POWDER METALLURGY

THINK > Innovations in Powder Metal

The world's largest manufacturer of sintered component solutions

GKN SINTER METALS

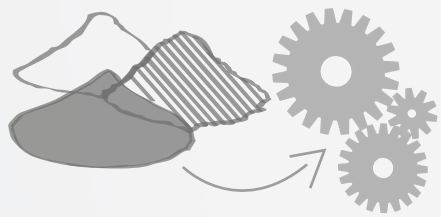
VISION AND STRATEGY

GKN's vision is to delivery sector leading, sustainable, value creating global growth and to continuously enhance our position as the world's number one sinter metals company.

GKN's strategy is to design, manufacture and supply market leading and technologically differentiated sinter metal components, products and services to our customer globally. Driven by our digital agenda and by our dynamic customer focused team of people, we always aim to fulfill or exceed customer expectations, delivering value to our shareholders and employees.

SINTERING | VERB

To make a powdered material into a solid or porous mass by compacting and heating for the purpose of increasing its strength by bonding together its particles.



GKN SINTER METALS IS THE WORLD'S LARGEST PRODUCER OF PRECISION POWDER METAL PRODUCTS.

Our global production and sales network employs more than 6,500 associates in more than 30 facilities on four continents. With a history dating back to the 1930's, today we have production sites in Germany, Italy, Turkey, India, China, USA, Mexico and Brazil.

With a focus on superior delivery, quality and total solutions, GKN offers extensive technical expertise in design, testing and various process technologies. Our dedicated Research and Development centers and global manufacturing facilities are committed to connecting our customers to the latest advancements in powder metal (PM) technology.

GKN Sinter Metals offers a full range of more than 10,000 complex shape and high-strength products for the automotive, commercial vehicle, home appliance, lawn and garden, office equipment, power tool, recreational vehicle and process industry markets.

OUR CAPABILITIES

RESEARCH AND DEVELOPMENT IS AT THE FOREFRONT OF THE GKN SUCCESS STORY.

GKN Sinter Metals operates a world-class, dedicated research and development center in Europe and a regional facility in America. Both are focused on leading technology development through innovation in support of the company's vision and goals.

This ongoing, balanced R&D keeps GKN Sinter Metals at the forefront of powder metal technology for materials, processes and equipment to:

- Improve product performance
- Reduce energy consumption and material cost
- Develop green technology
- Enhance material properties and performance
- Increase net shape capabilities

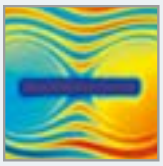
These activities are essential and enable GKN to provide creative solutions to our global customer base.

CONVENTIONAL PM

Improvements in materials and processes has resulted in a new class of high performance, consistent, competitive and creative products.

ALUMINIUM PM

Providing engineers with a new tool for weight reduction and improved product performance, GKN is taking PM Aluminium to a new level by leveraging unique materials capabilities not possible with competing technologies.



SOFT MAGNETIC PM

Enables engineers to develop smaller products with improved performance for electric motors and electromechanical systems.

SURFACE DENSIFIED PM

This technology enables GKN to deliver gears that combine the net shape advantages of PM technology with the performance of wrought steel.

POROUS METAL FILTERS

These filters and components are based on GKN´s controlled porosity materials for demanding applications where traditional filters are unable to deliver.

METAL INJECTION MOLDING (MIM)

MIM is 3D shape capability of plastic injection molding combined with the performance of alloy steels, stainless steels and high temperature alloys.

STAINLESS STEEL PM

Excellent choice for optimum corrosion resistance in high demand applications.

FORGED PM

This process step creates a nearly full dense part with high dynamic loads by utilizing a closed die which creates high axial precision.

ADDITIVE MANUFACTURING

In a competitive environment, speed is a crucial enabler and getting your solution to market first is a clear advantage. GKN's additive manufacturing capabilities are allowing us and our partners to develop products more rapidly without need for product specific molding tools.

ENGINEERING CAPABILITIES

3D DESIGN FREEDOM

GKN´s experience offers excellent opportunities to create highly complex, 3-dimensional products in powder metallurgy: Even undercuts can be realised with the sophosticated compaction technology developed by GKN.

This outstanding design freedom enables innovative and more efficient designs.

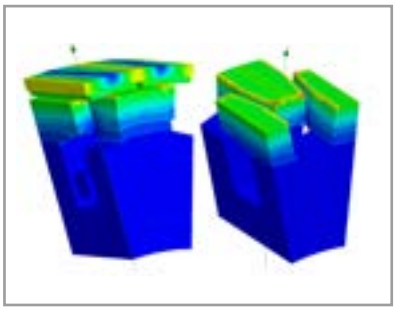
OUR INNOVATION CENTRES

As an essential building block of our company, the three innovation centers of GKN are supporting the development processes of our customers. The R&D centers are equipped with full size production facilities and advanced materials laboratories.

The analysis and simulation service of our R&D centers covers the entire life-cycle from the review of the technical feasibility of new ideas and technologies, up to the product development and production phase.

ENGINEERING

- GKN's competence in engineering and design for best possible customer satisfaction
- ~ 550 highly qualified engineers and designers



SIMULATION

- Structural mechanic simulation and system design
- Thermal simulation
- Electromagnetic simulation

DESIGN FOR PM

- Benefit from reduced total-cost-of-ownership (TCO) through GKN's development experience and support
- Technology-oriented design for cost efficient production
- Reduced development periods
- Added value due to integrated functionality

ADVANCED ENGINEERING POWDER METALLURGY SITES

RADEVORMWALD	AUBURN HILLS	CINNAMINSON
		

MATERIAL CAPABILITIES

MATERIAL OVERVIEW

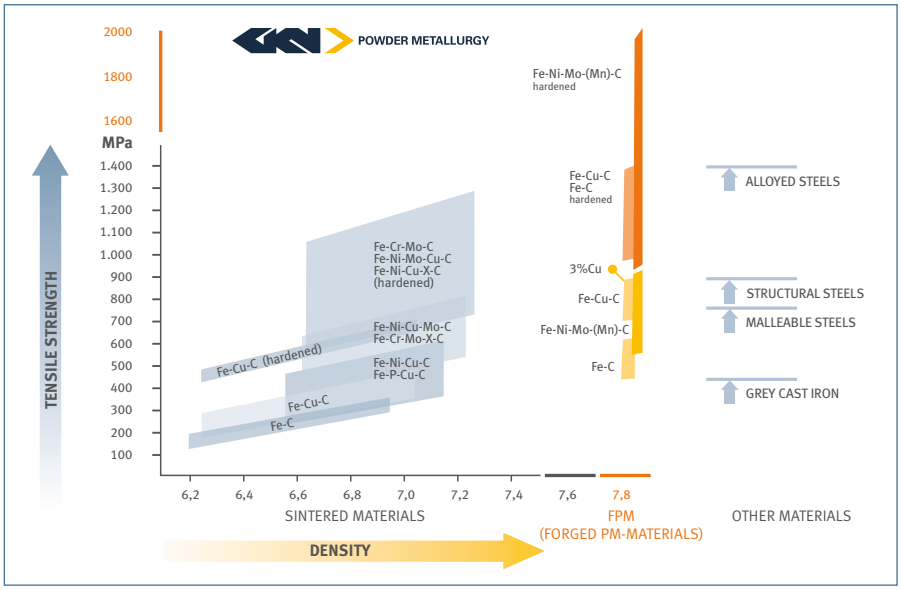
- Engineered powders optimized to reach mechanical and magnetic properties
- Extensive knowledge on characteristics of our materials

METROLOGY

- B-H field meter
- Coercimeter
- Resistance test

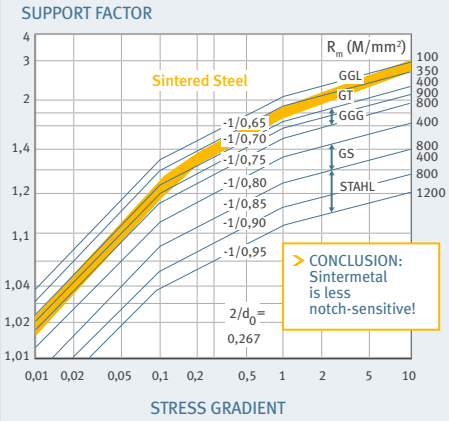
MATERIALS & ENGINE TEST BENCHES

- In-house materials test center for tensile testing, service life tests, elevated temperature testing, tribological testing
- In-house variable engine test bench for performance tests, long-run performance, thermal performance



NOTCH SENSITIVITY

GKN has introduced a worldwide accepted correction factor to figure out the lower notch sensitivity of PM-steels. With that approach, the effective stress concentration of a notch in different materials can be predicted more realistically. The part design and the material can be adopted. Sintered steels are less notch sensitive.



FATIGUE ENDURANCE LIMIT

The estimation of the fatigue endurance limits is an important step for GKN for the prediction of the part´s endurance.

The fatigue endurance limits and the scatter bands of sintered steels are comparable to those from conventional design materials. They can be influenced by the density, material alloys and by a potential following heat treatment.

TENSILE STRENGTH

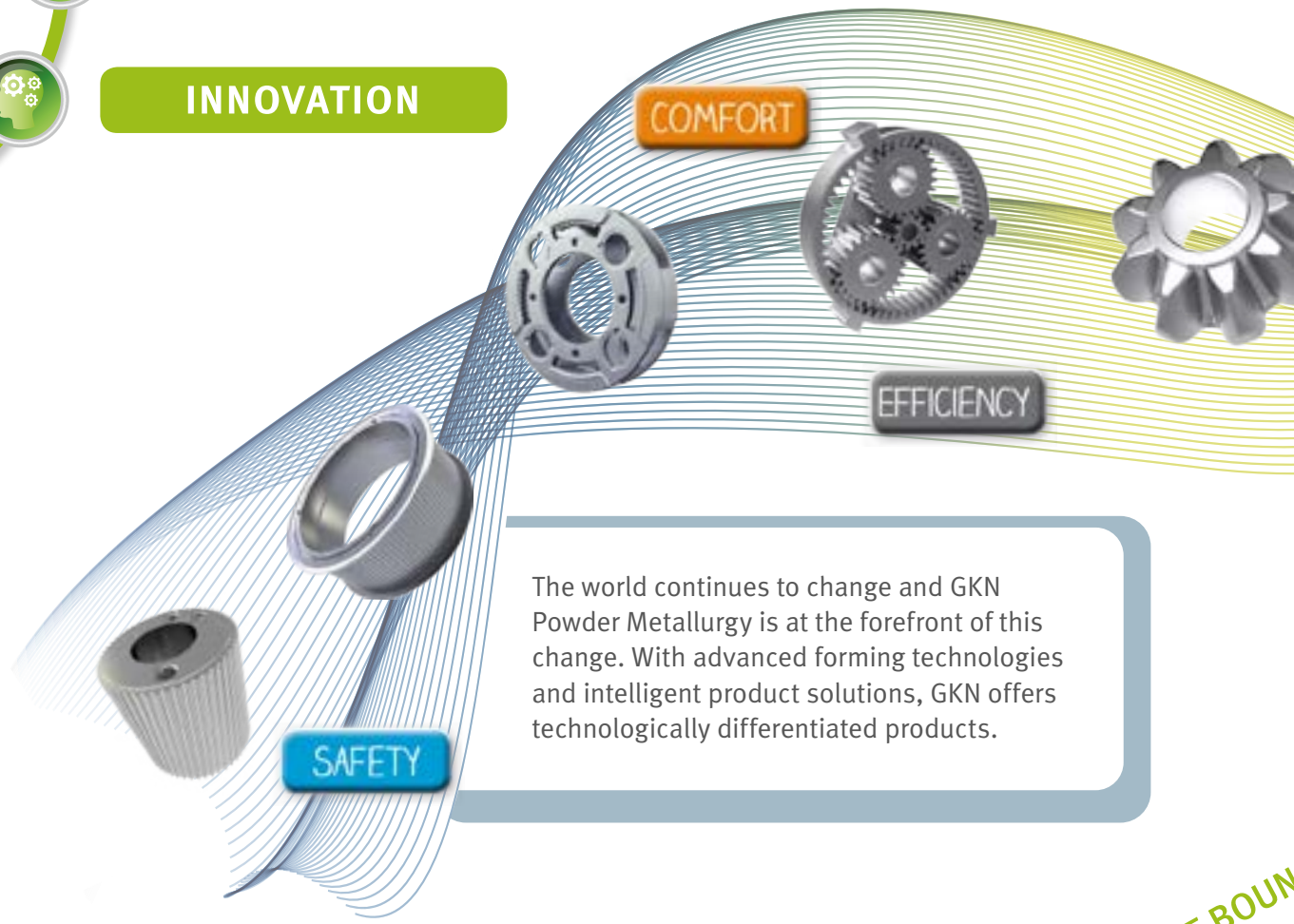
Sintered metal is light and strong. The weight advantage of sintered metal is based on its lower density at a comparable tensile strength. The density can be adjusted customer-specificly by the compaction pressure.

POWDER METALLURGY ...

IMAGINATION

CREATIVITY

INNOVATION



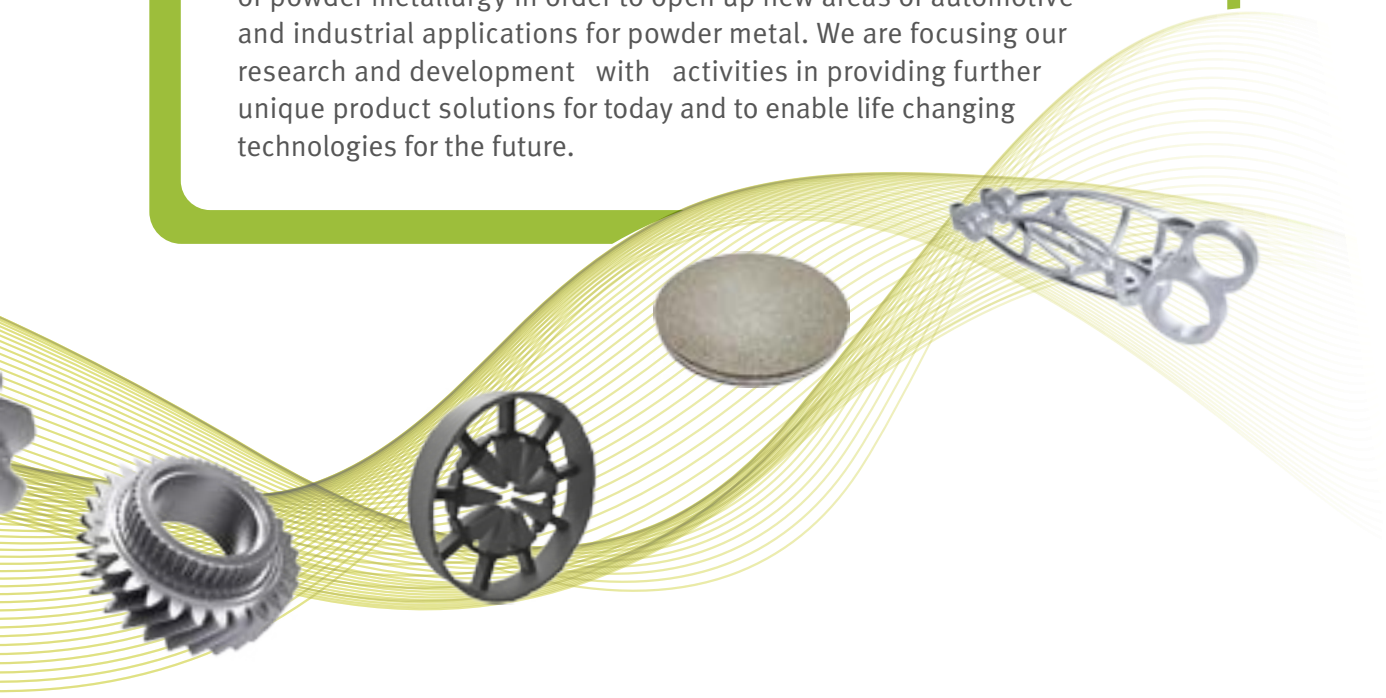
The world continues to change and GKN Powder Metallurgy is at the forefront of this change. With advanced forming technologies and intelligent product solutions, GKN offers technologically differentiated products.

PM™
A recognized green technology

TECHNOLOGICALLY DIFFERENTIATED PRODUCTS + EXPANDING THE BOUN

... IS AN AVENUE OF INNOVATION

Living the avenue of innovation, GKN is steadily expanding the boundaries of powder metallurgy in order to open up new areas of automotive and industrial applications for powder metal. We are focusing our research and development with activities in providing further unique product solutions for today and to enable life changing technologies for the future.



DARIES OF POWDER METALLURGY › LIFE CHANGING TECHNOLOGIES

E-MOTORS — MOTION

TRANSMISSION GEARS — SILENCE

ADDITIVE MANUFACTURING — FREEDOM

HYDROGEN STORAGE — CHARGE

MARKETS AND PRODUCTS

- Aerospace
- Automotive
- Bicycles
- Compressors
- Food Industry
- Furniture
- Lawn & Garden
- Market Appliances
- Medical
- Motorcycles
- Off-Highway
- Power Tools
- Sub Segments
- Sewing Machines
- Trucks & Buses

ENGINE

- Camshaft Components
- Connecting Rods
- Main Bearing Caps/Inserts
- Timing System Components
- Variable Valve Timing
- Camshaft Caps
- Turbocharger Components
- Starter and Stop/Start System Components

TRANSMISSION

- Torque Converter
- One Way Clutch
- Planetary Carriers
- Transmission One Way Clutch
- Clutch Hubs/Plates
- Parking Gears
- Main Drive Gears
- Shifting/Synchronizer Components

BODY & CHASSIS

- Mirror & Sensor Fixtures
- Door Components
- Passenger/Pedestrian Safety Components
- Seating Components
- Steering System Components
- Braking System Components
- Exhaust Components
- Gear Drives
- Shock Absorber Components

DRIVETRAIN

- Differential Gears und -bearing Caps
- Rear Axle Bearing Adjusters
- Transfer Case Components
- Cam Rings

FLUID TECHNOLOGY

- Compressor Components
- Gear Pump Components
- Planetary Rotor Pump
- Oil- and Water Pump Components
- Crescent Pump Components
- External Gear Pump Components
- G-Rotor Pump Components
- Pendulum Pump Components
- Piston Pump Components
- Vacuum Pump Components
- Constant Vane Pump Components
- Variable Vane Pump Components

MECHATRONICS

- Sensor Components
- Solenoid Components
- Heat Sinks
- Electromagnetic Clutch and Brake Components
- Axial Flux Motor and Generator Components
- Linear Motor Components
- Transversal Flux Motor/ Generator Components

FILTERS APPLICATIONS

- Beverage Industry – Filters and Spargers
- Catalyst Recovery Filter
- Catalyst Recovery Filter in H_2O_2 Production
- Chemical Industry
- Flame Arrestors
- Fluidization Elements
- Hotgas › 300°C: Polysilicone
- Oil Burner Filter
- Pneumatic Silencer
- Sensor Protection
- Spargers

SINTER METALS MATERIALS

GKN SINTER METALS OFFERS THE BROADEST MATERIAL SELECTION IN THE INDUSTRY TO MEET A WIDE RANGE OF NEEDS.

Manufacturing components from metal powder can reduce weight as well as minimize manufacturing costs through a process that allows broader design capabilities.

When selecting the best PM material for a particular application, consideration is given to requirements such as strength, ductility and wear-resistance. With our advanced alloys and processing techniques, GKN PM components often exceed industry performance standards.

POWDER METALLURGY: A RECOGNIZED GREEN TECHNOLOGY

A recognized green technology

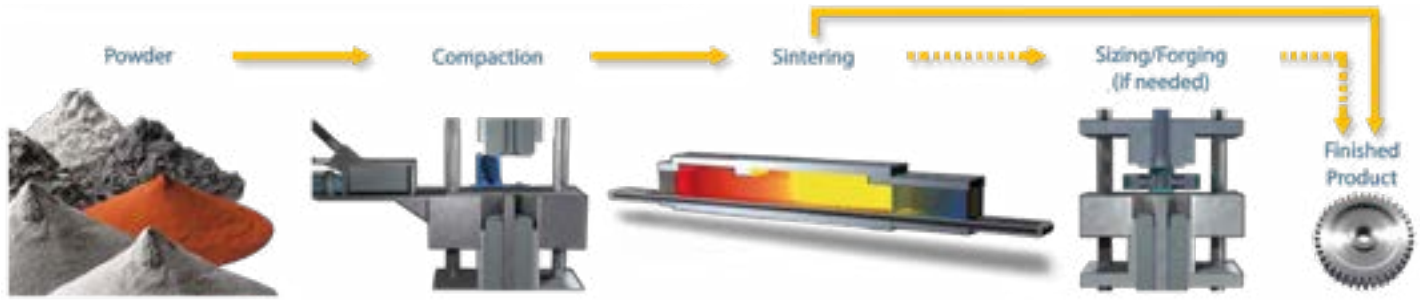
GKN Sinter Metals' technologies are environmental friendly and save natural resources through recycling.

All manufacturing processes are energy-efficient, yield low emissions and conserve raw materials.

MATERIAL		PROCESS/TECHNOLOGY				
Classification	**Description**	**Conventional**	**Forged**	**MIM ***	**Filters**	**Bearings**
Iron & Steel	Iron	■	■			■
	Plain Carbon Steel	■	■	■		
	Structural Alloy Steel (Cu, Ni, Mo, Mn, Cr) **	■	■	■		
	Specialized Alloy Steel **	■		■		
Stainless Steel	Austenitic	■		■	■	
	Ferritic	■		■	■	
	Martensitic	■		■	■	
	Precipitation Hardening			■	■	
Ferrous Soft Magnetic	Iron	■		■		
	Alloyed Iron	■		■		
	(P, Si, and Ni) **	■				
Copper-Based	Copper	■				■
	Brass	■			■	
	Bronze	■			■	■
	Diluted Bronze					■
Aluminum Alloys * **	Standard Series (PM2014, 6061, 7075; PM-AL-14SI	■				
	Thermal Series (TC-2000)	■				
	Mechanical Strength Series (MMC-1)	■				

* Metal Injection Molding)
** Several PM alloying methods are utilized: elemental blends, diffusion bonded, fully alloyed, or combinations of these.
*** Various alloys are available including 2014 (Al-Cu-Mg-Si), 6061 (Al-Mg-Si-Cu) and 7075 (Al-Zn-Cu-Mg) plus Metal Matrix Composite (MMC) variants.

THE PM PROCESS



GKN'S POWDER METAL MANUFACTURING PROCESS IS BEST-IN-CLASS FOR INNOVATION AND NET SHAPE CAPABILITIES.

GKN´s manufacturing process offers one of the most cost effective ways to produce high volume parts with the highest demand on accuracy, reproducibility, cleanliness and quality.

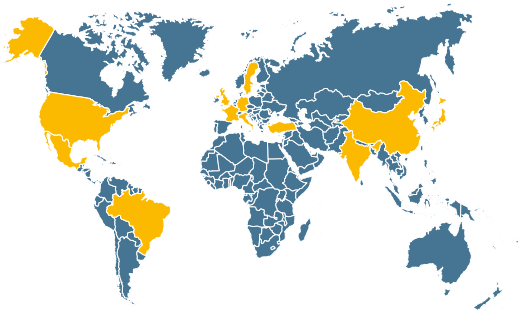
The PM production technique excels when compared with the cost of other metal shaping processes. Four important criteria characterize the process:

- 100% material utilization (no scrap loss)
- Wide variety of design possibilities with limited impact on production costs
- The utilization of all material properties in order to enhance the component functionality
- Environmentally-friendly

AWARDS

Awards from our customers, business partners and other organisations we work with are highly valued and we take great pride in these achievements. They reflect best our constant drive towards customer satisfaction and business excellence.

GKN POWDER METALLURGY OVERVIEW



GKN POWDER METALLURGY IS A GLOBAL ENGINEERING COMPANY.

We combine advanced powder metals with innovative production technologies to create unique metal products – smart, reliable and precise.

Approximately 7,000 people work in GKN Powder Metallurgy divisions. Together, we use our footprint in over 30 countries, harnessing our technology and our considerable manufacturing resources to supply the highest quality systems, structures, components and services.

OUR BUSINESSES.

We have three operating divisions: GKN Hoeganaes, GKN Sinter Metals and GKN Additive.

With our three focused businesses we deliver best in class “powder to part” solutions, providing enhanced value to the market and expanding the offerings of powder metallurgy.

GKN HOEGANAES

GKN Hoeganaes is the world leader in the development and production of atomized metal powders, producing 300,000 tons of powder per year.

We lead the PM industry in developing powders that allow the production of parts with more complex geometries, higher densities and improved dynamic properties.

GKN SINTER METALS

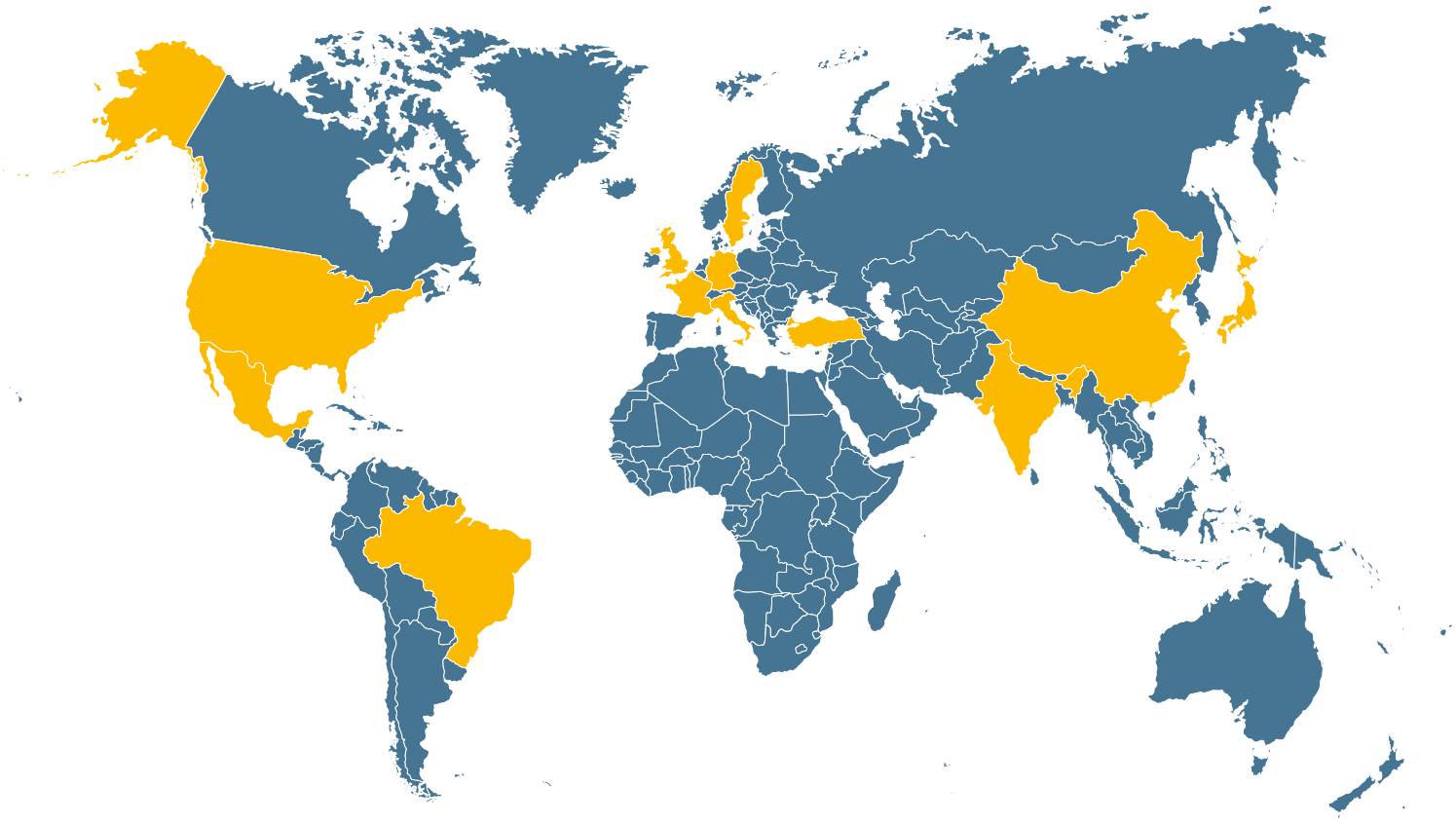
GKN Sinter Metals is the world´s leading manufacturer of precision powder metal products, producing 13 million parts per day.

Our people are developing and manufacturing product solutions with passion and constant drive to deliver superior quality and the best value for our customers.

GKN ADDITIVE

GKN Additive, a leader in metal additive manufacturing, controls a completely digitized value chain from powder to part and is divided into two sub-brands:

GKN ADDITIVE MATERIALS helps customers from automotive, aerospace, medical and industrial markets, who require metal powders tailored for low to high volume AM processes (Binder, Laser, DED). **GKN ADDITIVE COMPONENTS** delivers robust metal AM components for prototypes, medium series and the aftermarket.



GKN Locations

Over 30 locations
in 12 countries
on 4 continents

For specific details and contact information please write to us at contact@gknpm.com or visit our website www.gknpm.com

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