EPMA 2018 POWDER METALLURGY COMPONENT AWARDS

This booklet contains all of the entries into the EPMA PM Component Awards 2018

www.epma.com/awards
Introducing the latest material database development for Designers and Engineers worldwide

The Global Powder Metallurgy Property Database: a special online resource

The Global Powder Metallurgy Database (GPMD) was created in response to the absence of a readily accessible source of design data which was acting as a significant impediment to the wider application of PM products. The database was the result of a global collaboration between the three major regional trade associations: EPMA (Europe), MPIF (North America) and JPMA (Japan). Since its launch in 2004, the content has been steadily increased to a total of nearly 4000 lines of high quality data.

The GPMD provides physical, mechanical and fatigue data for a range of commercially available PM materials. Originally covering the mechanical and physical properties of PM Steels and Stainless Steels from 6.4 gm/cc upwards, Powder Forged Steels, non ferrous materials and bearing alloys over one thousand new lines of data have been added since the launch. These now additionally cover ferrous and non ferrous MIM materials, fatigue endurance limits and SN curves.

A well tested system of data collection and validation means that the maximum amount of technical information can be displayed without compromising the source and confidentiality of donating organisations. Current areas to be further developed include expanding the available MIM data, obtaining and verifying data from the PM HIP sector and additional data for fatigue properties. Users from all parts of the world can access the pmdatabase, which provides a significant resource to a wide range of designers and engineers, who may not yet be familiar with the PM process and the applications it can create.

The free to access database allows detailed searches on physical and mechanical properties to be made and results downloaded as either spreadsheets or into well-known FEA packages such as Abacus or MSC. The associated website at www.pmdatabase.com also provides background data on the PM process and designing for PM. Users can also view a list of contributing PM parts makers with contact details. For more first class data please visit:

www.pmdatabase.com

Visit the website for more information on:
- How it works
- How it can benefit you
- How to access it
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EPMA Membership Benefits
10 Reasons to join the EPMA

• European and world PM production statistics and information
• Access to PM technology and development programmes
• Networking opportunities at conferences, events and seminars
• Information and lobbying on legislation, such as REACH
• Join the industry-wide benchmarking programme
• Discounts on training courses, congresses and exhibitions
• Free listing on the world’s most comprehensive PM website
• Discounted PM publications, reports and journals
• Weekly email news bulletins and quarterly EPMA newsletters
• Access the ‘Translated Glossary of Powder Metallurgy’
Introduction
The European Powder Metallurgy Association (EPMA) has organised the Powder Metallurgy Component Awards to coincide with the Euro PM2018 Congress & Exhibition in Bilbao, Spain on 14-18 October 2018. These awards were open to companies who manufacture all types of components made by the following PM process:

- Additive Manufacturing
- Hot Isostatic Pressing
- Metal Injection Moulding
- Structural Parts (including Hard Materials and Diamond Tools)

A panel of independent experts drawn from across Europe, used the following criteria to referee the entries;

- To what extent is the PM component described in the entry expected to provide cost savings and/or improved quality?
- To what extent is the entry expected to stimulate further usage of PM materials and technology?
- How well is the entry prepared (description of component, inclusion of diagrams, photographs and other illustrations)?
- How do you rate this component in terms of excellence in exploiting PM or in terms of novelty, surpassing borders or bringing new ideas into practice?

The awards were presented in the Opening Plenary Session of the Euro PM2018 Congress & Exhibition on 15 October. This booklet contains details of all the entries in this year’s EPMA competition which will be on display on the Awards Showcase in the exhibition area. The EPMA wishes to congratulate and thank all the Member companies who entered the competition.

Further information on this year’s award entries can also be found on the EPMA website: [www.epma.com/awards](http://www.epma.com/awards)
ADDITIVE MANUFACTURING
FORGEBRID®

Company: Rosswag GmbH
Strand: Additive Manufacturing
End Use Sector: Power Engineering
Product Density: 7.8-8.2g/cm³
Tensile Strength: 1520 GPa
Yield Strength: 1290 GPa
Product Hardness: HRA
Elongation: 23%

By combining the two production processes of open die forging and selective laser melting, the disadvantages of each process can be circumvented. For this purpose, the respective method is only used in the segment of the part for which it is suitable. A basic body is conventionally forged and subsequently machined to produce a plane surface. On this surface, the functionally optimized contour is added by selective laser melting.

With this innovative production chain, for which Rosswag GmbH was awarded the German Resource Efficiency Award (Deutscher Rohstoffeffizienz-Preis 2016), a component is created which consists of one identically material charge and has been produced in a resource-saving manner. The loss of material is reduced, since the complex geometries aren’t produced with high costs and expenditure of time by machining. This also reduces the consumption of coolants and lubricants.

The remnants produced during sawing and forging can be used for the additive manufacturing process. For this purpose, they are converted into a fine-grained metal powder in an atomizing process. The so-called Atomizer has a melting crucible in which the metal scrap is heated above the melting point. The molten material is atomized from the crucible via a nozzle by means of an inert gas stream to a spray. Subsequently, the spray particles solidify in the drop tower. In a downstream process step, the particles are fractionated for a stable SLM process between 10 μm and 60 μm.
The forging-SLM-Hybrid produced in this way offers a possibility to equip even large-volume parts with features which can only be realized by the additive manufacturing process. Due to the optimum grain structure profile, the forged component area has excellent mechanical-technological properties, especially with regard to the fatigue strength. The complex segments of the part are then manufactured in such a way that an added value results which could not be achieved by conventional production processes.

The hybrid production process is therefore the ideal approach to meet safety requirements and still achieve a functional optimization of the component. Lightweight components in particular must be designed in such a way that the requirements can be met by the use of additive manufacturing technology.
The formula student car, Oxford Brookes racing team in collaboration partnership with The Manufacturing Technology Centre (MTC) demonstrated the capability to manufacture complex automotive parts using Additive Manufacturing (AM), Electron Beam Melting (EBM) process.

The Challenge:
- To achieve part weight saving with better improved mechanical properties though topology optimisation redesign
- Formula car students were looking to develop expertise in design and manufacture of AM
- To manufacture four upright suspension parts using Ti6Al4V material and gain in-depth knowledge of AM possibilities

The Outcome:
- A demonstration of how AM can be used to manufacture complex geometries
- Weight saving by >30% through topology optimisation
- Reduced lead time from design changes to manufacture of parts in comparison to existing conventional methods

The Solution:
- The parts were manufactured using the EBM process, providing a solution via non-conventional manufacturing
- Validation of the part quality through Non-Destructive Testing (NDT) using X-Ray Computed Tomography (XCT) and Bluelight technology for quality and dimensional measurements
- Benefits to the student and engineers:
  - Increased knowledge of design and validation of highly complex and efficient geometries for AM production, to support existing aerospace AM capability
  - Increased knowledge of the student and engineers in AM process, including understanding the role, requirements and influence of topology optimisation and post-processing
LENA SPACE ROCKET NOZZLE

Company: Oerlikon AM
Strand: Additive Manufacturing
End Use Sector: Aerospace
Product Density: 8.19g/cm³
Tensile Strength: 1375 MPa
Yield Strength: MPa
Product Hardness: HRA

This component perfectly demonstrates the advantages Additive Manufacturing has over traditional manufacturing process to create small scale regenerative cooled rocket nozzles. Firstly, using AM to create the component allows the customer to reduce the number of complex manufacturing steps to create a regenerative cooled nozzle. The part can be made as one piece instead of multiple pieces that are then combined together at a later date, which drastically reduces lead times. Secondly, the design freedom AM gives the customer, unlocks the opportunity to create complex internal channels that can improve rocket efficiency and reusability.
KRAKEN – SPECIAL LIGHT MILLING HEAD

Company: University of West Bohemia, Regional Technological Institute
Strand: Additive Manufacturing
End Use Sector: Aerospace/Automotive/Cutting Tools/Engineering
Product Density: 8.1 g/cm³
Tensile Strength: 1160 MPa
Yield Strength: 1050 MPa
Product Hardness: 35-55 HRC

This is a unique tool with specific industrial design features and a special frame structure which delivers more than 60% weight saving when compared to conventional tool construction. The advantages of additive manufacturing have been exploited to create an innovated internal cooling system thanks to which cutting fluid can be delivered not only onto the tool face but, above all, onto the tool flank. A modified cooling system outlet translates into higher cooling intensity on both surfaces of the tool. As a result, a 10-40% improvement in machining productivity can be achieved. The increase in the cutting edge life is 10-35%, depending on the work material. The frame structure and its key structural details provide stiffness and strength comparable with ordinary tools. The tool can serve as a general-purpose tool for conventional machining as well as for HSC and ultra-HSC processes.
SHAPER CUTTER

<table>
<thead>
<tr>
<th>Company</th>
<th>VBN Components AB</th>
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<tbody>
<tr>
<td>Strand</td>
<td>Additive Manufacturing</td>
</tr>
<tr>
<td>End Use Sector</td>
<td>Cutting Tools</td>
</tr>
<tr>
<td>Product Density</td>
<td>100%g/cm³</td>
</tr>
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<td>Tensile Strength</td>
<td>4300 (at full hardness) GPa</td>
</tr>
<tr>
<td>Yield Strength</td>
<td>4300 (at full hardness) GPa</td>
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<tr>
<td>Product Hardness</td>
<td>72 HRC (approx 1050-1100 HV) HRC</td>
</tr>
</tbody>
</table>

To meet the large global need of new alloys for better performance, VBN Components has developed the world’s hardest steel, Vibenite® 290. The company’s base in Powder Metallurgy Additive Manufacturing of wear resistant materials resulted in this new alloy. The properties are a unique combination of hardness and toughness, resulting in outermost abrasive and erosive resistance. In addition, a high cobalt content gives a very good hot hardness, leading to good performance in all applications of increased temperature.

Thanks to the additive manufacturing process, it can be used for any kind of component. VBN Components has developed a metal powder bed technique called AM-HSS™ (Additive Manufacturing High Speed Steel). This technique results in extremely fine microstructure and extremely low oxygen content for all grades in the Vibenite® series. The Vibenite® alloys are of course materials with 100% density.

Some application examples are metal cutting tools such as gear cutting hobs, power skiving cutters and shaper cutters. Other applications are erosion protection shields, wear parts, dry metal forming tools or applications with high rolling contact fatigue demands.

The example shown here is a shaper cutter. The major benefits of using Vibenite® AM-HSS™ when producing these are the heavily reduced needs for machining and eliminated needs of large high speed steel bar stocks in different dimensions. In earlier shaper cutter tests with the former top alloy Vibenite® 280, tool life time was doubled with double feed rates. We expect the results from Vibenite® 290 shaper cutters to heavily precede these fantastic numbers thanks to even higher hardness and heat resistance. Long running shaper cutter tests are on-going at some of the largest truck and construction machine companies in the world. In addition, the scrap when producing Vibenite® 290 is an absolute minimum. Due to the extremely efficient AM production, only approximately 0.5% scrap is generated. Without need for machining, no drilling, milling or turning scrap is produced. Only a final grinding is necessary. And when using the material, it will result in the most environmentally friendly factor of them all: a heavily increased tool or component performance and lifetime.
Framatome, fabricates and supplies reactor coolant pump (RCP) sets covering the worldwide nuclear market (Figure 1). In this RCP, a component with large-dimension and complex geometry puts real production difficulties. Moreover, the manufacturer aims at improving its mechanical performances in connection with the nuclear power plants lifetime extension politics.

Large components with complex shapes, such as impellers, were traditionally manufactured by casting but the lifetime of these products was limited by the ageing of the material due to the presence of ferrite years, alternative approaches consisting of machining impellers from a forged ingot have appeared in the market place. Of course, this solution offers an improvement of the mechanical characteristics but, in the case of a RCP impeller, it implies to start with a 4000kg ingot to finish with a 600kg impeller, resulting in the scrapping of 85% of the material. This observation is also valid in the field of aeronautics where impellers for gas turbines are elaborated by a forging/machining process with a mass ratio of 10 to 100 between the starting ingot and the final part. On the basis of this analysis, a consortium composed of Framatome, Aubert & Duval, Ventana Group, Metalscan and institutional laboratories (Université de Bourgogne, ARTS and CEA) established the manufacturing sequence of a large-dimension impeller in 316L austenitic stainless steel by means of PM-HIP processes with a Near Net Shape (NNS) approach.

The tooling of the impeller has been designed by 2D/3D simulation and then machined in low carbon steel elements. Once assembled and welded, the low-carbon steel container is filled with 316L powder and prepared according to classical HIP capsule preparation procedures. After the HIP cycle, a rough machining was performed to open hydraulic channels and then facilitate the chemical pickling. This approach aims at reducing as much as possible the machining and finishing operations after HIP, in particular on the blades of the impeller, to limit the final cost of the part and reduce the fabrication times.
Finally the part produced exhibited the expected geometric features (+/- 2mm), fine grain size (around 50µm) and isotropic microstructure and excellent mechanical properties (Rp0.2=290MPa, Rm=580MPa, A%=57) (Figure 2) thus validating the global NNS fabrication approach of a large and complex part by PM+HIP. At the end of the project, Framatome considers the PM+HIP NNS impeller as a technical solution, promising an extended lifetime, that could be quoted at the next calls to tender.

Figure 1: Views of the RCP and the impeller

Figure 2: NNS 316L impeller elaborated by PM+HIP
The metal injection molded One Piece Nozzle has pushed this technology to greater heights. It is an impossible task to produce this product near net shape using other conventional methods. Possible methods will be brazing of multiple machined components, which will end up with high material wastage and high cost. The MIM One Piece Nozzle produced good finish with complex internal channel in a sustainable and economical way. This product has opened up an entirely new application for MIM process capability, and definitely the most complex part that we have ever produced.

Development efforts were focused on controlling the distortion of the plastic inserts during metal injection molding, as high injection pressure and temperature will greatly affect the insert integrity. On the contrary, we need to maintain high packing pressure in the inner core channel, as any loss in pressure will encourage weakness resulting in cracks. Finding the ideal injection parameters that resulted in overall good part were highly challenging during development phase. The other critical feature is the tip of the nozzle, the diameter of the hole and gap surrounding it are controlled in micron range which are MIM without secondary operations. Looking at the cross-section you will understand the critical features were achieved with great definition.

The One Piece Nozzle is applied in a Selective Catalytic Reduction (SCR) system for commercial vehicles in Europe to comply with the Euro 5 and Euro 6 standards. Urea is connected to the center through hole, and compressed air is connected to the other channel. The compressed air is pumped into the nozzle exiting through the "ring" at the nozzle tip, this generates a low pressure region at the tip producing a venturi effect. This will draw out the urea from the middle channel and spray onto the SCR system, which will reduce the exhaust NOx to N2 and H2O.
The special feature is the undercut internal channel, which can only be produced using our patented In-Coring™ technology. No other metal forming process can produce this near net shape with minimal secondary finishing operations. Hence, it is specially designed for MIM process. The cost savings would probably be more than 200% if ever similar quality and finished part were produced by conventional machining + brazing.
BIKE RATCHET

Company: MIMECRISA
Strand: Metal Injection Moulding
End Use Sector: Consumer Goods
Product Density: 7,65g/cm³
Tensile Strength: 1329 MPa
Yield Strength: 1214 MPa
Product Hardness: 400 HV30 HRA
Elongation: 5%

These components are responsible for the transmission of movement between the pedals and the wheel of a bicycle. It is a system of transmission of magneto-mechanical movements and the coupling of both components is essential for proper work. The main difficulty at the time of the development of the parts was to achieve a perfect filling in such fine teeth and achieve a perfect coupling of both parts. Therefore, we have very strict dimensional requirements. The main advantages obtained doing these parts in MIM technology are the cost savings in manufacturing, mainly saves operations of machining and we obtain parts with good mechanical properties for the work of the parts.
We found the main difficulty at the time of the development of the parts in the injection process, as they are parts of 1mm thick in green stage and the correct filling of the parts is difficult. It is also very important to choose a good sintering position to avoid deformations in parts of such low thickness. Another difficulty at the time of manufacture is to avoid deformations when we hardened parts of such low thickness (0.8mm). Here in MIMECRISA, we have heat treatments in house, therefore we have the possibility of optimizing heat treatments to reduce deformations in parts. The main advantages obtained by making these parts in MIM technology are the cost savings in manufacturing and high mechanical strength and high yield strength for a geometry of such low thickness.
When we talk about the possibility of manufacturing complex parts in MIM technology, these parts reflect what we mean perfectly. Knurling, text, thin walls and the extremely complex shape in terms of support for sintering, make these pieces a manufacturing challenge. The main difficulties found at the time of the development of the parts were the correct design of the geometry, especially to avoid deformations and cracks when we sintered the parts. It was necessary to redesign both hinges to avoid defects. The main advantages obtained doing these parts in MIM technology are the cost savings in manufacturing, which saves operations of machining and secondary welding and, therefore, we obtain parts with better final mechanical properties. The parts are hinges used in glass and wood doors and they can open doors up to 270º.
ROTARY KNOB

Company: OBE Ohnmacht & Baumgärtner GmbH & Co. KG
Strand: Metal Injection Moulding
End Use Sector: Automotive
Product Density: 4.27g/cm³
Tensile Strength: >= 550 MPa
Yield Strength: >= 480 MPa
Product Hardness: 160-240 HV10 HRA

The component was designed to emphasize the lightweight and complex construction possibilities of MIM combined with the filigree impression of titanium. The idea is to create an innovative rotary knob for the automotive industry in high end cars. In cars full of touch screens this titanium knob should be a highlight design element giving an air of exclusivity and luxury as well as a cool touch.

The rotary knob is supposed to be equipped with a round Swarovski glass component to be fixed on top of the part. Therefore, tolerances in the diameter are important to be kept in a serial production. Thanks to the open construction of the part cool or warm light elements enable additional high class atmosphere.

In the inner center logos can be easily integrated directly in the mould.
HPC-VANE

Company: Schunk Sintermetalltechnik GmbH
Strand: Metal Injection Moulding
End Use Sector: Aerospace
Product Density: min. 7.9 g/cm³
Tensile Strength: min. 1300 (RT, 970 at 700°C) MPa
Yield Strength: min. 775 (RT, 750 at 700°C) MPa
Product Hardness: 330...380 HV10 HRA
Elongation: min. 10 (RT, 6.5 at 700°C)%

The HPC-vane is the first serial MIM application in high pressure compressor (HPC) of a turbine engine. The part substitutes a forged part without any reductions in performance. Schunk as the MIM producer had to develop based on its standard MIM process a technology that fulfills all requirements of aerospace industry in quality assurance, reproducibility and traceability. The most important challenge was the guarantee the shape stability of the aerofoil and the prevention of contamination of the material with carbon, oxygen and nitrogen along the process from powder production up to the sintered part. Additionally as well as material, the part itself had to be released by a process of several gates and engine tests of aerospace industry. Finally Schunk could pass all the gates and opens a new field of business. Further stages of HPC-vanes (different shapes and dimensions) are in preparation.
For more information on Powder Metallurgy

**Introduction to Additive Manufacturing Technology**
Download here [www.epma.com/am](http://www.epma.com/am)

**Introduction to Hot Isostatic Pressing Technology**
Download here [www.epma.com/hip](http://www.epma.com/hip)

**Introduction to Metal Injection Moulding Technology**
Download here [www.epma.com/mim](http://www.epma.com/mim)

**Introduction to Press and Sinter Technology**
<table>
<thead>
<tr>
<th>Company:</th>
<th>GEVORKYAN, s.r.o.</th>
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<tr>
<td>Strand:</td>
<td>Structural Parts</td>
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<tr>
<td>End Use Sector:</td>
<td>Power Tools</td>
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<tr>
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<td>42 HRC</td>
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<tr>
<td>Elongation:</td>
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The Driving Flange was designed in cooperation with one of the leading power tools producers. The part is absolutely brand-new. It has never been produced before by any other technology. The original conception, including prototypes, was designed for CNC machining from conventional bars. Yet, the adaptation to PM technology provided a huge price reduction in comparison to traditional technology.

The serial scale production provides a cost effective solution to the customer. The new design of the driving flange represents a truly new approach in cutting and brushing disc clamping action. We expect to spread this concept worldwide during next few years, including complete replacement of old generation of a flange, which uses an internal thread to create a clamping force. From an end user point of view, the main contribution is the reduction of the time which is needed to replace an already worn disc – within a few seconds instead of one minute. The Driving Flange is compacted on a CNC hydraulic press using all three upper axes and all four lower axes. To ensure a higher hardness of the surface layer and tough core of the part, case hardening is used. CNC turning is used to ensure a precise internal diameter, and CNC milling is used to create four counter bars for screws.
2018 WINNER
PM STRUCTURAL PARTS CATEGORY

STRUCTURAL PARTS
LOCK BOLT

Company: ASCO Sintering Co
Strand: Structural Parts
End Use Sector: Security
Product Density: 7.4gr/ccg/cm³
Tensile Strength: 550 MPa
Yield Strength: 480 MPa
Product Hardness: 90 HRB
Elongation: 1%

The part is an outstanding example of conventional PM lock hardware technology, stepping into the design realm of MIM technology. This highly sophisticated and complex tool design combines 9 levels of dimensional changes by using a combination of multiple punches synchronising with die shelves.

The component fully designed by ASCO is produced in Copper Infiltrated Steel and then finished with Electro Nickel plating, as per ASTM B633. This part replaces a 2 piece assembly, saving approximately 50% of the original cost when compared to traditional manufacturing processes.

Statistical controls are applied throughout the compacting and sintering processes to provide extensive powder transfer and fill compensations, resulting in even density distribution within all cross sections of the component.

ASCO also produces various types of Deadbolts and Latch bolts within the Residential and Commercial hardware sector, supplying onto major door lock companies for over 50 years. All of our design solutions are governed by a qualification through the BHMA Cycle Testing standards for functional strength, security, finish and corrosion requirements.
RADIUS ADJUST HEAD

Company: ASCO Sintering Co.
Strand: Structural Parts
End Use Sector: Commercial Lawn and Garden Irrigation
Product Density: 6.9g/cm³
Tensile Strength: 390 MPa
Yield Strength: 150 MPa
Product Hardness: 45 HRA
Elongation: 15%

Working closely with the customer, this part was converted to PM. Manufacturing efficiencies are realized by incorporating automation and multi-cavity tooling.

There are critical characteristic designations including Cpk requirements applied to tolerances as tight as plus/minus 0.025 mm. Other features are tolerated as tight as plus/minus 0.05 mm.
Company: GEVORKYAN, s.r.o.
Strand: Structural Parts
End Use Sector: Automotive
Product Density: 7g/cm³
Tensile Strength: 460 MPa
Yield Strength: 370 MPa
Product Hardness: 40 HRC

Shape-complex part with very fine tooth compacted in a step die, which could be very difficult and expensive to produce by another technology. Cost and weight reduction. Improved quality and performance.
Company: GEVORKYAN, s.r.o.
Strand: Structural Parts
End Use Sector: Security
Product Density: 6.6 g/cm³
Tensile Strength: 330 MPa
Yield Strength: 250 MPa
Product Hardness: 60 HRB
Elongation: 1%

Complex multi-level part from stainless steel used in anti-fire security lock system. It replaced originally used die casting part, which could not be used in anti-fire application. Part is laser-welded to the main body of the lock. Improved performance of the part and cost savings for customer. Part is used in a high class product.
The porous ring carrier was developed to replace a casting solution with a PM part. On the one hand for cost reasons, on the other hand due to mechanical and metallurgical requirements (keyword: clamping in the piston).

The porous ring carrier is an award winning part in recent competitions, because the PM part was developed that has an unconventional density (4.0 g/cm³) and can nevertheless be handled (moved). This was previously not possible with uniaxial methods. The key here lay in the development of materials. Setting the correct particle size distribution was particularly demanding. More than 100 tests with different powder mixtures were necessary to achieve the correct microstructure and balance between grain and pore ratio.

Furthermore, the Zell plant is currently developing a new manufacturing process based on the technology of "porous sintered materials". For competitive reasons, however, we are not yet able to give any details.

Further information on the advantages compared to the current casting solution has been elaborated with many pictures in the presentation.
HELICAL GEAR

Company: mG miniGears Spa
Strand: Structural Parts
End Use Sector: Automotive
Product Density: 7.1g/cm³
Tensile Strength: 1000 MPa
Yield Strength: MPa
Product Hardness: HRA

This gear will replace the old design made with the traditional wrought and machined steel granting a substantial cost decrease for the OEM.

Given the NVH requirements of the application teeth grinding was added to achieve the desired quality and tooth flank topology.
This component is the final gear in a transmission of an electric bike drive unit.

The product, which was designed specifically as a powder metal solution, integrates a number of functional properties within one single component:

- Transmission of torque from outer teeth to output hub
- Precise inner bore for needle roller bearing
- Complex geometric features for accommodating damping rubber elements and the direction sensor module
- Distinctly reduced NVH emissions compared to previous drive generation for pleasant drivers' experience by applying optimized gear profile
- High strength material for demanding torque transfer capability and extended wear resistance
- 10% less weight compared to a gear from wrought steel
- Approx. 50% cost reduction compared to a steel solution.
International Congress & Exhibition

13 – 16 October 2019

Maastricht Exhibition & Congress Centre (MECC), Maastricht, The Netherlands

www.europm2019.com
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