petzoldt came to Fraunhofer IFAM as a research associate in the mid-1980s, taking over the Powder Technology department by 1993. Through his R&D work in the

fields of Powder Metallurgy, Metal Injection Moulding, and Additive Manufacturing, Fraunhofer IFAM's research area underwent expansion to become a vital part of the institute's portfolio. He succeeded in linking powder technology to the Fraunhofer IFAM name in the scientific and economic worlds. His work also contributed to the institute's development of national and international networks.

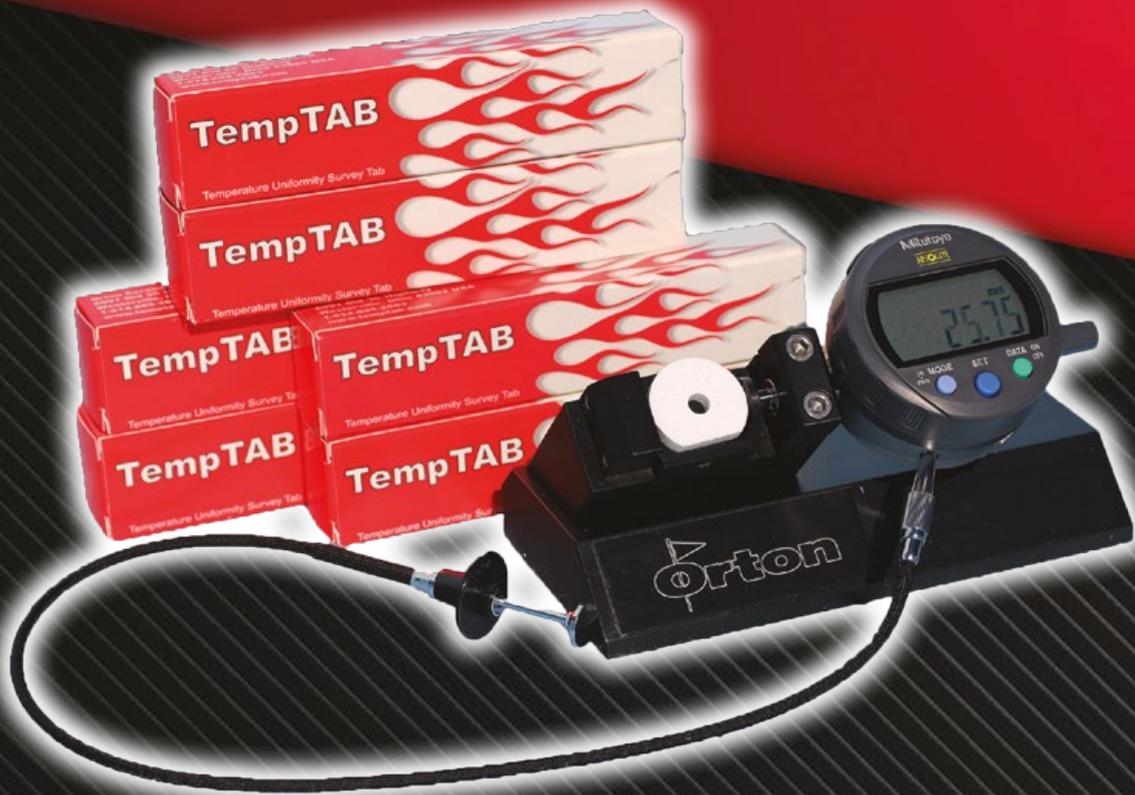
In his retirement, Petzoldt will work as a freelance management consultant. He can be reached through [info@petzoldt-consulting.de](mailto:info@petzoldt-consulting.de) or +49 151 21170556.

Dr Sebastian Hein will take over the management of the Powder Technology department. He joined Fraunhofer IFAM as a project manager after completing his doctorate at the University of Hannover. Since 2018, Hein has worked as group leader, and comes to this new management role with the intention of pushing greater digitalisation and sustainability.

[www.ifam.fraunhofer.de](http://www.ifam.fraunhofer.de) ●●●



# TempTAB



*A Practical Method to Monitor Process Temperatures  
Inside Your Furnace*

Contact Us Today to Learn How We Can Help

[ortonceramic.com/temptab](http://ortonceramic.com/temptab)

[info@ortonceramic.com](mailto:info@ortonceramic.com)

+1 (614) 818-1343

APPLICATIONS

MIM/AM  
Powder Metallurgy  
Hardmetals

DESIGNED FOR USE IN

Batch Furnaces  
Continuous Furnaces  
All Sintering Atmospheres

TempTab Overview Video: <https://youtu.be/EBxSIBMLesQ>

## MPIF releases 2022 edition of *Standard Test Methods*

The Metal Powder Industries Federation (MPIF) reports that the 2022 Edition of *Standard Test Methods for Metal Powders and Powder Metallurgy Products* is now available to purchase.

This new volume contains forty-eight standards covering terminology and recommended methods of testing for metal powders, Metal Injection Moulding (MIM) parts, metallic filters, Powder Metallurgy equipment and metal Additive Manufacturing.

The most current versions of these standards, which are used in the production of both metal powder and Powder Metallurgy products, are required by Quality Assurance programmes in order to maintain full compliance.

The 2022 edition includes the following three new standards:

- MPIF Standard 73 Preparing and evaluating tension test specimens of materials produced from metal powders by Binder Jetting (BJT), Material Jetting (MJT), Material Extrusion (MEX) or similar metal Additive Manufacturing technologies
- MPIF Standard 74 Preparing and evaluating tension test specimens of materials produced from metal powders by Laser Beam Powder Bed Fusion (PBF-LB) and Electron Beam (PBF-EB), Directed Energy Deposition (DED), and Cold Spray or similar hybrid metal Additive Manufacturing technologies
- MPIF Standard 75 Determination of flow rate of metal powders using the Carney Flowmeter Funnel



The Metal Powder Industries Federation has released the 2022 edition of 'Standard Test Methods for Metal Powders and Powder Metallurgy Products' and an updated version of 'A Collection of Powder Characterization Standards for Metal Additive Manufacturing' (Courtesy MPIF)

Additionally, an updated version of A Collection of Powder Characterization Standards for Metal Additive Manufacturing is now available which contains twelve existing MPIF Standard Test Methods that can be applied for the characterisation of powders used in metal Additive Manufacturing processes.

[www.mpif.org](http://www.mpif.org) ●●●

## Ultra Fine Specialty Products commissions pilot atomiser

Ultra Fine Specialty Products, LLC, an affiliate of Novamet Specialty Products Corporation, reports that its manufacturing site in Woonsocket, Rhode Island, USA, has installed capabilities to produce pilot quantities of gas atomised powders. This is expected to enable the development of custom alloys based on iron, cobalt, nickel, and copper for Powder Bed Fusion (PBF) and Binder Jetting (BJT) Additive Manufacturing, as well as Metal Injection Moulding (MIM).

Ultra Fine Specialty Products' pilot and production atomisers utilise a unique gas atomisation process to

produce high-purity spherical metal powders with tightly sized particle distributions ( $d_{90} < 30 \mu\text{m}$ ) to meet customers' stringent specifications for MIM and metal Additive Manufacturing, particularly applicable to BJT.

The newly commissioned pilot atomiser enables orders of as little as 50 kg, reducing the amount of material that customers must purchase for development projects. Upon successful evaluation, quantities can be readily scaled to high volumes on existing production equipment. The pilot equipment will enable the development of technology to further

optimise particle size distributions, improve sphericity, and reduce satellites to facilitate the growth of these processes.

Ultra Fine Specialty Products was purchased on June 30, 2020, from Carpenter Technology by a group of investors affiliated with Novamet. Novamet Specialty Products Corporation was formed in 1976 to apply technology to the development of nickel-base powders with unique morphologies, shapes, and sizes. The company currently processes and distributes various metal powders and coated products for the MIM, aerospace, automotive, coatings, and electronic materials markets.

[www.ultrafinepowder.com](http://www.ultrafinepowder.com)  
[www.novametcorp.com](http://www.novametcorp.com) ●●●

## Advertisers' index & buyer's guide

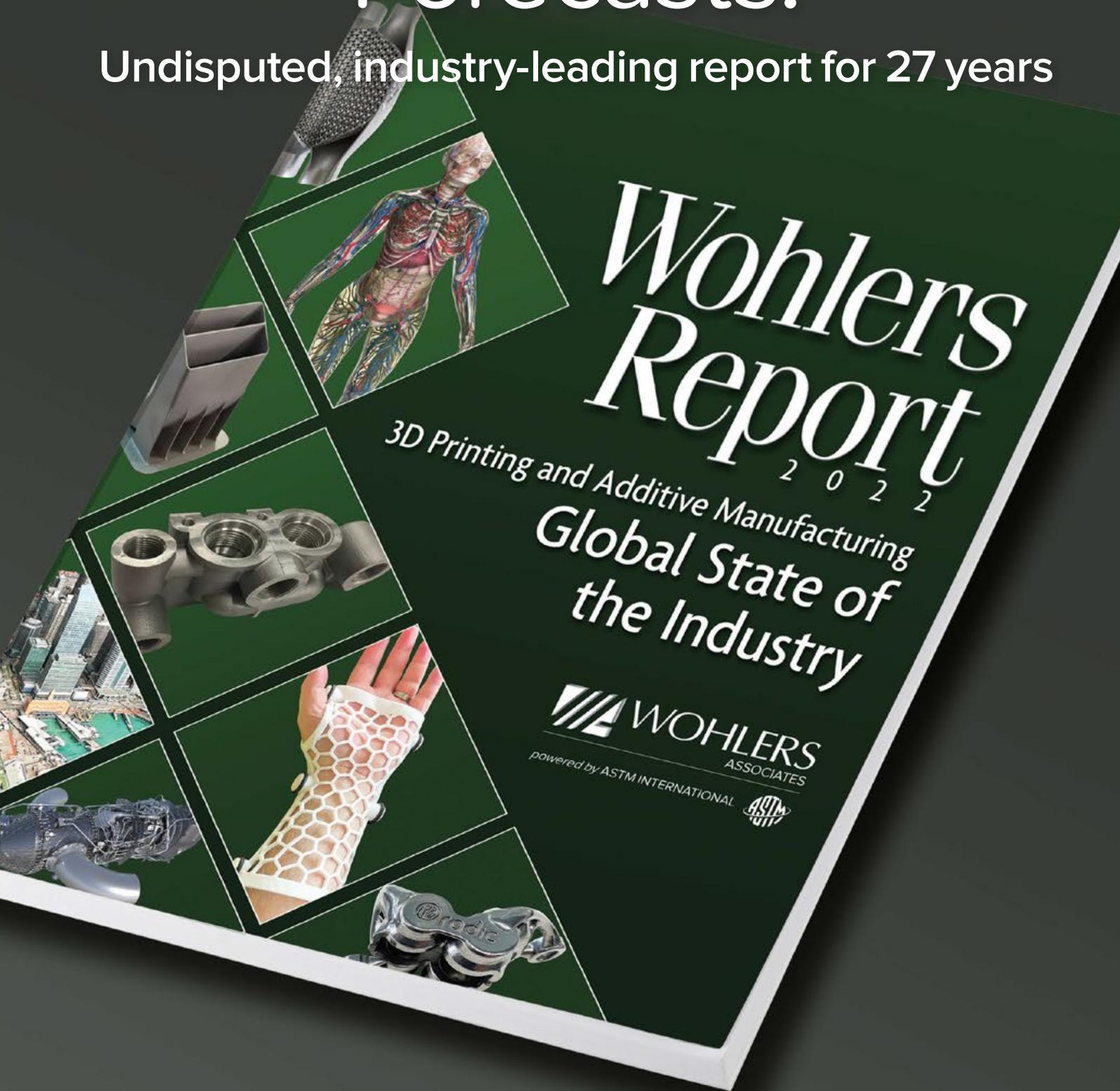
### Looking for PM production equipment, metal powders, R&D support and more?

Discover suppliers of these and more in our new advertisers' index and buyer's guide, from page 90 to 92.



# Trends. Perspectives. Forecasts.

Undisputed, industry-leading report for 27 years



Order your new 2022 report today!

[wohlersassociates.com](http://wohlersassociates.com)

On-site and via livestream!

VDI

SAVE  
THE  
DATE!

[www.dritev.com](http://www.dritev.com)

## 22. International VDI-Congress

July 6-7, 2022  
Baden-Baden

# Dritev

### Focus Topics:

- Design and Efficiency of electric drives
- Thermal management of e-machines
- Sustainability and life cycle analyses in development
- Vehicle development with fluid mechanics
- Parallel running: 7th VDI conference Powertrain Systems in Mobile Machines



Electrified city of Rüsselsheim:

Development of an urban charging infrastructure for electric mobility

+ 800+ participants discussion

+ 60+ technical presentations

+ Interactive networking experience

+ 70+ international exhibitors

Gold-Sponsors



# Hot Isostatic Pressing as a Powder Metallurgy-based alternative to AM for large, near-net shape components

For decades, industries such as oil & gas have relied on Hot Isostatic Pressing (HIP) to produce large, corrosion resistant, near-net shape components from high-alloy materials. Outside the PM industry, HIP is more widely recognised as a technology for the post-processing of AM parts than as a tried and tested powder metallurgical part manufacturing process in its own right. In this article, Jimmy Bovin, MTC Powder Solutions AB, Sweden, makes the case for HIP as the best, lesser-known alternative to Additive Manufacturing for large, near-net shape components.

No one can have missed the immense hype recently generated around Additive Manufacturing. The number of new materials, products, applications and standards are increasing at an impressive rate; progress is rapid, and many of the products developed are truly marvellous achievements of engineering. Currently, most of the products that have been, or are being, developed, are relatively small, with a design envelope of approximately 400 x 400 x 800 mm and weighing below 20 kg. Within this size range, Powder Bed Fusion (PBF) and Binder Jetting (BJT) offer design possibilities unmatched by any other process. For larger parts, the Directed Energy Deposition (DED) process offers almost equal design flexibility and the possibility to manufacture substantially larger components. These processes are, by now, well known to design engineers and metallurgists in most industries globally. Less known to many engineers is the fact that there is already a process that offers much of the

design flexibility that was previously mentioned with these AM processes, but with other far-reaching design and material benefits.

Hot Isostatic Pressing (HIP) was developed in the 1960s for the manufacturing of simple shapes in high-alloy materials such as

Alloy 625, a nickel-chromium alloy used for its high strength, high fabricability and corrosion resistance. During the 1980s, the technology was evolved further when the ability to manufacture near-net shape (NNS) components by HIP was developed by ASEA in Surahammar, Sweden, the

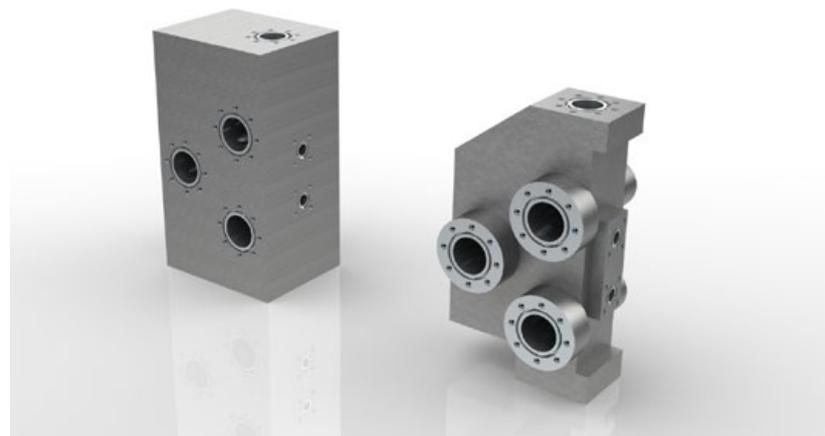


Fig. 1 Comparison between a forged design valve block to the left and a near-net shape HIP designed valve block to the right with the same function

	Forging	HIP	Difference
Blank weight [kg]	3,500	1,500	2,000
Machined weight [kg]	2,750	1,350	1,400
Material removed in machining [kg]	750	150	600

Table 1 Comparison between a NNS HIP designed valve block and a forged design valve block

company that would later evolve into MTC Powder Solutions (MTC PS). The first commercial product produced by ASEA using HIP was a separator cap, which tackled and provided solutions to material strength issues and material cleanliness demands. The technology was broadly commercialised in the 1990s, and the first components were supplied in 1992 for a subsea oil & gas manifold utilised by Marathon Oil in the North Sea.

The oil & gas industry has since become the largest user of HIP, and many subsea systems are now designed to be manufactured using the process. This choice is not based solely on the design benefits of HIP versus the forging process, but is also taken from a metallurgical perspective, where HIP provides significant benefits over forged material. There are several reasons why HIP is extremely attractive in the oil & gas industry and is gaining traction in

others. Many of those reasons are similar to the factors that make metal AM so attractive.

### Design flexibility

The design flexibility of HIP is very high and, in many aspects, matches that of AM, especially for components weighing over 500 kg. The AM industry has succeeded in creating a design mindset where material is used only where it is needed (i.e., as little material as possible is added when building a part to obtain the desired function and/or strength). This way of thinking should also be adopted when designing for HIP. Forging, the major competing technology to HIP, often approaches part design with the mindset of removing the minimum of material possible from a block to achieve the desired function, as shown in Fig. 1.

With a forged solution such as this one, manufacturing would start with a square block, whereas HIP would use a lighter, near-net shape HIP blank. The weight of the raw blank, the machined weight for a forged and HIP part, as well as the amount of material removed in machining, can be seen in Table 1.

This design mindset is fundamentally the same as that used when designing for the AM process and is why HIP, in MTC’s opinion, should be considered as something similar to an AM process in its own right. Also note that the HIP design can be optimised even further if weight is critical. This design flexibility is utilised in many industries to make components lighter, more efficient, as well as smaller and safer. Some examples of this are:

#### Subsea manifolds

First, we will look at a subsea manifold manufactured by conventional methods, in which several forged components are welded together, as shown in Figs. 2 and 3.

HIP, like AM, offers designers the option to remove all the welds and produce the part in one entire section, as a strong single component. The tees, branches, and flanges can be integrated into a single HIP blank. Ultimately, this increases safety by removing welds



Fig. 2 A typical subsea manifold consisting of several standard forged fittings and pipes prior to joining by welding



Fig. 3 A typical subsea manifold after welding the multiple standard fittings together

and the associated weak spots in the component, all while decreasing fabrication costs. Furthermore, the technology offers the designers the opportunity to decrease overall system weight. This is accomplished by reducing the length of the header and placing branches and flanges closer to each other, which is made possible when we remove concerns about weld proximity from the design. Consequently, by using the technol-

ogy to its full potential, the header could look like the example in Fig. 4 and fill the same function, but with a reduced length and a reduction in the material needed.

**Valve and choke bodies**

The production of large valve and choke bodies for high-pressure services is often done by open die forging, which limits the flexibility in terms of geometry as only relatively

simple shapes can be achieved using this manufacturing method. The consequence of this is that the forged blank often needs to spend many hours being machined to arrive at the desired shape and function. It's also very common that the heat treatment must be carried out in multiple stages, which increases the process time and could have some negative affects in terms of material integrity. With HIP, the blank can be produced



Fig. 4 NNS HIP subsea manifold produced as a single component, featuring no welds, with optimised design and reduced length

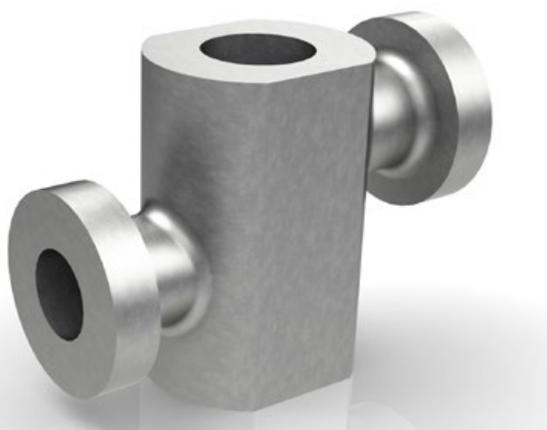


Fig. 5 Showing a HIP-produced valve body with integrated flanges and bores, reducing the amount of material that needs to be removed during the machining stage

closer to the final shape, resulting in less machining and improved material integrity as multiple heat treatments are not required. Fig. 5 shows an example of how a HIPed blank could be produced. With this design only minimal machining will be required on the flanges and bonnet interfaces.

Today, some choke bodies are produced using the closed die forging method, which is cost

effective for larger volumes and offers some degree of flexibility on the outer shape of the forged blank. However, the opportunity to integrate internal channels is still restricted within this option, resulting in the need for post machining to introduce the desired flow paths through the body. With HIP, the channels could be integrated in the initial build process, resulting in less machining and less mate-

rial waste, which is beneficial on bodies produced in costly exotic alloys such as Alloy 625 (UNS N06625).

**Special fittings**

The design of special fittings used to redirect flow of different media – for example, cooling water in nuclear power plants, or wyes and tees in oil & gas pipelines – have, in many ways, been restricted by conventional manufacturing techniques. As an example, flow paths with radiuses to optimise flow have been produced by either complicated machining or, in some cases, the flow paths have needed to be simplified due to the inability to produce integrated flow paths in a forged blank. With the opportunity to utilise HIP, design engineers are not restricted by the manufacturing method and, as such, a complicated flow path can be integrated in the HIP blank, without the need for expensive and time-consuming machining. Even geometries that would be impossible to machine can be manufactured with HIP, much like AM. The fitting in Fig. 6 is designed to divide one flow path



Fig. 6 A 2,500 kg special fitting designed to direct one flow into four different flow loops

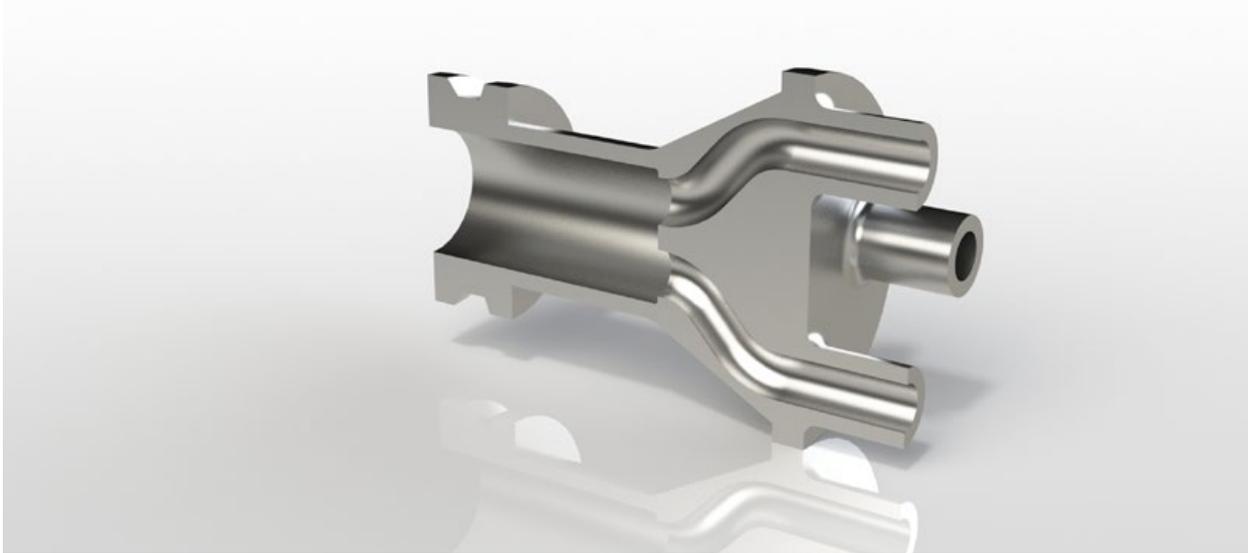


Fig. 7 Integrated S-shaped flow channels in the HIPed blank

into four equal smaller flow paths, which could, for example, be routed to different flow loops. The integrated flow paths are shown in Fig. 7.

### Metallurgy of HIP parts

Unlike some press and sinter PM materials such as those used in PM bearings and other smaller mechanical components manufactured by this process (in which porosity can itself be a benefit), MTC's HIPed material is 100% dense, making it suitable for applications requiring a very high material integrity.

HIP also has several metallurgical benefits compared to other competing technologies, like casting, forging and AM. Materials manufactured by Powder Bed Fusion (PBF) or Directed Energy Deposition (DED) have what is essentially a welded microstructure, and may suffer from some of the associated problems. HIPed material is completely different: it is consolidated to 100% density under isostatic pressure and at a temperature well below the melting point of the material, which means the resulting material properties are isotropic, with a very fine-grained microstructure. In fact, HIP itself can be used to improve

the material integrity of AM materials. One can think of the process as slowly forge welding together millions of tiny spherical ingots (powder particles), with a maximum size of 500  $\mu\text{m}$ . The resulting 100% dense, isotropic, fine grained and super-clean material has superior material integrity that is highly sought after in, for example, the oil & gas and nuclear industries.

The combination of these design and metallurgical possibilities creates unique ways to manufacture multi-material components or compound

solutions. MTC Powder Solutions has manufactured compound components and parts with up to four different materials. In fact, in one of our prototypes, twelve different alloys were utilised, all of them being metallurgically bonded together and showing excellent bond strength. This part, an exhaust valve for a marine two-stroke ship engine, can be seen in Fig. 8.

The valve consists of a forged valve steel substrate onto which three different alloys have been

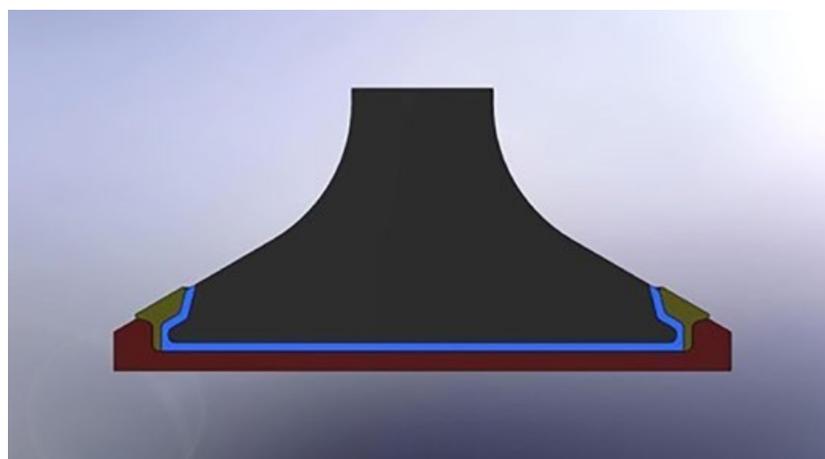


Fig. 8 Cross section indicating four different materials combined through HIP

	HIP	PBF	DED
Small part (< 5 kg) complexity	✓	✓✓✓	✓✓
Medium part (5–500 kg) complexity	✓✓	✓✓✓	✓✓✓
Large part complexity (500–5,000 kg)	✓✓✓	-	✓✓✓
Very large part complexity (5,000–15,000 kg)	✓✓✓	-	✓✓
Isotropic material	✓✓✓	-	-
Consistent material properties	✓✓✓	✓✓	-
Repeatability	✓✓✓	✓✓	✓
Low sensitivity to consolidation process variation	✓✓✓	✓	✓
Compound solutions with material flexibility	✓✓✓	✓	✓
Metal Matrix Composites	✓✓✓	✓	✓
UT inspectability	✓✓✓	✓	✓
As-manufactured surface finish	✓✓	✓✓	✓
Codes and standards	✓✓	✓	✓

Table 2 Comparison between the different AM technologies and HIP

HIPed. Each material has a specific function and is designed to provide optimum performance in the various areas of the part. Both corrosion resistance and wear resistance are thus applied and positioned specifically where needed.

Using HIP makes it possible to manufacture materials with compositions and properties that cannot be manufactured with any other technology. A good example of this is the manufacture of Metal Matrix Composites (MMCs) consisting of a hard ceramic phase embedded in a ductile metallic matrix. MTC Powder

Solutions has a range of proprietary MMC wear materials for use in components that are subjected to extreme wear in various conditions. One example is a crusher tooth, where our proprietary wear materials are used as a diffusion bonded cladding, a compound material. The teeth supplied by MTC Powder Solutions increase the wear life of the part by a factor of 4-6 compared to the customer’s previous solution of a tungsten carbide overlay on carbon steel. This is used in one of the world’s toughest crushing applications.

***“Using HIP makes it possible to manufacture materials with compositions and properties that cannot be manufactured with any other technology.”***

## Post-processing and testing

Just as with AM, post-consolidation machining is usually required. Machining of HIPed material is not more complicated than with conventional material. In fact, the isotropic material minimal inclusion content means the machining will be very consistent throughout the part, minimising the risk of any unwanted defects and scrap parts. Also, the isotropic material means that any movement by residual stresses is more predictable. In most cases, though, only mating surfaces are machined (e.g., weld preps, seals, hubs and flanges). The rest of the part is left unmachined, with a good surface finish from its as-HIPed condition. The surface finish on these as-HIPed surfaces is usually Ra 6-15 µm, considerably finer than that which can be achieved by most PBF and DED processes, for example.

Since, in general, most HIPed material is used in industries with very strict material specifications and significant quality assurance requirements, all the produced material undergoes heat treatment and rigorous testing after HIP. This usually consists of a full set of destructive and non-destructive testing procedures. The years have shown that material produced with HIP has very stable properties, and it is very rare that HIPed material does not meet requirements on mechanical properties per specifications. In fact, in the vast majority of tests, HIPed material vastly exceeds the requirements.

The HIP process is not very sensitive to consolidation parameters, and properties are mainly dictated by powder quality and heat treatment, not the HIP-process. In non-destructive testing methods such as ultrasonic testing (UT), HIPed parts produced by MTC PS have never failed a test in close to thirty years. Furthermore, in the very unlikely event that there is an internal defect in the material, the

extremely good UT inspectability of the HIPed materials means that it can be identified in non-destructive testing and the customer can rest assured that there will be no surprises down the line.

## Compared to Additive Manufacturing

Since HIP has had many years head start on the AM process, there has been more time to develop codes and standards, as well as dedicated material specifications, in the industry. In the oil & gas industry, for instance, the technology is mature enough that the type of testing that needs to be performed to verify the material as sound is widely understood. Despite this, testing is still often performed according to specifications aimed at forgings.

A good example is the requirement to test mechanical properties in two directions, something that is not needed with isotropic HIPed material. This really demonstrates the time it takes to get widespread acceptance and develop relevant codes and standards for a new process, a task that has unfortunately been slow going for HIP but seems to be progressing very well for the AM industry. We have high hopes that this trend, and the hard work undertaken by the AM community, will accelerate and support a similar development for HIP.

PM NNS HIP is, in general, considered a process for manufacturing of parts above 100 kg in small quantities. While that is true for the most part, there are exceptions to this. A great example are the fuel nozzles for two-stroke ship engines, a product that has been manufactured using HIP for fifteen to twenty years. The very first generation of fuel nozzles was manufactured in solid Co-base alloy and has since developed into a number of generations using a solution with a tool steel base clad with a Ni-base alloy for corrosion resistance. That part weighs less than 200 g and has been manufactured in the hundreds

***“AM is not considered a competing technology to HIP, but rather as a complementary process that can do many things that HIP cannot. At the same time, however, HIP can do things AM cannot. The technological possibilities with both processes are immense.”***

of thousands of parts over the years. To meet the extremely high quality requirements combined with a competitive price, new and improved manufacturing processes have continuously evolved together with new generations of the nozzles.

Table 2 compares some of the technical characteristics of HIP against two different AM processes. As can be seen, there are a lot of similarities between the technologies, but also some fundamental differences.

AM is not considered a competing technology to HIP, but rather as a complementary process that can do many things that HIP cannot. At the same time, however, HIP can do things AM cannot. The technological possibilities with both processes are immense. In our opinion, the broad spectrum of possibilities with HIP are even bigger than that offered by PBF and DED. The biggest hurdle is making more engineers aware of the process and prepared to consider HIP in the first design stages of a new product. Equally important is to change the mindset of engineers and purchasers to stop considering cost/kg of material and start thinking on a wider scale by looking at the total cost of ownership.

So, how could the wider PM industry work to promote HIP as a manufacturing technology? This is a question that many have considered over the years that the process has

been around. In MTC's experience, it's essential to collaborate with the customer deeply, and to do this in all industries and with all types of challenges, from the ground up. Taking on the customer's problems, and the limitations they have experienced with conventional manufacturing technologies, early, is key to developing new parts and new options for HIP. It's important that the approach taken is to 'find an engineering solution,' and to unleash the variety of options that HIP's design and usage can bring to the table.

For over thirty years, this process has helped our customers' products become safer, lighter, stronger, more efficient, and more. Using this technology, MTC Powder Solutions is ready to work with customers and support the goal of reducing total cost of ownership using metal powder and HIP.

## Contact

Jimmy Bovin  
& Iain Dandy  
MTC Powder Solutions AB

[mtcpowersolutions.com](http://mtcpowersolutions.com)

# PowderMet2022 AMP2022

June 12–15, 2022  
Portland, OR

## PowderMet2022

International Conference on Powder  
Metallurgy & Particulate Materials

## AMP2022

Additive Manufacturing with  
Powder Metallurgy



### TECHNICAL PROGRAM

Held with the co-located Additive Manufacturing with Powder Metallurgy (AMP2022) Conference, PowderMet2022 attendees will have access to hundreds of 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 metal additive manufacturing processing equipment, powders, and products.



### SPECIAL CONFERENCE EVENTS

Special guest speakers, awards luncheons, and evening networking events round out a world-class program.

For details visit [PowderMet2022.org](http://PowderMet2022.org) or [AMP2022.org](http://AMP2022.org)



  Metal Powder Industries Federation  
APMI International

**Powder  
Met2022**  
.....  
**AMP  
2022**  
JUNE 12–15 • PORTLAND, OR

# Backing the right horse? Safeguarding PM part usage in a new automotive industry

No matter our personal views on electrification, we can all agree that the automotive landscape, and with it, one of PM's leading consumer markets, is changing. Currently, much of our industry's focus is on how best to market PM's strengths as an EV-enhancing technology to the traditional 'Big 5' automakers. But is this strategy enough? In this article, EV commentator Alex Voigt, with input from *PM Review's* Emily-Jo Hopson-VandenBos, compares Tesla's approach to that of traditional automakers, and asks whether the PM industry should keep its focus on those companies that have traditionally led the auto industry, or whether it is new relationships with flexible, innovative startups that will safeguard the future of Powder Metallurgy as a supplier to the automotive industry.

For a long time, the PM industry has been preoccupied with concerns over the decline of the internal combustion engine (ICE), the rise of the electrified automotive industry, and how to get PM parts into electrified vehicle engines. Those concerns are founded in good sense; regardless of our opinions on the viability of vehicle electrification, often discussed in these pages, we all know that without a concerted effort to find PM parts a core position within the new automotive manufacturing supply chain, our industry will suffer.

Many of those efforts are focused on ensuring decision-makers at today's major automotive companies are aware of press and sinter Powder Metallurgy as a green, affordable, versatile and sustainable manufacturing solution. If a legacy automaker were to approve the use of a PM part in a new mass-produced battery electric vehicle (BEV), many in the PM industry would breathe a sigh of relief; here is another PM application safeguarding our future.

However, automotive industry journalist Alex Voigt suggests that to protect PM's future as a key supplier to the biggest automotive names in the world, we must reassess who those names are likely to be in future. That is to say: while we worry about how to woo the traditional Big 5 automakers with the promise of PM

as an EV-enhancing technology, we run the risk of backing the wrong horse in the race.

In Voigt's career as an automotive industry journalist, he has seen the landscape shift, for the first time in over a century, away from the old giants and toward new names, most notably Tesla. While Elon Musk's



Fig. 1 Tesla's Model 3 BEV is one of its two mass-produced vehicles (Courtesy Tesla)

***“While Elon Musk [...] cannot yet boast whole-line sales to match those of the traditional giants of the industry, it far outstrips them in terms of EV sales; and when one compares the company’s speed of electric vehicle production, and capacity to expand in line with customer demand, to the rate of change within traditional automakers, the future landscape looks set for a seismic shift.”***

relatively new company cannot yet boast whole-line sales to match those of the traditional giants of the industry, it far outstrips them in terms of electric vehicle sales; and when one compares the company’s speed of electric vehicle production, and capacity to expand in line with customer demand, to the rate of change within traditional automakers, the future landscape looks set for a seismic shift.

Alex Voigt will now explain why it is that legacy automakers struggle with the mass production of battery electric vehicles. By comparing the legacy production model to Tesla’s, and considering how these fundamental differences may affect suppliers down the chain, it will become clear just how vital it is that PM doesn’t bet all of its marketing budget on the old world leaders, and that a major effort is now undertaken to build new relationships, before it’s too late.

### **Why legacy automakers struggle with the mass production of BEVs**

We are used to affordable products that cost little because they are produced at high speed and in large quantities. In some manufacturing plants, products are manufactured at such a speed that our eyes cannot follow the individual units, and this is

done to reduce the cost (and with it the price). A product that cannot be produced fast enough remains an expensive, luxury and niche product that only a few can afford.

Mass production of vehicles is nothing new. Ford began production 100 years ago on a car designed to be affordable for the average American. Until that time, a car had been a luxury item for the upper classes, but Ford showed the world that an average household could have some, if not all, of the same luxuries as the upper class. Many copied the iconic US automaker successfully and, today, every product that can’t be mass produced is classed as a niche, luxury product, with affordable mass production the standard.

Because we are so used to their success, most expected established automakers to succeed in mass-producing BEVs and quickly dominate the market, as they have throughout automotive history; but in recent years we have learned that they face many challenges in producing BEVs in a high enough volume, at the required rate and quality, for a variety of reasons. We have seen supply chain issues with semiconductors, batteries or wire harnesses, wars or pandemics; and even if all of that were removed from the picture, legacy automakers would still face problems nobody anticipated.

I will now explain why Tesla, still a small automaker by comparison to the giants it is competing with, is succeeding with low-cost mass production of battery electric vehicles, while established automakers previously known to be strong in mass production are failing.

The term mass production is not actually defined by the mass of products produced, but by the speed of production; a better term for it would be speed production. At high speed, equipment utilisation is better or, the cost per unit produced goes down, and product prices can be lowered while the profit margin rises.

The problem with high-speed vehicle production is that to achieve it, you need high demand for a few models, and standardised parts and systems in facilities where you can produce these few models without a lot of product changes and interruptions. Every different batch and each product change leads to interruptions, tooling changes, potential quality problems and higher unit costs. If you have mass production with high demand for a few products and variants, you can design your production to run at a high speed and lower the cost per vehicle significantly.

However, if you have many product variants, like the Volkswagen Group (with its brands such Audi, Porsche, SEAT etc), BMW, Mercedes, General Motors, Ford and other legacy auto leaders, which offer thousands of models in millions of variations, you need a large variety of parts and systems, a large supplier base, and expensive flexible production equipment to produce not only new vehicles, but also aftermarket spare parts to supply the maintenance and repair business for future decades. All of that adds to the costs, and higher costs are the enemy of demand.

High demand, with just a few products and variants, is key for low cost, high profit, and success, but in the new world of battery electric vehicles, only the Tesla Model Y and Model 3 have achieved this. Tesla has faced some criticism for the

very few models, colours, interiors and options it offers its customers, with only four models available for custom orders, while the mass-produced vehicles come in only two models, the Model 3 and the Y, which some have rather accurately called the same model in two variations.

However, what many see as a weakness is in fact a strength. By investing every dollar in R&D, design, and technology rather than marketing and PR, the company has presented a desirable product that created a huge (and even for Tesla, unexpected) wave of demand. That high demand allowed the company to standardise high-speed mass production of just two variants on a very similar model, and created an affordable, high-margin, high-profit BEV; something other automakers both dream of achieving and have nightmares about competing against.

The production volume of established automakers may be large in terms of total units of all models combined, but the volume per model and variant produced is actually quite small. Since each model and variant requires special tooling and has its own production requirements, costs rise and so do vehicle prices, while margins and profits fall. Incumbent automakers cannot simply abandon their old model policies without risking the loss of customers, revenues, and profits, because customers are used to having the choice of these variations, even if only a relatively small number of each variation is sold (one notable example of this is VW Porsche, Fig. 2). Therefore, legacy automakers are stuck trying to transfer their old ICE manufacturing structure to the new BEV world, but so far they have not been successful, despite their economies of scale. If time was on their side, this would be a barrier they easily have the resources to tackle to continue dominating the market; but the existence of new automakers like Tesla, which can produce a BEV in the same segment in a third of the time, means that time is a luxury most of the market does not have.



*Fig. 2 High demand has allowed Tesla to standardise high-speed mass production of just two variants on a very similar model, creating an affordable, high-margin, high-profit BEV. In contrast, legacy automakers such as VW Porsche, which already offers numerous variants of the same model, each highly customisable, is constrained by legacy model policies (Courtesy VW Group)*

***“Incumbent automakers cannot simply abandon their old model policies without risking the loss of customers, revenues, and profits, because customers are used to having the choice of these variations, even if only a relatively small number of each variation is sold.”***

### **The Tesla production model**

Tesla poses an existential threat to legacy automakers because it can produce vehicles in brand new production facilities, with new technologies, much faster than incumbent automakers with a century of experience. If you can't compete on cost, technology, specification, and price, you lose the competition, and German and US automakers are losing it right now.

Many wonder how it is that these long-established automakers could suddenly lose their core competence, overlooking the fact that producing a BEV is a fundamentally different process to producing an internal combustion engine, and that without vertical integration and affordable, desirable products, demand will fail to materialise. Without high demand for a few models, costs go up, which, in turn, reduces demand. What sounds like a vicious cycle is a vicious cycle.



Fig. 3 Tesla's Giga Berlin was opened in March 2022 and is squarely aimed at leveraging production speeds to increase volume (Courtesy Tesla)

***“Battery electric vehicles have fewer parts than ICE-powered vehicles, but Tesla’s BEVs also have fewer parts than legacy automakers’ BEVs, and that poses a fundamental cost problem for the old guard.”***

Battery electric vehicles have fewer parts than ICE-powered vehicles, but Tesla’s BEVs also have fewer parts than legacy automakers’ BEVs, and that poses a fundamental cost problem for the old guard. Every part that you don’t have to make and then weld, glue or rivet together saves money, and one approach that can be used to eliminate many parts at once is to use large castings; Tesla refers to these as Giga castings (Figs. 4-5).

The PR has it that, one day, Elon Musk wondered why cars aren’t made in one piece, like the matchbox toy cars on his desk. When asked, his engineers struggled to come up with a convincing answer. “The best part is no part,” Musk is famously quoted as saying, and this oft-used ‘first principle’ approach proved useful in reducing the challenge of production to the lowest conceivable element that most would say was impossible.

Producing a real car in one piece like a matchbox car seems like an impossible task, until you start thinking out of the box. Tesla was the first automaker to take the risky approach of upscaling a technology that all other automakers used only for small parts. Of course, risks are only worthwhile for those who take them and master them, and founders like Musk can take risks no manager would ever dare to take.

Molten metal die casting machines are nothing new to the industry, but the very large castings Tesla makes are indeed new and have not been used before on this scale because it is a risky, still not very well understood, and costly process. Risky in the sense that yield and quality are often low and costly in the sense that the large casting machines are a huge investment, but when you make hundreds, thousands or even millions of the same parts at high quality, there is a huge cost and production time advantage to this approach.

Not only are cars made in this way cheaper to produce, because fewer parts and less time are invested, but with each additional car that leaves the factory, costs drop further. Quality issues in particular can be overcome if rocket engineers from Musk's SpaceX aid Tesla with innovative alloys that eliminate the need for heat treatment after die casting.

It is often overlooked that in using fewer parts, you create a quality advantage, since you have eliminated hundreds of process steps. Repairs are rarely an issue, because in an average accident the rigidity and stable structure of the castings, copied from nature, means that they are not damaged, and in a serious accident the entire car is a total loss anyway and would not be repaired. For all the legacy car manufacturers with many variants and models, this is a new business model they cannot compete with, because the change-over cost and time to employ this method, as well as the many different moulds that would be needed, are not practical for the millions of vehicle variants they produce.

Volkswagen has a cost problem with its BEVs already, but isn't planning to invest in any large casting equipment comparable to Tesla's high-end 8,000 ton casting machine for the next generation of its hyped Artemis and Trinity factories, and has therefore already lost the competition. Even worse, it is now trying to match the 2021 production time of about ten hours for a Shanghai-made Tesla Model Y by 2026, using a traditional manufacturing approach at its new plant in Wolfsburg, Germany. That would be an astonishing improvement from thirty hours for today's Dresden-made ID.3, but in the automotive industry, four-to-five years represents an entire generation of vehicle development, and when VW launches its new Wolfsburg facility in 2026, Tesla will already be a generation ahead.

Being a generation behind the company that is accelerating the pace of innovation faster than you is deadly to your business, because you will never be able to catch up. In hockey



Fig. 4 A tooling for Tesla's Giga Press, installed at Giga Berlin (Courtesy Alex Voigt)

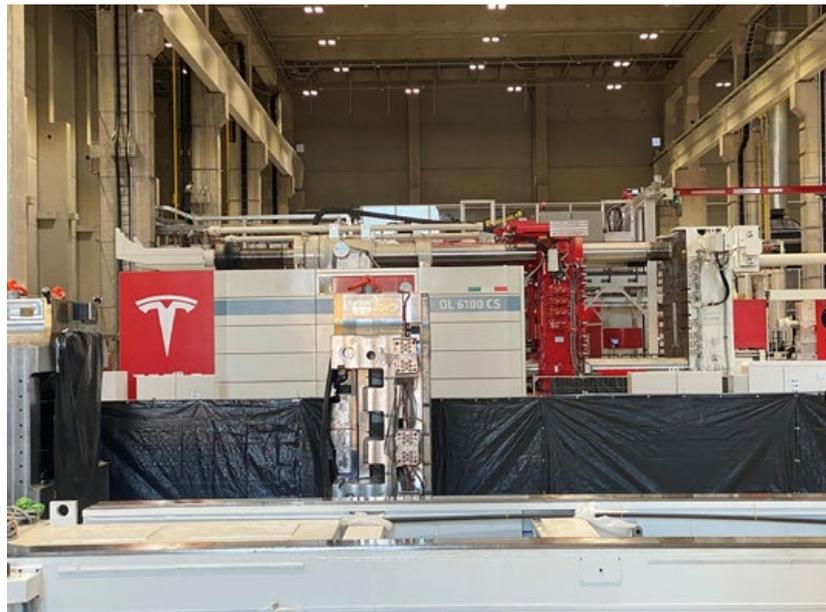


Fig. 5 View of the Giga Press in Tesla's Giga Berlin factory (Courtesy Alex Voigt)

***“... with each additional car that leaves the factory, costs drop further. Quality issues in particular can be overcome if engineers from Musk's SpaceX aid Tesla with innovative alloys that eliminate the need for heat treatment after die casting.”***



Fig. 6 Volkswagen's electric ID.3 was launched in 2020, but for VW, overall sales have fallen from 11.8 million in 2017 to 8.8 million in 2021. Voigt believes the automaker will likely see its sales halve in a few years; for the 40,000 suppliers it uses today, that signals a coming, unprecedented change (Courtesy VW Group)

***“In hockey terms, if you want to catch the puck, you must go where the puck will be and not where it is right now. The electric vehicle registration data from all leading auto manufacturers globally compared to Tesla shows that they are falling further behind, and simply not catching up.”***

terms, if you want to catch the puck, you must go where the puck will be and not where it is right now. The electric vehicle registration data from all leading auto manufacturers globally compared to Tesla shows that they are falling further behind, and simply not catching up.

### **What this means for suppliers**

The mass production problem described above, which negatively impacts automakers' costs, poses an even bigger threat for its suppliers. The giga-cast parts mentioned will never be used by Volkswagen

or other automakers because they are risk-averse and are used to suppliers delivering, but there is no chance of the suppliers taking that risk for them. Even for a major Tier 1 supplier, a large die-casting machine and production is a project that would be a too high risk, given the many uncertainties and the fact that a return on their investment would be almost entirely dependent on a single customer, which history has shown is not good for business or profit. In addition, companies would need to learn the process and build expertise in large castings, which could take many years without any guarantee of success, a risk few serious managers or board

members would ever think about taking. Both Volvo and Volkswagen intend to investigate castings, with the latter entrusting its internal supplier VW Group Components with the task.

Further down the food chain, Tier 2 and Tier 3 suppliers are being forced by automakers to take even higher risks, and many will not make it unless they adapt very quickly to the new world of BEVs and their requirements. Transforming into an industry that offers products and systems critical to legacy automakers' BEVs is a key strategy that many are still struggling with. As a BEV has only a fraction of the parts and systems, and this fraction continues to be reduced, and because automakers are increasing vertical integration, each supplier should choose its market very carefully and decide where it has a competitive advantage. As the shift to BEVs accelerates year by year, time is not on suppliers' side and therefore R&D spending should be very high to prepare for the future. Unfortunately, we don't see that happening, and many try to continue their ICE business as if it would continue forever.

In addition, while most try to unlock the secrets of mass or speed production of BEVs, they forget probably the most important and non-replicable ingredient is the culture of a company. To illustrate using a simple example, at Tesla, anyone can communicate with anyone and is encouraged to do so, regardless of their position in the corporate hierarchy. At legacy automakers, cross-rank communication is a clear 'no go' unless you have permission from your manager to make contact. What sounds like a small detail has profound consequences for mass production and, while you can introduce new technology into an existing organisation, it's hard-to-impossible to introduce a new culture. In a startup, it's quite easy and natural to adopt the culture introduced by management, but an existing organisation lacks

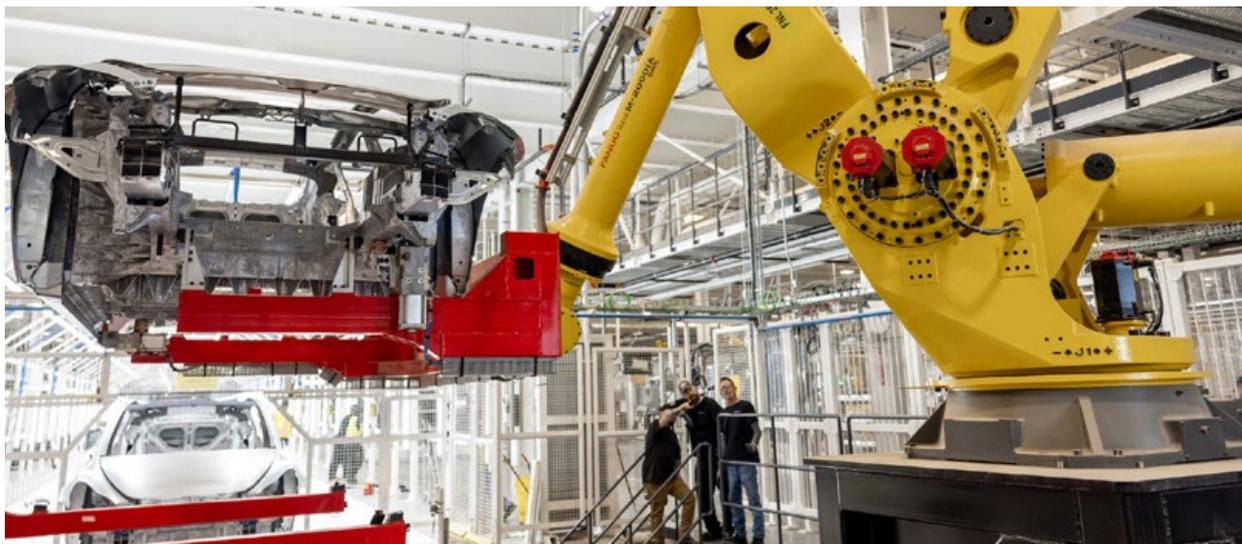


Fig. 7 Vehicle manufacturing at Tesla's Giga Austin factory, launched in April 2022 (Courtesy Tesla)

the flexibility to change that much and needs a lot of time to do it, time that right now is simply not available.

Many Tier 1, 2 and 3 suppliers are highly specialised in their technology segment and are now caught in the inventor's dilemma that this is what has made them what they are today – a success story. Persistence and conviction in their highly specialised products may now lead them to maintain their business model for too long without initiating change quickly enough – or this may simply be down to a cultural inability to change; both will have the same result. If suppliers don't change fast enough, they will disappear, because what made them successful in the past may be their end in the future world of BEVs. Specialising narrowly in a fast transforming industry is a huge risk.

It is a stunning psychological effect not to recognise how fundamental the change in the automotive supplier industry is today, and to continue to argue that the good profits the industry is seeing these days from rising vehicle and part prices are something positive. We are not just dealing with new technology, but with a new approach to production, a new way of thinking, and a paradigm shift. All those who come to understand too late what this means will not have enough

time to react, and will be forced, too late, to adapt, or will disappear right away. We see this happening in the industry already, and the war in Ukraine, supply chain issues with semiconductors, and the continuing pandemic, are accelerating the momentum.

In the next few years, we will see a change that will surprise many, and a shift in consumer behaviour that only a few can imagine, triggered by the establishment of the largest electric vehicle production factories in the world, such as the Tesla Giga Austin production plant that has just opened (Fig. 7). Large car manufacturers like the Volkswagen

Group, which sold 11.8 million vehicles in 2017 and only 8.8 million in 2021, will most likely see their sales halve in a few years. Losing 50% of supplier volume means that 50% of the revenue that has to come from somewhere else to keep the supplier industry alive. Arno Antlitz, CFO of Volkswagen, has stated that the group will reduce its line-up of petrol and diesel ICE vehicles – which currently consists of at least 100 models from various brands – by 60% in Europe over the next eight years. Meanwhile, the new VW Trinity factory in Wolfsburg will have a capacity of only 250,000 vehicles per year, while the Tesla Giga Berlin factory

***“In the next few years, we will see a change that will surprise many, and a shift in consumer behaviour that only a few can imagine, triggered by the establishment of the largest electric vehicle production factories in the world...”***

is expected to have the capacity to produce some 2 million annually.

For the 40,000 suppliers VW uses today, that signals a coming, unprecedented change that most of them are not designed to withstand. While the traditional automakers will sell fewer vehicles, they will keep their own sales and profits high by selling more premium vehicles, but this does not help the supplier industry, which will lose revenue and profits from mid- to low-cost vehicles their legacy customer no longer sells. In addition, many suppliers either have not yet developed parts and systems for BEVs, or they will no longer be needed at all because the manufacturers will produce them in-house due to increased vertical integration.

What is just a shrinking business exercise for most automakers will be the end of the journey for many suppliers. The change ahead is more

severe than most anticipate, and my recommendation is to get prepared for it now. If you don't change fast enough, you will either be changed, or disappear.

## Preparing for change

Whatever your view on the viability of electrification as the solution to vehicle emissions, the market is responding and electric vehicle registrations are on the rise. Efforts to market PM as an EV-enhancing technology must now consider not just which technology will power the cars of the future, but which company will produce those cars. While the automotive landscape has long seemed fixed, with roughly the same legacy automakers having held their position at the top for decades, we should not rule out a changing of

the guard in future. While the success of some EV startups – Rivian, Lucid Motors, etc – remains to be seen, Tesla, at the very least, would appear to be here to stay.

Hopefully, the comparison of business models and rate of change presented by Alex Voigt here has demonstrated to you why it is so vital that, while working to maintain its existing relationships, PM doesn't bet all of its marketing budget on the old world leaders. A major effort must be undertaken to build new relationships, before it's too late.

## Author

Alex Voigt  
Munich, Germany  
avoigt@web.de



# POWDER METALLURGY REVIEW

## SUBSCRIBE

## TO OUR WEEKLY E-NEWSLETTER

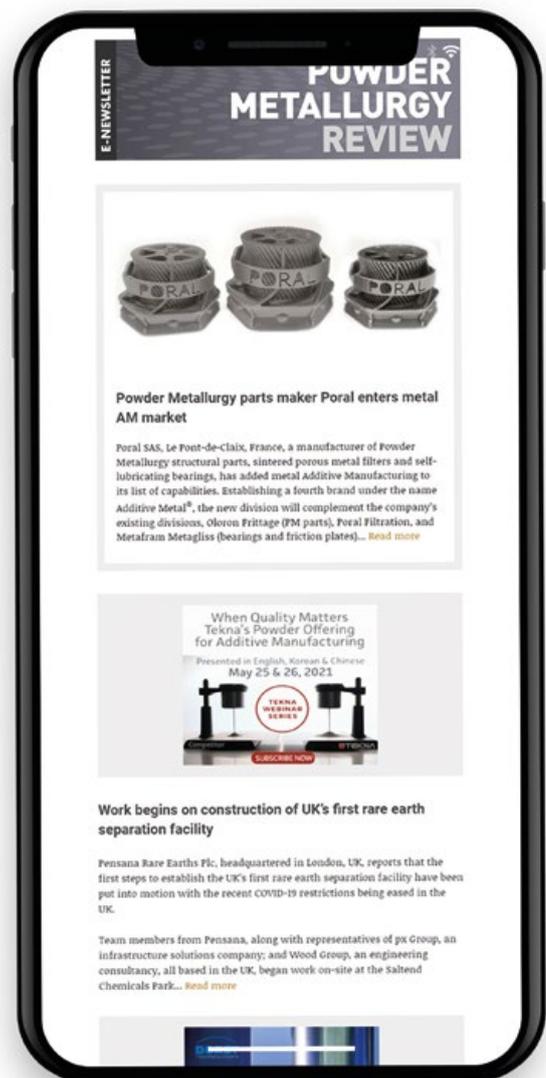
Subscribe to the *Powder Metallurgy Review* e-newsletter, sent weekly to key PM professionals and end-users worldwide, to make sure you benefit from timely access to the latest industry news and technology trends.

E-newsletter subscribers also benefit from a free digital subscription to *Powder Metallurgy Review* magazine.



[https://www.pm-review.com/  
subscribe-pm-review-e-newsletter/](https://www.pm-review.com/subscribe-pm-review-e-newsletter/)

[www.pm-review.com](http://www.pm-review.com)





MESSE  
MÜNCHEN



## Hot spot for the ceramics industry

**The big reunion of the ceramics industry.  
Personal and on site.**

The international and leading trade fair for the ceramics industry enters the next round: this is where market leaders, decision-makers along the entire value chain exchange information on industry-wide topics for the future and insights. Become part of this world full of innovation. Finally on site in Munich.

**Secure your ticket now!**  
[ceramitec.com/tickets](https://ceramitec.com/tickets)

**ceramitec**

**Technologies · Innovations · Materials**

**June 21–24, 2022 · Messe München**  
[ceramitec.com](https://ceramitec.com)

# How to make metal powders.

## Part 3: Understanding gas atomisation and gas atomised powders

In the third instalment of our four-part series on metal powder atomisation, atomisation experts Joe Strauss and John Dunkley explore gas atomisation. Gas atomisation has in recent years seen a major uptick in interest due to its use in the production of metal powders for Additive Manufacturing. However, gas atomisation is nothing new; the concept was first patented more than 100 years ago, and powders produced by this method have a wide range of applications on a global scale, from the production of PM superalloy and MIM powders, to solders, spherical bronze powders for filters, brazing pastes, and more.

The gas atomisation process involves, in its most fundamental definition, breaking up a stream of molten metal, using a stream of high-velocity gas, into a spray, which freezes in flight to form powder particles. There are several possible arrangements for this. Perhaps the simplest, and one still widely used for some non-ferrous metals, is to pour a vertical stream of metal into one or more horizontal gas jets. Most atomisers, especially for higher melting point metals, have the melt travel vertically downwards and pass through downward-facing jets of gas.

Gas atomisation is very different from water atomisation, due to the far lower heat transfer rate afforded by gas compared to water. This means that the solidification times for molten metal droplets are at least an order of magnitude longer and that the atomising vessel needs to accommodate flight paths as long as several metres, while, for water, less than one metre often

suffices to ensure no splatting on the atomising vessel walls. The same difference in characteristics means that water atomised powders always leave the vessel at < 100°C, while gas atomised powders can be over 300°C at exit and further cooling is often needed downstream. An example of the upper melt end of a modern gas atomiser is shown in Fig. 1.

Gas atomised powders are often thought of as 'spherical.' This is by no means always true. Firstly, most air atomised powders of alloys with high-melting and stable oxides, like Zn, Al, Sn, and Pb, are inhibited from spheroidising by the strong oxide film, which forms on the liquid droplets. Even inert-gas atomised powders, which naturally have little



Fig. 1 Atomising Systems Ltd anti-satellite atomiser incorporating two 250 kg furnaces, installed at Castolin-Eutectic Ireland (Courtesy John J Dunkley)

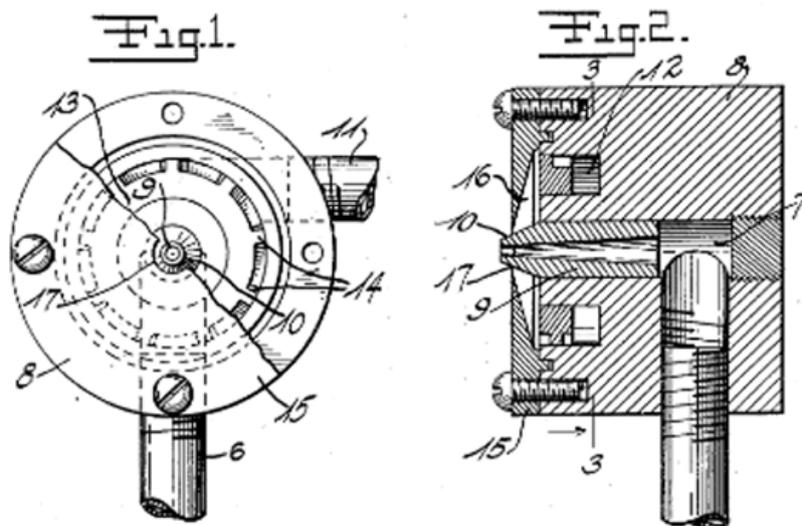


Fig. 2 'Process for disintegrating metal' from the original US Pat 1,659,291 – 1917 – E J Hall (Courtesy US Patent Office)

or no surface oxide, often suffer from 'satelliting,' where fine powder particles are welded to the larger particles. In extreme cases, this can reduce Apparent Density from 4.5 g/ml to 3.5 g/ml for a steel.

## History of gas atomisation

As outlined in our introduction (published in *PM Review*, Winter 2021, Vol. 10 No. 4), materials in the form of powder constitute a substantial volume of many metals, ranging from ~0.1% to nearly 50% of global production of different metals. A large proportion of metal powders by mass is produced by gas (both inert gas and air) atomisation. This process dates back over a century, with an early patent filed in the UK in 1872, namely patent no 3322 by W Marriot, which shows the steam atomisation of molten lead. Steam was the most readily available compressed gas at the time, but, in the 1890s, compressed air became available as an economical alternative.

It seems likely that the concept of gas atomisation was well understood by the turn of the century and possibly applied to other low-melting metals such as zinc and tin. Certainly, the great Professor Everett Hall (1879–1931) filed a number

of patents in the First World War covering the production of aluminium powders by air atomisation, with designs that still seem very familiar to us a century later (Fig. 2).

By 1940, air atomisation was a well-established process for the production of zinc, aluminium, and probably also copper/brass/bronze powders. During World War Two, German engineers applied it to pig iron for iron powder production using the RZ process (Roheisen Zunder-Verfahren or 'pig iron ignition process'). In the 1950s, W D Jones in the UK worked on inert gas atomisation as well as water atomisation and, by the 1960s, plants were being built for thermal spray alloy powder production of the NiCrBSi self-fluxing type. The development of Powder Metallurgy of high alloys and the concept of Rapid Solidification (RS) for refinement of microstructures led to the construction in Sweden of inert gas atomisers for tool steels, which went commercial on a 1–2 t scale in the 1970s. At the same time, the US government invested heavily in R&D on RS superalloys for aerospace and the first Vacuum Inert Gas Atomiser (VIGA) units were constructed with 100–300 kg capacity.

Since then, the use of inert gas atomisation (IGA) with air melting, as well as VIGA, has become widespread in use for thermal spray powders,

PM superalloys, AM powders, and MIM powders. VIGA production of superalloy powders in the US alone now amounts to something in the order of 10–20 kt/year.

## Range and (global) scale of current applications

Air atomisation is currently used very widely for Al and Zn powder production. Al volumes total well over 100, probably 200 kt/year, and are used for a huge variety of applications. Zinc volumes are even bigger, but the Zn powder market is (paradoxically) smaller. Most zinc powder is produced inside zinc smelters for use in the purification of the zinc sulphate liquor from which zinc is electrowon. Some 13 Mt/year of zinc is produced, the vast majority by electrowinning, and such smelters typically use 2–5% of their production as powder in purification, suggesting a volume of 260–600 kt/year is being atomised.

Modest amounts of tin and lead-based solders are also produced with air atomisation, although most solders for electronic purposes must be handled with inert gas. Non-ferrous metals like Cu, brass (Cu-Zn) and bronze (Cu-Sn) are also air atomised, the latter to make spherical bronze for filters (using phosphorus additions in the melt to avoid surface oxidation in flight). Total tonnage is probably in the 20–40 kt/year range.

Inert gas atomisation is the method of choice for more demanding applications, such as MIM, AM, HIP, HVOF, brazing pastes, etc. Nitrogen is the most economic option, but argon is also used on reactive alloys like superalloys and titanium. Helium is used mostly in the production of aluminium and magnesium powders, but there is currently a huge incentive to switch to argon due to the unstable supply and high cost of helium. Total installed capacity of IGA and VIGA probably approaches 100 kt/year, with large numbers of plants in different countries and industries. They range from tiny plants for a few kgs of precious metal brazing alloy to 3 t/h continuous plants for tool steel

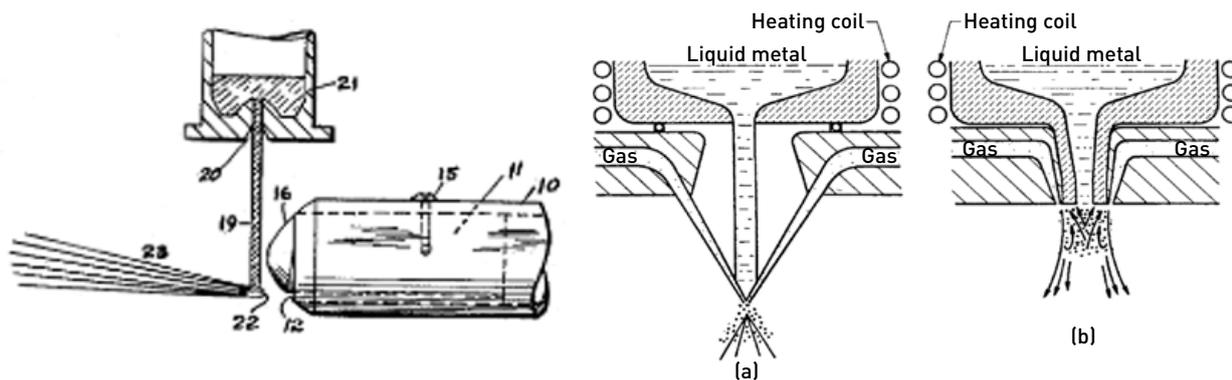


Fig. 3 Left; 'Apparatus for making metal powder,' showing a cross-jet atomiser for zinc powder production, from US Pat 2,440,531, 1946 – W Zebroski (Courtesy US Patent Office). Right; Diagram of free-fall and close-coupled atomisation process (From 'Atomization The Production of Metal Powders,' by Alan Lawley, MPIF)

production. The fact that they are mostly processing relatively valuable metals and alloys (high value-added, large margin applications) makes small, local, plants economically feasible as opposed to iron powder plants, where low cost and economy of scale is imperative.

### Atomisation nozzle designs

Historically, we have seen a progression from the simple cross-jet type to free-fall and close coupled (confined) types. These are illustrated in Fig. 3. It is found that the cross-jet systems need a large horizontal vessel and often suffer a lot from a very broad distribution, leading to splatting on surfaces and poor yields. This is primarily due to the inefficiencies of the non-symmetrical disintegration of the melt stream. Also, in this configuration, the gas jet is a distance away from the melt stream, in the order of an inch or several inches (25–100 mm), and the gas loses energy quickly over this distance. The molten metal side is, however, very simple and reliable, as it just entails the unimpeded gravitational flow of melt from the bottom of a crucible or tundish.

It is difficult to control the particle size distribution, but these systems are still used extensively for the production of zinc, tin, and many red metal powders. The Free-fall type [of which it can be said the cross-jet is a member] allows the melt to fall

into gas jets that are often arranged in a radially symmetric geometry so that the melt stream is disintegrated evenly around its perimeter. Again, since the melt stream is not confined, this reduces difficulties due to freezing of the tundish nozzle, but the energy in the gas jets is still somewhat dissipated due to the relatively long travel before impact. Thus, it is not well suited to fine powder production (medians much below 100 µm), but is used on a very large scale for HIP tool steel powders.

The terms 'confined' and 'close-coupled' with respect to atomisation nozzle design are used interchangeably. The term 'close-coupled' was coined by Walter Giles of GE CR&D in the late 1970s or early 1980s and

referred to the close geometrical proximity of the gas exit and the melt stream; fractions of an inch (1–5 mm) rather than several inches (70–200 mm) for a free-fall nozzle. However, it is not just the geometric configuration between the gas and the melt stream that merits the term 'close-coupled.'

Close-coupled also refers to the attribute that the melt flow is coupled to the atomisation gas flow. The melt flow rate is affected by, if not effectively controlled by, the atomisation gas pressure, flow rate, and the geometric attributes of the nozzle. In order to implement the close-coupled effect, the melt stream must be confined within the nozzle (usually via a refractory insert). Fig. 4 is a

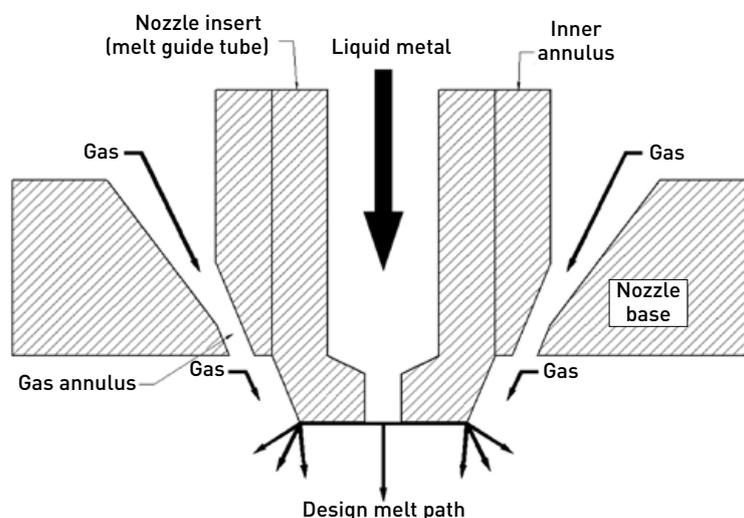


Fig. 4 Schematic of a contemporary close-coupled nozzle in cross section (Courtesy HJE R&D)

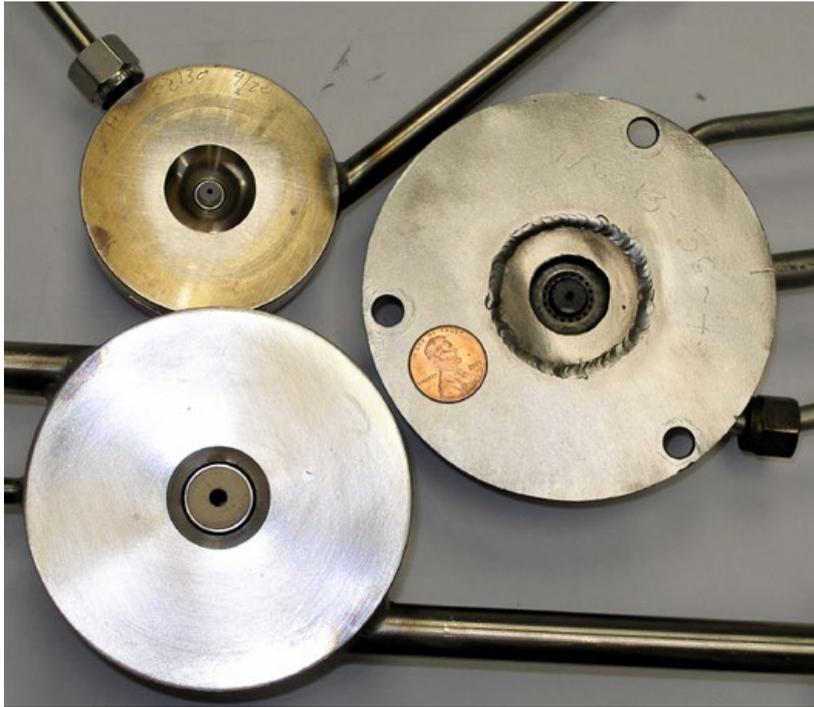


Fig. 5 The gas and metal exit side of some close-gas nozzles (with refractory inserts in place) (Courtesy HJE R&D)

***“The close-coupled nozzle, where the gas impinges on the melt very close to both the gas nozzle and the ceramic nozzle, is more efficient and allows the production of steel powders with median sizes as fine as 20 µm...”***

schematic of a typical contemporary design of a close-coupled nozzle insert.

The melt stream, although confined in a refractory insert, is nevertheless in close proximity to the relatively cold atomisation nozzle body and gas plenum. The heat loss of the confined melt must be minimised so that solidification does not occur. Also, note that this schematic is very similar to that in Fig. 2; the original Hall nozzle. A gas plenum surrounds the confined melt stream. The melt exits from a centre orifice in the tip of the insert, while the gas exits through an annulus surrounding the melt stream. Fig. 5 shows the exit

side of some typical gas atomisation nozzles. Note that the gas exit can be annular or a ring of discrete jets.

As mentioned earlier, the melt flow rate in a close-coupled nozzle is not a simple function of gravity, but is controlled by the gas pressure (among other nozzle and nozzle insert design attributes). Fig. 6, top, shows a plot of the melt flow rate vs gas pressure for a particular small-scaled close-coupled atomisation nozzle. The red line is the theoretical melt flow rate through the nozzle insert from gravity alone. It is clear that not only does the nozzle gas flow enhance the melt flow rate, but the effect is not monotonic. Further,

the accepted figure of merit for rating the performance efficiency of an atomiser is the ratio of the gas mass flow rate to the melt mass flow rate, otherwise known as the Gas/Metal Ratio (GMR). Fig. 6, bottom, shows the GMR vs gas pressure that corresponds to the top graph. The GMR is also not monotonic with gas pressure. It should be noted that close-coupled atomisation nozzles are designed to produce various profiles of these curves to match gas source pressures and flow rates and to optimise the powder yield in the desired size range.

The close-coupled nozzle, where the gas impinges on the melt very close to both the gas nozzle and the ceramic nozzle, is more efficient and allows the production of steel powders with median sizes as fine as 20 µm, but has the drawback that nozzle freezing is much more likely and that the gas greatly affects the melt flow rate due to its altering the pressure, to either positive or negative values, under the melt nozzle. Given the well-known dependence of median size on the square root of GMR, this gives rise to big changes in PSD if not carefully controlled.

Gas pressures and flows used vary significantly. Air atomisers often run at 7-12 bars (0.7-1.2 MPa), while inert gas free-fall units often run at rather higher pressures, from 12-20 bars (1.2-2.0 MPa). Close coupled nozzles, being often targeted at the finest powders, can run up to 100 bars (10 MPa), but the benefits of pressures above 30 bars (3 MPa) are the subject of debate and engineering difficulties obviously increase costs at very high pressures. Gas flows also vary greatly; generally speaking, a GMR of 1 n.cu.m/kg is suitable for coarser powders, but the finest powders can, in some plants, demand flows approaching 10 n.cu.m/kg. In the case of very special drip-melting units for titanium, volumes approaching 100 n.cu.m/kg of argon have been reported.

Given the current trend to build plants for AM, MIM, and other demanding applications requiring low oxygen and spherical powders, close-coupled nozzle design has been the subject of great interest with hundreds of academic papers published on modelling of gas flows using CFD methods. While these can accurately model gas-only flow fields, the extreme complications involved in 2 or 3-phase flow, with extreme heat transfer rapidly changing the gas properties and very rapid momentum transfer from gas to melt, make the results unhelpful in designing practical nozzles. Sadly, in most cases, it is trial and error that has led to successful designs, which are to a greater or lesser extent proprietary. The two most critical aspects of a nozzle's performance are:

1. To run reliably for extended periods
2. To produce consistent powder, requiring consistent GMR and hence melt flow rate.

The second requirement can be summarised as providing powder with a good and consistent yield of the required particle size.

### Process parameters

The most important parameters (ignoring nozzle design factors) controlling the resulting powder particle size distribution are:

1. Gas/Metal Ratio
2. Gas temperature
3. Melt temperature
4. Alloy surface tension
5. Atomising gas type (especially density)

Gas pressure, as mentioned above, is often thought important, but with a fixed nozzle design, gas flow, and hence GMR, will increase directly with pressure (if melt flow is constant). It is hard to find much reliable data to distinctly show that pressure, of itself, is very important. A major complicating factor is that, for close-coupled nozzles, the

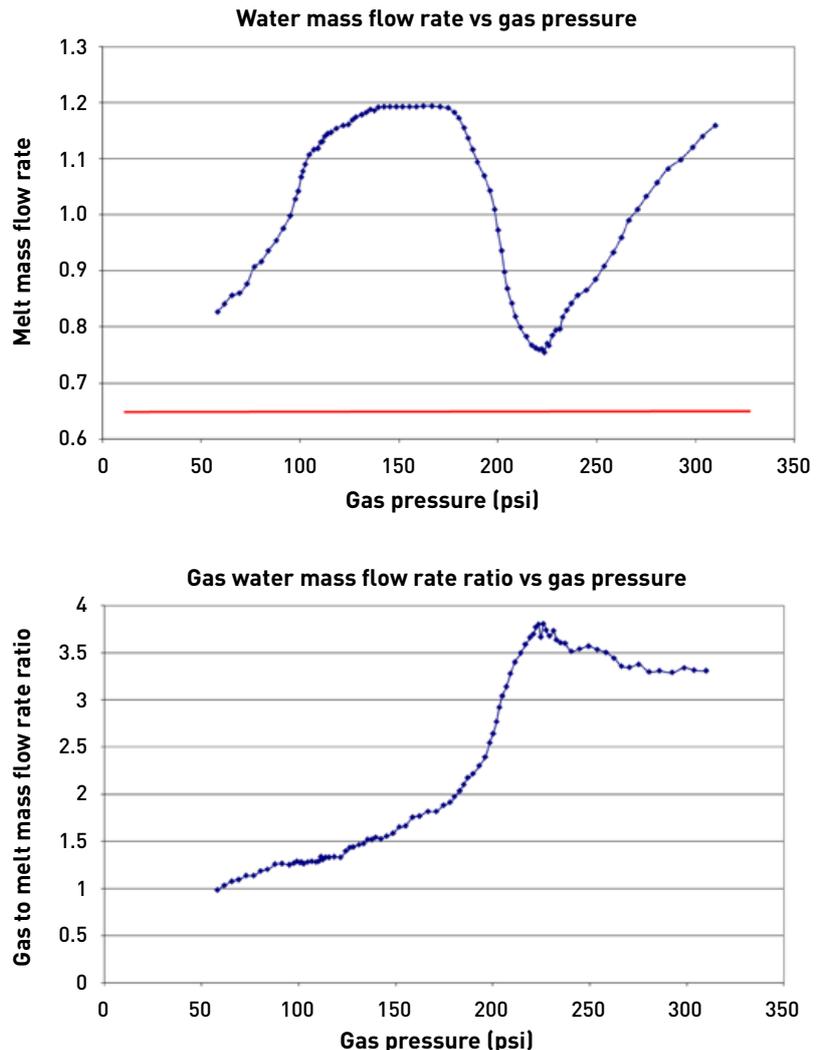


Fig. 6 Top; A plot of the melt mass flow rate vs nozzle gas pressure, Bottom; The corresponding plot of the gas to melt ratio (GMR) vs nozzle gas pressure (Courtesy HJE R&D)

suction/pressure at the nozzle tip often changes with gas pressure. This means that the GMR will be changed both by the gas flow changing and the melt flow. Generally speaking, we find that D (particle median size) and GMR (on either a vol/mass, mass/mass or vol/vol basis) are related by:

$$D = k (GMR)^{-0.5}$$

Furthermore, we find experimentally that D is related to the gas absolute temperature by:

$$D = k' T^{-0.6}$$

In each case k, k' are constants for the given nozzle design and metal.

The effect of gas temperature is very beneficial, as the gas consumption of a nozzle falls with the square root of absolute temperature as well as producing finer powder.

The effects of melt temperature are generally second order and, for steels etc., are hardly practically applicable as minimum reliable pouring temperatures for the close coupled nozzles are so close to the maximum permitted by refractory life. For lower melting alloys, some variation in size could be achieved as hotter melts have lower surface



Fig. 7 Small gas atomisation system in operation with liquefied gas in the vessel as a quenchant (Courtesy HJE R&D)

tensions, but the cost of increasing melt losses makes it very unusual to use superheat in this way.

Alloy surface tension is very important, with median size roughly inversely proportional to it. Thus, such things as sulphur addition, which drastically reduces surface tension, or even oxygen in copper, can be used to make finer powders. However, the end-use alloy specifications must be addressed before making upstream changes, even at the impurity level. While melt surface tension may not be a variable that can be easily manipulated, the understanding of its contribution helps explain why different alloys may have completely different atomisation results using the same atomisation parameters.

Gas type, particularly gas density (which affects the speed of sound and hence the velocity through the nozzle – rather like temperature) is important. Nitrogen and argon (and air) are rather similar, while helium is dramatically different and makes far finer powder, although at huge cost, so is very little used. Hydrogen would be interesting, but is generally considered too dangerous.

## Atomisation system components

### Atomisation vessels

The purpose of the atomisation vessel is to contain and confine the powder. Depending on the case, this could be as much to protect the

immediate work area and personnel as to protect the powder itself. In some fundamental air atomisation systems, especially those with horizontal cross jet configurations, the vessel may be a bottom-emptying trough and the atomisation end is open. At the far end is ductwork that leads to a cyclone, baghouse, and fan, which provides a continuous flow of air through the system so the powder is drawn into the ductwork. The fan draws far more air than the atomisation nozzle issues so the 'make-up' air comes from the immediate environment. This has the advantage that all heat is removed as hot air and no water-cooling of the vessel is necessary.

Inert gas atomisation utilises closed chambers, which are almost always vertical. The system is sealed and the powder remains within the system – sometimes throughout all post processing, which can include sieving and loading into HIP cans. In some systems, the powder is pneumatically conveyed to a remote area where the powder is separated from the gas stream via a cyclone and baghouse. Smaller systems collect the majority of the powder in the bottom of the chamber in a receiver (removable container) and the fines are separated from the gas stream with a cyclone.

In all cases, the vessel must perform the following tasks:

1. The vessel must be of sufficient size so that the powder droplets have solidified before contacting the vessel walls. Higher atomisation gas pressures, higher melt flow rates, and larger particle sizes produce longer droplet trajectories and thus require larger vessels. Some of the larger systems may exceed 50 feet (15 m) in height. Some very small systems use forced cooling in the form of a water quench or atomisation directly into liquefied gas. Obviously, to use a water quench, the alloy must not be affected by the water, such as with many precious metal alloys. Fig. 7



Fig. 8 The melt system of an EIGA atomiser. The ingot (upper centre) is melted from the bottom by a conical induction coil. The melt stream drops into a non-closed nozzle [Courtesy ALD]

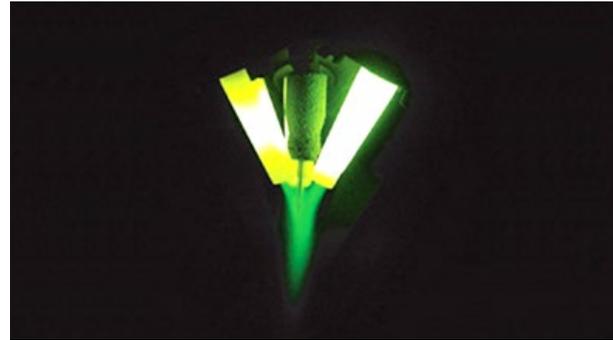


Fig. 9 Picture of a non-transferred arc plasma-wire atomiser. Three plasma torches are focused on a wire that runs through the focal axis [Courtesy PyroGenesis]

shows a very small system that utilises either water or liquified gas ( $N_2$  or Ar) for the quenchant.

2. Provide cooling to the powder and the gas stream. The powder needs to cool off sufficiently so that it does not sinter in the receiver or other collection areas and does not react with the environment (oxidise) when it is removed from the system. The effluent gas stream also needs to be cooled so that downstream processing (filtering) does not exceed the temperature capacity of the bag house. In order to achieve this, most vessels are at least, in part, water jacketed. Thermal expansion of large, unjacketed vessels is also a consideration.
3. Prevent the introduction of contaminants to the powder. Most vessels are stainless steel so that they may be exposed to the environment for collection and cleaning without oxidising. Plain carbon steel has better thermal conductivity and is sometimes used for less expensive systems not using a water jacket. However, their exposure times must be limited or the insides may oxidise, which could result in contamination of the powder.
4. Must be structurally designed to withstand any pressure

differentials between the inside of the vessel and the external ambient pressure. Gas atomisers are often operated at up to several psi (~1-200 mbar) internal pressure, while some are operated at sub-ambient pressures internally. In both cases, the vessel design must withstand the operating pressures without structural failure and also must not leak powder/gas out or ambient atmosphere in, depending on the internal operating pressure. This is especially important for systems processing reactive metals such as Al, Mg, Ti, and others.

#### Melting systems

Melting systems vary considerably, depending on scale and the alloy being melted. Examples of a modern EIGA melt system and non-transferred arc plasma-wire atomiser are shown in Figs. 8 and 9. The vast majority of melting for atomisation is crucible melting, where the melt is contained in a refractory material, such as ceramic. Gas-firing is often employed for air melting of low temperature materials such as tin, zinc, some red metal alloys, and lead. Electrical resistance melting is used for aluminium and magnesium. Induction melting can be used for just about all of the others and over a wider range of melt sizes from 1 kg to 50 t.

Small scale batch atomisers may only have a single melt source using bottom-pouring. In this case, the material to be atomised is melted directly in the atomiser 'tundish' and bottom tapped via a stopper rod into the atomisation nozzle. Systems of this scale are usually limited to melt capacities of about 25 kg. Larger systems use a primary melter to bulk melt the material and this is transferred to a tundish on the atomiser, which bottom feeds into the atomisation nozzle. The tundish may be heated and the heat source is often different from the primary melter. The heating of the tundish is primarily to mitigate heat losses as the melt flows to the nozzle. In large systems, the tundish may simply be preheated by gas burner, which is removed once the pour is initiated. For atomisation rates exceeding about 25 kg per minute, the heat loss in the tundish can be modest, thus avoiding the need for continuous heating. For systems pouring at slower rates, the tundish may need to be heated throughout the atomisation run.

Air melting, where the melt is exposed to the air and may be poured from the primary melter to the tundish through air, is common. Many metals, even some stainless steels and Co-Cr alloys are air melted, even though the atomisation is done inertly. Enclosed melters (inerted or vacuum) are

*“The source of gas chosen for the gas atomisation system is primarily a function of the gas flow rate and pressure/temperature required.”*

more complex and tend to limit the size of the primary melter, as well as drastically slowing cycle times. In some special cases, the melt system may be enclosed and pressurised to enable use of nozzles that do not normally aspirate.

Plasma and arc melting have also been used in atomisation. Cold hearth plasma melting has been used for refractory alloy melting and arc melting has been applied to small refractory melt systems as well as the largest iron systems as a source for the primary melt production and refining.

The above-mentioned melt methods all use crucibles of some sort to contain the molten metal. In the case of ceramic crucibles (including clay-graphite, SiC, graphite, and rammed systems), there may be issues with the melt reacting with the crucible (such as titanium) or the melt temperature being greater than the temperature rating of the available crucible materials (i.e., refractory metals). There are several non-crucible melt methods that are currently used:

1. **EIGA (Electrode Induction melting Gas Atomisation):** In this method, an ingot or billet of material is rotated slowly in the vertical axis in a conical induction coil. The induction power melts the bottom of the melt stock forming a melt stream, which drops into a free-fall atomisation nozzle. This method can theoretically atomise any material that will melt in the induction coil, as there is no contact between the melt and any surface. Fig. 8 is a picture of the EIGA melt system.

2. **Plasma wire atomisation:** This method uses a wire as the melt feedstock. The wire is fed into the focal intersection of several (3 to 4) non-transferred arc high pressure plasma torches. These torches issue a plasma, which is capable of melting the wire and disintegrating the melt. There has been a significant use of this method for producing titanium powder as well as some refractory metals and alloys.

#### Atomising gas supply

The source of gas chosen for the gas atomisation system is primarily a function of the gas flow rate and pressure/temperature required. For example, air atomisation systems rely solely on air compressors. Air compressors are available to provide almost any flow rate, but pressures are generally limited to less than 300 psi (20 bar, 2 MPa). Rotary screw compressors are most efficient when running at 100% output (flow and pressure), but multi-stage piston compressors can achieve higher pressures, although at lower efficiency and higher cost if high flow rates are needed. Many helium atomisers use compressors to recycle the expensive gas. The gas is compressed for the atomisation and then compressed again to move it to storage (bags or tanks).

Inert gas atomisation (N<sub>2</sub>, Ar, and He) that operate at pressures greater than can be achieved from a compressor can be fed directly from a compressed gas bottle, direct evaporation of liquefied gas (N<sub>2</sub> and Ar), or cryopumping of liquefied gas through a high-pressure evaporator

to a bottle gas store for high flow, short run atomisers; the method chosen depends mostly on the pressure required and the volume used per minute and per batch.

Individual gas bottles are most expensive per gas unit, but are ultimately portable and require no special infrastructure. Their use is mostly restricted to small atomisation systems (less than 25 kg melt capacity) operated less frequently.

Evaporation from liquefied gas requires a storage unit for the liquefied gas (dewars or bulk cryotanks) and an evaporator. The maximum pressure achieved is usually limited by the liquid storage unit, which is about 350 psi (23 bar, 2.3 MPa) when the storage directly feeds the evaporator. There are speciality units that will allow higher pressures by transferring the liquid to a higher pressure capacity storage unit, which is then valved off from the primary storage. Heating of the liquid gas is used to increase its pressure for higher delivery pressure applications.

If higher pressures (> 30 bars, 3 MPa) are required, the liquefied gas can be cryogenically pumped to very high pressures, where it is evaporated and can be stored in high pressure cylinders (AKA 'tube farm') for future use. Pressures of up to 3,000 psi (200 bar, 20 MPa) can be achieved with this method. It is possible, for larger systems (>500 kg), to feed the atomiser directly from the cryogenic pump and evaporator but this requires larger or multiple cryopumps. It is more common to use a small cryogenic pump, which works between melts to fill the tube farm in the case of smaller melts.

Bulk gas storage, evaporation/pressure building, and delivery systems are complex and costly. Normally, a gas supplier will design and install the system and lease it to the gas user. In return, the gas user must purchase their gas from this supplier.

In some cases, oxygen is added to the inert gas to passivate the powder. This is intentional oxidation

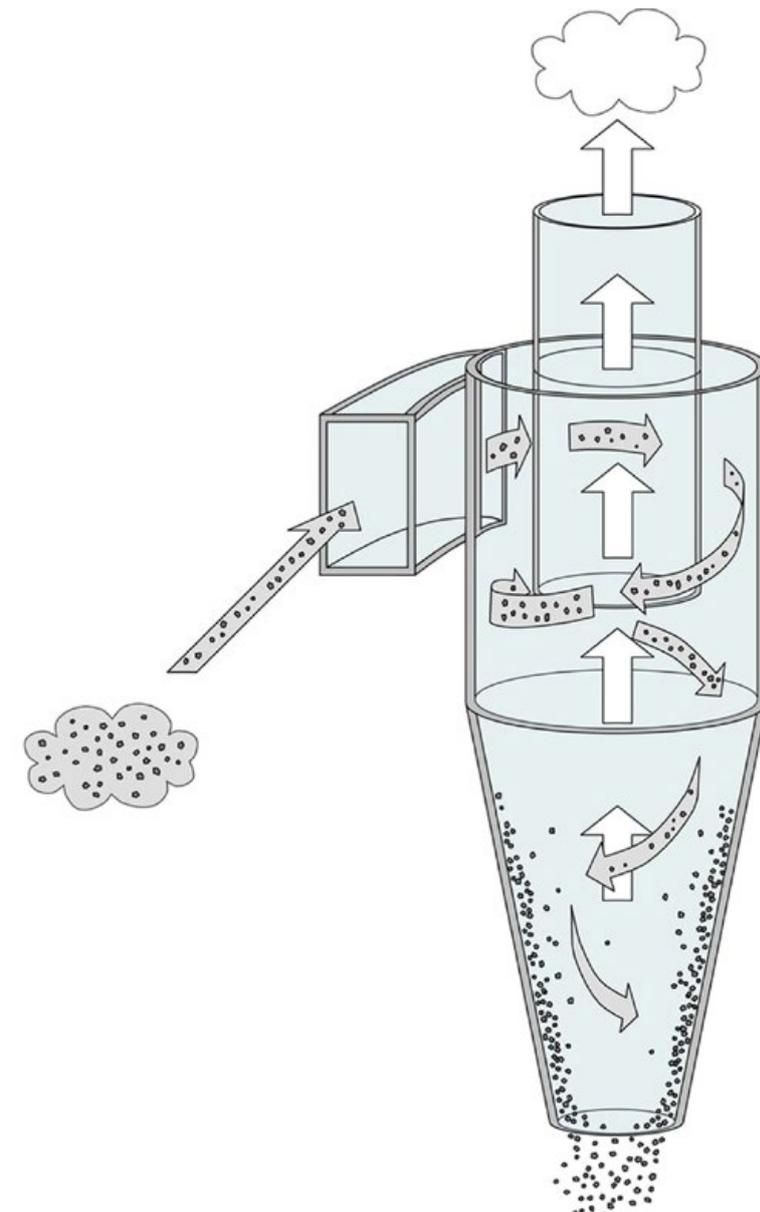
to the surface to render it more stable or less pyrophoric. Oxygen can be added to the atomisation gas or to the gas in the atomisation chamber. This is common for aluminium, magnesium and other very easily oxidisable metals.

#### Exhaust gas treatment

Once the gas has been used for the purpose of atomisation, it must be treated to remove the product and trap 'fines' from the gas stream. Almost universally, a cyclone is the first line of defence, followed by a filter, usually in the form of a bag house.

Cyclones are usually passive devices, that is, they have no moving parts and act entirely on gas passing through them, which is (modestly) pressurised by the atomisation system. Cyclones can tolerate high temperatures >300°C. When water-cooled, they are efficient cooling devices. A cyclone routes the gas tangentially into a cylinder where it swirls and generates centrifugal forces, which act on the particles to separate them from the gas stream. High gas velocities and smaller diameter cyclones generate the highest centrifugal forces, which enables them to remove finer particles. The trade-off is that there is a pressure drop across the cyclone and this is essentially controlling the pressure in the atomisation vessel. Thus, the cyclone has to be designed specifically for the atomisation gas flow parameters known. Fig. 10 is a schematic of a gas cyclone.

There will always be some particles that are too small to be removed efficiently in the cyclone (less dense materials exacerbate the issue). Large cyclones struggle to remove steel particles much below 5 µm. Bag houses (an enclosure with many filters, cartridges or bags) are used, which can be designed to remove particles down to the sub-micron level if required. Bag houses can be passive or active. Passive ones simply deal with the volume flow rate fed to them by the atomisation system.



*Fig. 10 Schematic of a gas cyclone. The gas/particulate stream is fed tangentially into the top of the cyclone. The particulates separate from the gas stream and flow down the inner surface to a collection receiver at the base (Courtesy Sujay Mistry, Solution Pharmacy)*

Active ones use a downstream blower/fan to move the flow through the bag house. In some cases, the blower can operate at greater flow rates than the atomiser produces. This can help control the pressure in the atomisation chamber, especially with cyclones that are designed with a high pressure drop. It should be noted that the gas must be cooled to <~100°C prior to the bag house as filter elements are usually low temperature fibre or cloth.

#### Gas recycling

The cost of gas can be a significant portion of the atomisation unit costs. As mentioned previously, helium is almost always recycled. Argon is also costly and is often recycled. Nitrogen has a relatively low cost and is rarely recycled unless atomising for thousands of hours/year. Air, other than pre-treatment (compressing, filtering, and moisture removal), is essentially free. While prices are now volatile, due to energy cost changes,

recently compressed air energy cost was about £0.03/n.cu.m, nitrogen ~£0.14/nc.u.m, argon £0.88/n.cu.m and helium over £30/n.cu.m.

If the gas pressures needed for atomisation are low, direct compression of the effluent gas can be used to feed the atomiser in real time or for low pressure storage. This is most common for helium but can be used with nitrogen or argon.

For high pressure atomisers that use argon, the exhaust gas can be condensed by passing it through a heat exchanger with liquid nitrogen as the cooling medium. Argon liquefies 10K above nitrogen. The liquefied argon can be stored or cryogenically pumped. Although the nitrogen used for cooling is lost, the cost is much less than that of the argon.

## Secondary powder processing

As with essentially all powder production methods, it is not currently possible to atomise directly into a shipping bucket. In order to provide powders for specific uses (MIM, thermal spray, AM, HIP, etc.) the powder will need to be separated into the size range required by the end use. Further tailoring of the particle size distribution can be made by selective blending as well.

### Sieving

Sieving is the most common method of size separation. Conventional gyratory and vibratory sieves are

available over a very wide range of capacities: from 75 mm (3 in) in diameter to 1600 mm (64 in) in diameter and generally used for sieving from 45 µm (325 mesh) and larger. Throughputs mostly vary inversely with mesh size and, below 45 µm, the sieving rate can be limited. Ultrasonic sieving and high energy sieving can extend this to finer mesh sizes, but the sieving rate will still be a bottle neck in the processing route.

### Air classification

Air classification is mostly used for separations below 45 µm. For MIM applications, air classification is used to provide the upper limits of the powder size distribution (for example D90 of 25 µm). For AM, air classification is used to provide the lower limits of the powder size distribution, for example a D10 of 15 or 20 µm.

### Blending

Blending is typically done in rotating enclosed vessels. Different size distributions can be blended to provide a range to optimise a specific end use. More often, blending is used to combine multiple small atomisation melts to provide a large lot with uniform properties.

### Safety and material issues

All powder production technologies have issues that are intrinsic to the operation. Solutions are engineered into the equipment, the process, and the personnel responsible for all of the unit operations involved.

### Cross contamination of powder

Atomisers, sieves, classifiers, etc. are expensive. One cannot afford to dedicate a complete system to each specific alloy. Different alloys are made and processed in the same equipment and it is critical to clean the residual powder from the equipment prior to processing the next alloy. All of the equipment involved in powder production is complex with lots of interior surfaces, plumbing, valving, etc. There are numerous places for powder to reside and hide. Simply put, it is extremely labour intensive to perform a completely thorough clean out of a production atomiser and cleaning greatly affects the required economy of scale. For this reason, alloy production campaigns are made as large as possible to minimise the time lost to cleaning, which has been as much as 50% of available hours in poorly designed plants.

In some cases, a strictly limited level of cross contamination may be acceptable. For example, a system that has just processed 316L powder probably does not have to be thoroughly cleaned if the next alloy to be processed is 304 or similar. However, for nickel-base superalloys for aerospace or alloys for medical implants, cross contamination is disallowed.

## Powder and dust issues

### Nuisance or toxic dust

Human respiratory systems are sensitive to powder and dust of almost all types; atomised metal powders are no exception. The severity of the problem is a function of the particle size and the alloy. Finer powders are more problematic. They are more difficult to remove from the ambient air and will penetrate more deeply into the respiratory system. Depending on the situation, masks, respirators, or even complete enclosure suits may be required in some powder operations. Powders containing beryllium, nickel, cobalt, and others have their own intrinsic issues with respect to human toxicology and require more stringent precautions.

*“As with essentially all powder production methods, it is not currently possible to atomise directly into a shipping bucket. In order to provide powders for specific uses (MIM, thermal spray, AM, HIP, etc.) the powder will need to be separated into the size range required by the end use.”*

### Pyrophoric powders

While an alloy can be quite stable in the ambient environment, the conversion to powder increases the specific surface area by many, many orders of magnitude, rendering the powder much more reactive to the environment. In some cases, the powder will simply oxidise. However, in some cases, the powder can spontaneously oxidise at a rate high enough to become a fire. This is pyrophoric behaviour. If a powder is suspended in the air as a dust at a critical concentration and an ignition source is available (even a spark from static electricity), the powder may cause an explosion. This is, in some ways, more dangerous than pyrophoricity. Although powders of Al, Mg, and Ti are well-known to be of concern, even fine iron powder can be dangerous under certain conditions. Proper powder handling procedures must be prescribed that minimise or contain dust and also eliminate ignition sources.

### Gas asphyxiation

For inert gas atomisation, the gas eventually ends up mixing with the ambient environment. Thus, the gas exhaust must be into an area that either is not confined (outdoors) or in an area with sufficient air exchange to accommodate the exhaust gas flow. In this case, oxygen monitors should be used in the exhaust area. In addition, whenever the vessel of the atomiser needs to be entered (for example, for cleaning), oxygen monitors must be used to ensure that the environment inside the atomiser is safe.

## New developments in gas atomisation

### Nozzle development

Although gas atomisation has been utilised for over 100 years, nozzle development continues in the academic, national lab, and commercial sectors. Although most of this work is considered proprietary to the developer, the areas of focus include:

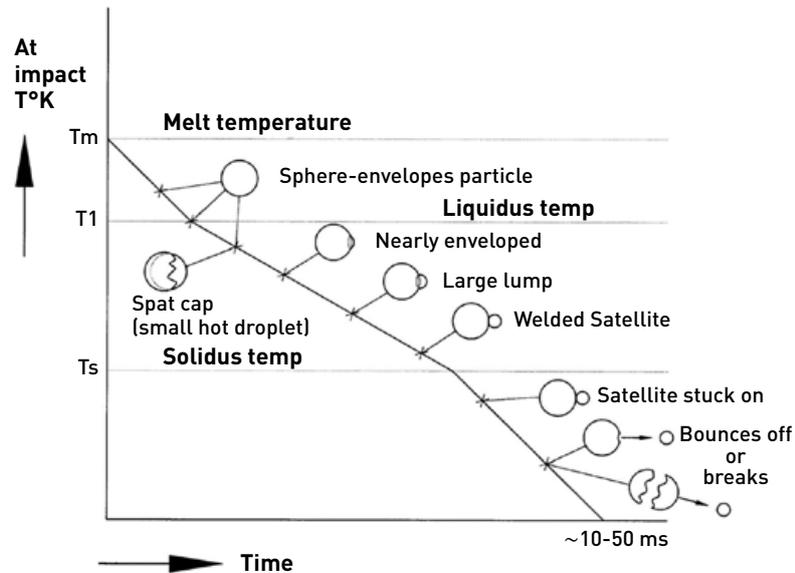


Fig. 11 Plot of relative temperature vs time for a molten particle in flight (Courtesy John J Dunkley)

- Tuning of the atomisation nozzle to produce controlled particle size distributions. This includes not only the median size, but the standard deviation as well. The holy grail is to be able to “atomise into a shipping container,” but reality dictates the ambition of increasing yields in marketable size ranges. Although CFD is becoming more powerful, it is, at best, an aid to optimising the design of the atomisation nozzle. Iterative testing is still required.
- Increasing the reliability of close-coupled nozzles. This genre of nozzle suffers from two primary failure modes: migration of the molten metal until it contacts the metallic nozzle (and destroys it) and minimising heat loss so that freeze-ups are prevented. Work involving the nozzle design includes the insert design and material.

### Heated gas

In the earliest usage of gas atomisation, heated gas, sometimes in the form of superheated steam, was utilised. Even with air or inert gas, heating the gas was found necessary to prevent freeze-ups and increase

nozzle performance. In some way or another, heated gas has always been used with atomisation, but mostly at modest temperatures, sometimes just to even-out the supply gas temperature swings that occur seasonally. However, recent work has confirmed that much higher temperatures lead to increased yield of fines, so work on gas heaters that can operate at greatly elevated temperatures (>500°C) and high flow rates are of interest. If nozzle materials are available, it may be possible to atomise isothermally, that is, the nozzle and gas are at the same temperature as the melt. This is already achieved with low temperature alloys (tin solders and aluminium for example), but even isothermal atomisation of copper would pose a challenge at this time.

### Anti-satellite devices

The need for more spherical powder (mainly for Additive Manufacturing) has resulted in development of active anti-satellite devices. One of the causes of satellites is the entrainment of the powder-laden atmosphere into the newly formed particle plume and trajectory. The development of satellites and other misshapes can be understood using Fig. 11, where  $T_m$  is melt tempera-

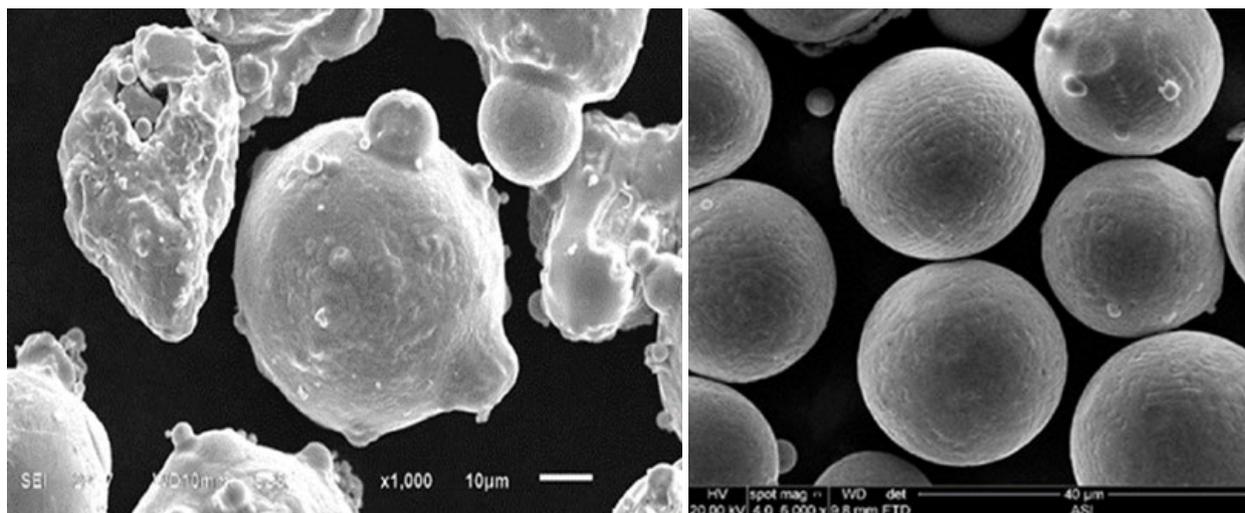


Fig. 12 Left; Badly satellited powder, Right; Powder from 'anti-satellite' atomiser (Courtesy John J Dunkley)

ture,  $T_l$  and  $T_s$  liquidus and solidus temperatures of the alloy. Time is from break-up of the liquid. Collisions can be eliminated by providing a clean gas source to shroud the atomisation plume. In principle, this can be achieved by introducing more gas; however, the gas volumes needed to do this are significant and thus costly. An anti-satelliting system, which includes filtration, cooling, and recompressing the exhaust gas has been designed and implemented (ASL). Fig. 12 offers a comparison of powder made from atomisers with and without anti-satelliting systems.

### Reactive gas

In most cases, it is desired (or assumed) that there is no chemical/metallurgical interaction between the 'inert' atomisation gas and the molten particle. There has recently been some activity entailing intentional doping of the atomisation gas to modify the metallurgy of the particle or change the surface characteristics. Obviously, the addition of oxygen for passivation is an early implementation of 'reactive gas' and the use of nitrogen has been found to be an austenite stabiliser and also form nitrides with certain alloying additions. Further developments in reactive gas atomisation may be specific oxidation for ODS (Oxide

Dispersion Strengthening) applications, the use of gases containing hydrocarbons for increasing the carbon content or carbide content of the powder, or even the addition of reducing gases to produce ultra-low oxygen powder.

### Conclusion

In the 150 years that gas atomisation has been documented, the technology has evolved significantly. Its origins entailed relatively crude jets of steam or air used to disintegrate a molten stream of metal into irregularly shaped particles primarily used for their surface area. The current state of the technology includes specialised nozzles in enclosed systems, using heated inert gas to produce high yields of specialised spherical powder.

Gas atomisation is essential for producing powders used in a myriad of technologies including HIP, MIM, and thermal spray, and it is an enabler for most Additive Manufacturing methods. Gas atomised powders are used in numerous critical applications in the medical, aerospace and military industrial sectors, as well as in parts for consumer devices, automotive components and even luxury items.

While gas atomisation is an established technology, many challenges remain and there are numerous on-going efforts for future improvements in efficiency, cost, and carbon footprint.

### Authors

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

John J Dunkley, PhD, FREng  
Chairman  
Atomising Systems Limited  
jjd@atomising.co.uk  
www.atomising.co.uk

# METAL AM

## SUBSCRIBE TO OUR E-NEWSLETTER

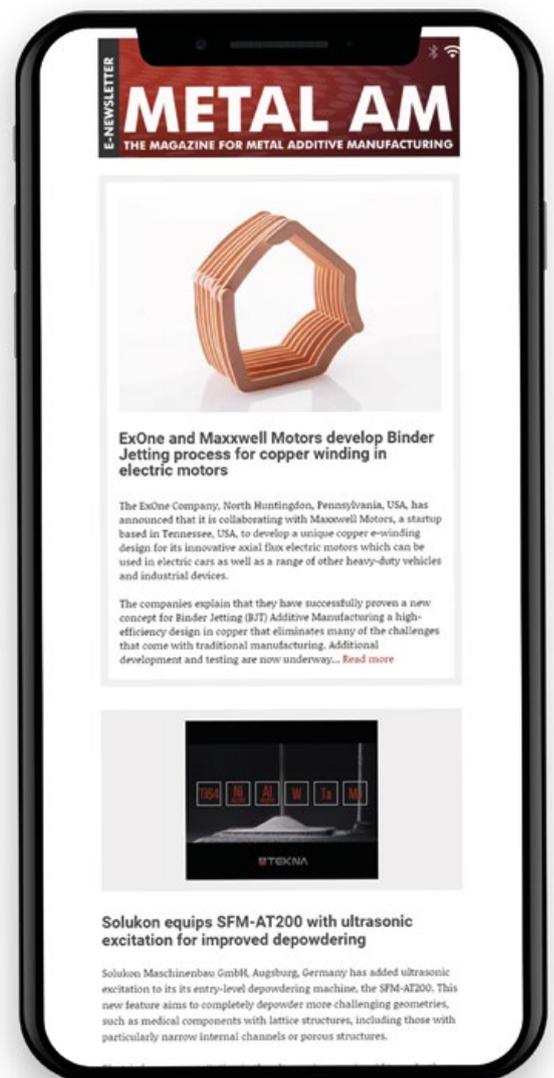
The *Metal Additive Manufacturing* e-newsletter is sent to key metal AM industry professionals worldwide, twice a week. Register today to ensure you benefit from reading the latest industry news and advances in metal AM.

E-newsletter subscribers also benefit from a free digital subscription to *Metal AM* magazine. As soon as each new issue is available we'll send you an email containing a direct link to your free digital copy.



[www.metal-am.com/subscribe-to-the-metal-additive-manufacturing-e-newsletter](http://www.metal-am.com/subscribe-to-the-metal-additive-manufacturing-e-newsletter)

[www.metal-am.com](http://www.metal-am.com)



**formnext**  
SOUTH CHINA



14 – 16.9.2022

Shenzhen World Exhibition and  
Convention Center, Shenzhen, China

Shenzhen International Additive Manufacturing,  
Powder Metallurgy and Advanced Ceramics Exhibition

# Explore endless possibilities

[www.formnext-pm.com](http://www.formnext-pm.com)  
[www.pm-formnext.cn](http://www.pm-formnext.cn)



Uniris Exhibition Shanghai Co Ltd  
Tel: +86 4000 778 909 / +86 20 8327 6389  
Fax: +86 20 8327 6330  
Email: [formnext-pm@unirischina.com](mailto:formnext-pm@unirischina.com)

Guangzhou Guangya Messe Frankfurt Co Ltd  
Tel: +86 20 3825 1558  
Fax: +86 20 3825 1400  
Email: [formnext-pm@china.messefrankfurt.com](mailto:formnext-pm@china.messefrankfurt.com)



# Jiangxi Yuean Advanced Materials: The powder producer thriving in China's growing advanced manufacturing landscape

Formerly known as Yuelong Superfine Metal Powders, Jiangxi Yuean Advanced Materials is a leading Chinese producer of metal powders, including carbonyl iron powders (CIP), as well as powders produced by hybrid-water and gas atomisation. Now a listed company with major expansion plans in the pipeline, it was one of the first Chinese metal powder producers to have a significant presence on the international market. In this article, Fei Tong, Sales Manager, reports on the company's development and plans for the future.

Founded in 2004, Jiangxi Yuean Advanced Materials Co., Ltd., located in Dayu, in China's Jiangxi province, is a leading producer of micron and sub-micron metal powders. Formerly known as Yuelong Superfine Metal Powders, the company joined the Shanghai Stock Exchange in 2021, becoming the first publicly listed metal powder manufacturer focused on powders for use in both Soft Magnetic Composite (SMC) manufacturing and Metal Injection Moulding (MIM).

With the vigorous development of the 3C (computers, communications and consumer electronics) industry in recent years, the demand for electronic components and precision parts, such as inductors, is increasing year by year. Based on this market growth, Yuean decided to focus on expanding its presence in the soft magnetic materials and MIM industries.

Since 2005, when it inaugurated its first Carbonyl Iron Powder (CIP) production line, Yuean has

specialised in the production of fine, high-purity CIP powders with unique morphological properties used in PM, MIM, inductive electric components, diamond tools, microwave radar absorption parts, and nutritional supplements, to name just a few

uses. Initially, Yuean produced CIP for synthetic diamond catalysis, but, due to market demand, the company soon expanded its focus to include MIM for consumer electronic components. For many years, Yuean has worked in close collaboration with experts



Fig. 1 The entrance to Jiangxi Yuean Advanced Materials (Courtesy Jiangxi Yuean Advanced Materials)



Fig. 2 The foundation laying ceremony in 2021 for the expansion of the company's CIP facility (Courtesy Jiangxi Yuean Advanced Materials)

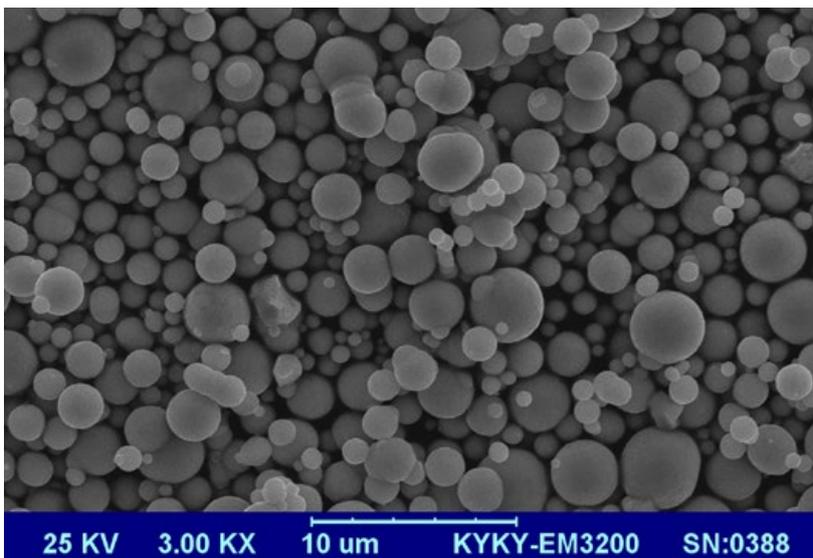


Fig. 3 Scanning Electron Microscope (SEM) imaging of CIP (Courtesy Jiangxi Yuean Advanced Materials)

and scholars in the area of CIP and powder processing technologies to make its products more compatible with a wider range of applications. Among those professionals who have been engaged by the company as R&D consultants is Prof Randall M German, formerly of San Diego State University, California, USA.

In 2009, the company established new hybrid water atomisation facilities for alloy powders and soft magnetic powders to meet customer demand. In the same year, the company began producing MIM

feedstock and, in 2010, it established a German subsidiary, Yuelong GmbH, entering into the international MIM feedstock market. This was followed by the 2011 inauguration of its first gas atomisation line. However, 2015 saw major changes in the MIM feedstock market in China as a result of BASF opening a new facility in Taiwan. This led to Yuean strategically expanding to carbon nanotubes (CNTs) and conductive nickel powders. In the same year, the company further expanded its portfolio with the addition of an atomisation

line specifically for the production of metal powders for Additive Manufacturing (AM).

At present, the company employs a total of 410 workers in its plants and boasts an active management team, including its president Li Shangkui, currently charged with leading Yuean's continuous development and innovation. The company reported a 2021 annual turnover of CNY 410 million, equivalent to around \$64 million.

### Present capacity

Currently, Yuean has a capacity of 4,000 mt/year for carbonyl iron powder; 3,000 mt/year for soft magnetic powder; 3,000 mt/year for hybrid-water atomised powder; 2,000 mt/year for gas atomised powder; 1,500 mt/year for MIM feedstock and 50 mt/year for microwave absorption materials.

The company's powders are widely used in press and sinter Powder Metallurgy, MIM, Additive Manufacturing, electronic components, microwave absorption components, chemical additives, diamond tools, pharmaceutical and nutritional additives, magnetorheological fluids, laser cladding, thermal spray and other applications.

In the realm of high-performance hybrid water atomised powders, the company offers stainless steels such as 304L, 316L, 17-4PH, 420, 430, 440C, 2507, and F75 in high volumes. It can also create bespoke powders per customer requirements.

### Pre-alloy vs master alloy

One area of interest in the production of CIP for MIM is the competition between pre-alloyed and master alloy materials on the market. MIM stainless steel components can be made from either pre-alloyed powders, or master alloy powders blended with the appropriate proportion of CIP. The master alloy/CIP route provides significant cost benefits when very fine particle sizes (typically ~16 µm) are required. However, because

pre-alloyed materials are alloyed prior to atomisation, there is no segregation in the process.

Master alloy powders, in contrast, acts as a kind of concentrated powder, which enlarges the element content in the same proportion based on the elements of the finished powder. This means that the master alloy can be regarded as semi-alloying. According to Yuan, if the atomisation cost is lower for a master alloy than for pre-alloyed powders, many feedstock producers will choose to use master alloys, especially for iron-based feedstocks.

### Gas atomisation at Yuan

Yuan has a range of production equipment with various capacities, enabling it to offer products in a variety of batch sizes, as required by the customer, and achieve optimal material utilisation. In order to lower the cost of gas atomisation and reduce its dependence on external supply factors, Yuan opted to construct its own nitrogen production plant, thus bringing its gas supply in-house. The company also conducts its own research and development of amorphous metal powder production equipment, resulting in an amorphous degree of 100% and product yield of more than 90%.

Through its optimisation of the gas atomisation process, the company has seen a 45% increase in the yield of fine powders and a 50% reduction in the consumption of atomising gas. Gas atomised powder production at Yuan primarily focuses on ferrous materials, iron-base alloys and cobalt-base alloys. Among these products are ferromagnetic materials with applications in coils and chokes such as FeSi, FeSiCr, FeSiAl, FeCo, and FeNi. Ferromagnetic alloys produced at Yuan offer a highly stable chemical composition and uniform particle size distribution (PSD). The company also produces stainless steel powders, including



Fig. 4 Yuan's nitrogen gas production centre (Courtesy Jiangxi Yuan Advanced Materials)

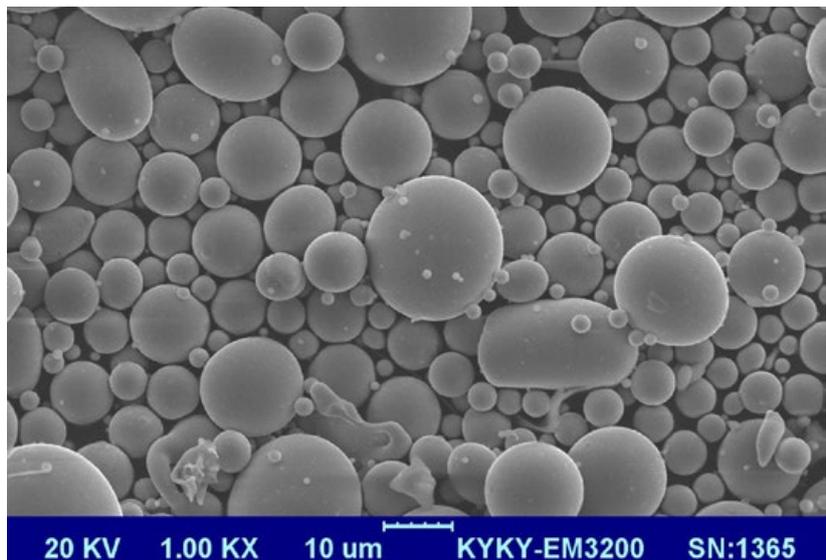


Fig. 5 Scanning Electron Microscope image of gas atomised powder 431 stainless steel (Courtesy Jiangxi Yuan Advanced Materials)

***“Through its optimisation of the gas atomisation process, the company has seen a 45% increase in the yield of fine powders and a 50% reduction in the consumption of atomising gas. Gas atomised powder production primarily focuses on ferrous materials, iron-base alloys and cobalt-base alloys.”***



Fig. 6 This smartphone uses F75 powder for the camera frame (Courtesy Jiangxi Yuean Advanced Materials)



Fig. 7 A 316L smartwatch case produced using Yuean's powders (Courtesy Jiangxi Yuean Advanced Materials)

***“One of Yuean’s main markets is the MIM market. At present, the company’s feedstock facility contains three production lines, with production capacity reaching 120 mt per month. Each production line produces a different feedstock, thereby avoiding cross-contamination.”***

300 series, 400 series and nickel-free stainless steels, for use in MIM feedstock, Additive Manufacturing and laser cladding.

### **MIM feedstock capacity**

One of Yuean’s main markets is Metal Injection Moulding feedstock. At present, the company’s feedstock facility contains three production lines, with production capacity reaching 120 mt per month. Each production line produces a different feedstock, thereby avoiding cross-contamination when switching between feedstock types. The facility incorporates comprehensive performance control and testing equipment, as well as quality control technology, in addition to basic equipment such as a semi-automatic melt index detector, densitometer and true densitometer for MIM shrinkage test sample processing, an injection moulding machine, a debinding furnace (one nitric acid furnace and one oxalic acid furnace), and a Shimadzu vacuum sintering furnace, so that Yuean can test its feedstock using a customer’s chosen technology. Also available is a range of material performance testing equipment including a hardness tester, material testing machine, and Leica metallographic microscope.

Bing Wang, president of Yuean, stated, “In short, Yuean has what it considers to be a perfect range of MIM equipment, both for manufacturing and testing, which not only ensures the quality of its products, but enables it to offer help and guidance for its customers’ part production, new material development and accident prevention and handling.”

Because it produces and tests all its powders in-house, the company’s MIM feedstock production is self-sufficient. The ability to control its materials supply chain from an early stage is conducive to improving the stability of the feedstock Yuean offers. Further, producing base powders in-house means that materials can more easily be customised, according

to customer requirements, including materials with different component contents, or adjusted shrinkage and melt indexes to meet different product or mould requirements.

One example of the advanced MIM feedstocks produced by Yuean is its mirror polish 316L stainless steel, with a sintered density of  $\geq 7.94 \text{ g/cm}^3$ , a porosity of  $< 0.3\%$ , and dense surface layer of  $> 200 \mu\text{m}$ . Another is an ultra-high strength steel, developed in house, with a yield strength of  $\geq 1800 \text{ MPa}$  (typical value  $1900 \text{ MPa}$ ) and good corrosion resistance (per neutral salt spray test  $> 24 \text{ h}$ ).



Fig. 8 An ultra-high strength steel is used in this MIM folding smartphone hinge (Courtesy Jiangxi Yuean Advanced Materials)

## Impact of COVID-19

Despite the COVID-19 pandemic, the demand for micro and nano powders by the high tech industries located around Yuean have maintained a strong continuing demand. Over this period, the technical strength of Yuean has been improved and its product and service structure have been continuously optimised, further enhancing its market development ability. At the same time, driven by the rapid growth in demand from downstream customers, the company's annual sales volume increased significantly in 2021 compared with the same period in the prior year. These rounds of production and sales have further driven the improvement of the company's operating performance.

## Future plans

Looking ahead, Yuean intends to respond to market demand and expand its production capacity for CIP and atomised powders. The company plans to add another CIP production line and install more hybrid water and gas atomised lines between 2022 and 2024, bringing production capacity to around 11,500 mt/year for CIP; 6,000 mt/year for hybrid water-gas atomised powder; 4,000 mt/year for gas atomised powder; 3,000 mt/year for MIM feedstock; 6,000 mt/year for soft magnetic powders and 250 mt/year for microwave absorption materials.

***“The company plans to add another CIP production line and install more hybrid-water and gas atomised lines between 2022 and 2024, bringing production capacity to around 11,500 mt/year for CIP.”***

Bo Li, company vice president, stated that Yuean is also in the process of further capacity expansion and release. “In 2021, the company raised CNY 278 million in IPO and invested in the construction of a series of product projects with an annual output of 6,000 tons of CIP, an expansion project focusing on high-performance ultra-fine metal and alloy powder, and the construction of an R&D centre.” By January 2022, the expansion project on high-performance ultra-fine metal and alloy powder had been put into operation in batches. The project to add an output of 6,000 mt/year of CIP is expected to complete within eighteen months, by the end of this year. Upon completion of the new CIP plant, the company will have a total CIP production capacity of 10,000 mt/year.

The company plans to strengthen its status, based on its optimisation of internal workflows, as one of the few enterprises to produce CIP, atomised powder and MIM feedstock

simultaneously. Clearly, Yuean is a company capable of changing alongside the industry. It is now meeting challenges in new areas such as automotive, micro-miniaturisation inductors, smartphones, etc, by leveraging its competence in metal powder, MIM feedstock and other micron and sub-micron materials. As Yuean continues to embrace the market, the efforts of the team point to a bright future and continued, lasting value for the company.

## Author

Fei Tong  
Sales Manager  
Jiangxi Yuean Advanced Materials  
Co., Ltd.

f.tong@yueanmetal.com  
Tel:+86 797 8772869  
www.yueanmetal.com

# Advertisers' index & buyer's guide

Our advertisers' index and buyer's guide serves as a convenient guide to suppliers across the PM supply chain. In the digital edition of *PM Review* magazine, available at [www.pm-review.com](http://www.pm-review.com), simply click on a company name to view its advert, or on the company's weblink to go directly to its website.

## POWDERS & MATERIALS

<b>Arcast Inc.</b> <a href="http://www.arcastmaterials.com">www.arcastmaterials.com</a>	<b>46</b>
<b>Global Tungsten &amp; Powders Corp.</b> <a href="http://www.globaltungsten.com">www.globaltungsten.com</a>	<b>13</b>
<b>Höganäs AB</b> <a href="http://www.hoganas.com">www.hoganas.com</a>	<b>IFC</b>
<b>Imerys Graphite &amp; Carbon</b> <a href="http://www.imerys-graphite-and-carbon.com">www.imerys-graphite-and-carbon.com</a>	<b>14</b>
<b>Kymera International</b> <a href="http://www.kymerainternational.com">www.kymerainternational.com</a>	<b>25</b>
<b>Mimete S.r.l.</b> <a href="http://www.mimete.com">www.mimete.com</a>	<b>37</b>
<b>Rio Tinto QMP</b> <a href="http://www.riotinto.com">www.riotinto.com</a>	<b>04</b>
<b>Tekna</b> <a href="http://www.tekna.com">www.tekna.com</a>	<b>08</b>

## POWDER PROCESSING, CLASSIFICATION & ANALYSIS

<b>BluePower Casting Systems GmbH</b> <a href="http://www.bluepower-casting.com">www.bluepower-casting.com</a>	<b>17</b>
---	-----------

## PM PRODUCTS

<b>Zhuzhou Cemented Carbide Group Co.,Ltd</b> <a href="http://www.chinacarbide.com">www.chinacarbide.com</a>	<b>43</b>
---	-----------

## ATOMISERS & POWDER PRODUCTION TECHNOLOGY

<b>Arcast Inc.</b> <a href="http://www.arcastinc.com">www.arcastinc.com</a>	<b>34</b>
<b>BluePower Casting Systems GmbH</b> <a href="http://www.bluepower-casting.com">www.bluepower-casting.com</a>	<b>17</b>
<b>GEA Group AG</b> <a href="http://www.gea.com">www.gea.com</a>	<b>18</b>
<b>Hexagon Product Development Pvt. Ltd.</b> <a href="http://www.alphiemixer.com">www.alphiemixer.com</a>	<b>40</b>
<b>Phoenix Scientific Industries Ltd</b> <a href="http://www.psilttd.co.uk">www.psilttd.co.uk</a>	<b>44</b>
<b>Topcast SRL</b> <a href="http://www.topcast.it">www.topcast.it</a>	<b>11</b>
<b>Tekna</b> <a href="http://www.tekna.com">www.tekna.com</a>	<b>08</b>

**COMPACTION PRESSES,  
TOOLING & ANCILLARIES**

<b>DORST Technologies</b>	<b>06</b>
www.dorst.de	
<b>Osterwalder AG</b>	<b>19</b>
www.osterwalder.com	
<b>Progrit GmbH</b>	<b>26</b>
www.progrit.ch	
<b>Sacmi</b>	<b>21</b>
www.sacmi.com	
<b>System 3R International AG</b>	<b>23</b>
www.system3r.com	

**SINTERING EQUIPMENT &  
ANCILLARIES**

<b>Bandas Metalicas Codina S.L.</b>	<b>39</b>
www.codinametal.com	
<b>DSH Technologies, LLC</b>	<b>29</b>
www.dshtech.com	
<b>ECM Technologies</b>	<b>20</b>
www.ecm-furnaces.com	
<b>Edward Orton Jr. Ceramic Foundation</b>	<b>49</b>
www.ortonceramic.com	
<b>Fluidtherm Technology Pvt. Ltd.</b>	<b>45/47</b>
www.fluidtherm.com	
<b>GeniCore Sp. z o.o.</b>	<b>27</b>
www.genicore.eu	
<b>MUT Advanced Heating GmbH</b>	<b>35</b>
www.mut-jena.de	
<b>Sunrock Ceramics Co</b>	<b>31</b>
www.sunrockceramics.com	
<b>Ultra Infiltrant</b>	<b>15</b>
www.ultra-infiltrant.com	

**HIP EQUIPMENT AND SERVICES**

<b>American Isostatic Presses, Inc.</b>	<b>41</b>
www.aiphip.com	
<b>Bodycote</b>	<b>33</b>
www.bodycote.com	
<b>Isostatic Toll Services, llc</b>	<b>41</b>
www.isostatictollservices.com	

**Alphabetical  
index**

American Isostatic Presses, Inc. ....	41
Arcast Inc. ....	34/46
Bandas Metalicas Codina S.L. ....	39
BluePower Casting Systems GmbH ....	17
Bodycote ....	33
ceramitec ....	70
DORST Technologies ....	06
Dritev ....	52
DSH Technologies, LLC ....	29
ECM Technologies ....	20
EcoMatech ....	38
Edward Orton Jr. Ceramic Foundation ....	49
Fluidtherm Technology Pvt. Ltd. ....	45/47
Formnext ....	OBC
Formnext + PM South China ....	84
GEA Group AG ....	18
GeniCore Sp. z o.o. ....	27
Global Tungsten & Powders Corp. ....	13
Hexagon Product Development Pvt. Ltd. ....	40
Höganäs AB ....	IFC
Imerys Graphite & Carbon ....	14
Isostatic Toll Services, llc ....	41
Kymera International ....	25
Mimete S.r.l. ....	37
MUT Advanced Heating GmbH ....	35
NLB Corporation ....	30
Osterwalder AG ....	19
Phoenix Scientific Industries Ltd ....	44
PowderMet2022 / AMPM2022 ....	60
ProGrit GmbH ....	26
Rio Tinto QMP ....	04
Sacmi ....	21
Sunrock Ceramics Co ....	31
System 3R International AG ....	23
Tekna ....	08
Topcast SRL ....	11
Ultra Infiltrant ....	15
Union Process, Inc. ....	22
Wohlers Associates ....	51
World PM2022 ....	IBC
Zhuzhou Cemented Carbide Group Co.,Ltd. ....	43

**POST-PROCESSING**

- NLB Corporation** 30  
www.nlbcorp.com
- Union Process, Inc.** 22  
www.unionprocess.com

**CONSULTING & TOLL SINTERING**

- DSH Technologies, LLC** 29  
www.dshtech.com
- EcoMatech** 38  
www.ecomatech.com
- Wohlers Associates, Inc.** 51  
www.wohlersassociates.com

**EVENTS**

- ceramitec** 70  
www.ceramitec.com
- Dritev** 52  
www.vdiconference.com/dritev
- Formnext** OBC  
www.formnext.com
- Formnext + PM South China** 84  
www.formnext-pm.com
- PowderMet2022 / AMPM2022** 60  
www.powdermet2022.org / www.amprm2022.org
- World PM2022** IBC  
www.worldpm2022.com

**Advertise with us...**

**Combining digital and print publishing for maximum exposure**

Reach out to our rapidly expanding international audience that includes component manufacturers, end-users, industry suppliers, analysts, researchers and more.

**For more information contact**

Jon Craxford, Advertising Sales Director  
Tel: +44 207 1939 749  
jon@inovar-communications.com

**PM FOLLOW US**



[www.twitter.com/PMRMag](http://www.twitter.com/PMRMag)



[www.facebook.com/PMRMag](http://www.facebook.com/PMRMag)



[www.linkedin.com/company/powdermetallurgyreview](http://www.linkedin.com/company/powdermetallurgyreview)

# POWDER METALLURGY REVIEW

## DOWNLOAD ALL PAST ISSUES

**THE *PM REVIEW* MAGAZINE ARCHIVE GIVES FREE DIGITAL ACCESS TO PAST ISSUES DATING BACK TO 2012**

A decade of exclusive content, offering unparalleled insight into the world of metal powder production and manufacturing.



[www.pm-review.com](http://www.pm-review.com)

**INOVAR**  
COMMUNICATIONS

# Industry events

*Powder Metallurgy Review* is dedicated to driving awareness and development of Powder Metallurgy and its related technologies. Key to this aim is our support of a range of international partner conferences. View our complete events listing on [www.pm-review.com](http://www.pm-review.com)

## 2022

### **PowderMet2022 / AMPM2022**

June 12–15, 2022  
Portland, OR, USA  
[www.powdermet2022.org](http://www.powdermet2022.org) / [www.ampm2022.org](http://www.ampm2022.org)

### **EPMA Powder Metallurgy Summer School**

June 20–24, 2022  
Ciudad Real, Spain  
[www.summerschool.epma.com](http://www.summerschool.epma.com)

### **ceramitec 2022**

June 21–24, 2022  
Munich, Germany  
[www.ceramitec.com](http://www.ceramitec.com)

### **Dritev – International VDI Congress**

July 6–7, 2022  
Baden, Germany  
[www.vdiconference.com/dritev](http://www.vdiconference.com/dritev)

### **PMTi2022**

August 29–31, 2022  
Montréal, QC, Canada  
[www.pmti2022.org](http://www.pmti2022.org)

### **13<sup>th</sup> International Conference on Hot Isostatic Pressing**

September 11–14, 2022  
Columbus, OH, USA  
[www.hip2022.com](http://www.hip2022.com)

### **Formnext + PM South China 2022**

September 14–16, 2022  
Shenzhen, China  
[www.formnext-pm.hk.messefrankfurt.com](http://www.formnext-pm.hk.messefrankfurt.com)

### **World PM2022**

October 9–13, 2022  
Lyon, France  
[www.worldpm2022.com](http://www.worldpm2022.com)

### **Formnext**

November 15–18, 2022  
Frankfurt, Germany  
[www.formnext.com](http://www.formnext.com)

### **Hagen Symposium 2022**

November 24–25, 2022  
Hagen, Germany  
[www.pulvermetallurgie.com/symposium-terminer/symposium-aktuell/](http://www.pulvermetallurgie.com/symposium-terminer/symposium-aktuell/)

## 2023

### **MIM2023**

February 27–March 1  
Costa Mesa, CA, USA  
[www.mim2023.org](http://www.mim2023.org)

### **Hannover Messe 2023**

April 17–21  
Hannover, Germany  
[www.hannovermesse.de](http://www.hannovermesse.de)

## Event listings and media partners

If you would like to see your Powder Metallurgy related event listed in this magazine and on our websites, please contact Kim Hayes, email: [kim@inovar-communications.com](mailto:kim@inovar-communications.com)

# WORLD PM22



CONGRESS & EXHIBITION

9-13  
OCTOBER  
2022  
LYON - FRANCE

## EXHIBITION SALES OPEN RESERVE YOUR EXHIBITION BOOTH!

### CATERED NETWORKING BREAKS

Maximise networking opportunities away from your stand with complimentary Coffee Breaks and the Poster Awards Reception

### COMPLIMENTARY WIFI

Stay connected and share your World PM2022 experience on Social Media with free WiFi throughout the Exhibition Area

### PROMOTE YOUR BUSINESS IN INDUSTRY CORNER

Book a presentation slot to tell the PM world about your innovations and breakthroughs

### COMPONENT AWARD 2022 SHOWCASE

Promote your innovate PM designs by showcasing your components in the Exhibition Area

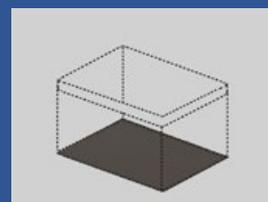
9 m<sup>2</sup>



12 m<sup>2</sup>



Space only



Messe Frankfurt Group

**formnext**

15 – 18 NOVEMBER 2022  
FRANKFURT / GERMANY

mesago

# Make the impossible possible!

We know that additive manufacturing offers undreamed-of potential. In addition to the printer, however you also need the upstream and downstream processes plus the experts, who have mastered the technology. You'll only find all this at Formnext! Find out more now and join us in Frankfurt.

[formnext.com](http://formnext.com)

**Where ideas take shape.**

#formnext

