Expert solutions and top quality – this is what MS-Schramberg has personified as medium-sized company for over 50 years. We are one of the world’s leading manufactures of permanent magnets and assemblies. Our Credo: Everything from one single source for unbeatable reliability.

Since the requirements on magnets and components are becoming ever more individual and complex, we assume responsibility for the entire value chain: from the selection of material to the construction of our own tools, equipment and production facilities. Nothing is left to chance. Our specialists accompany every step of the process, from product development all the way to ontime delivery. Comprehensive know-how of shaping possibilities and the mechanical and magnetic properties of materials are combined in our facilities with the most modern process and automation engineering. With this approach we create the basis for high standards of quality.

Across an area of around 33,000m², more than 500 employees develop and produce approximately 5,000 customer-specific products, which are used by companies from the most diverse industrial sectors:

- Automotive
- Heating and Climate
- Electrical and automation technology
- Mechanical engineering
- Electric mobility
- Rail and special vehicles
- Energy and environmental
- Medicine
- Aerospace technology
In the development and manufacture of innovative products, application engineers, machine builders and die makers must work hand in hand. We have created the best preconditions for that collaboration with our own tool and die making division.

Those who want to manufacture economically with a minimal rate of error (zero error strategy), can achieve this goal only with an appropriate level of automation. Thanks to precision in the realisation and simultaneous optimisation of the work processes, we successfully achieve the desired result.

Our special machine construction department develops, designs, and assembles feeding, handling, assembly and test devices as well as complete production facilities. We also carry out the development and manufacture of magnetising coils and the necessary magnetising devices.
Your advantages

• As a customer you will receive comprehensive advice. Since our application engineers have practical knowledge in the area of automation technology at their disposal, we can already lay the foundation for the most efficient automation at the product development stage.

• We develop automation concepts for you which are tailored to the product. We thereby take account of the complexity of the products, quality demands and the number of units.

• Our special machine construction department ensures maximum facility availability with fastest reaction times in the case of assembly facility interruptions or product changes.

On the basis of our large in-house production capacity – beginning with the powder preparation and compounding – we are able to optimally influence the design quality of a product at all times.

Partnership based on development

Your demands are our challenge – in all phases of product development and batch production.

**CHALLENGE US!**
**Sintered Magnets – Hard Ferrite**

**Type of material**
Ceramic material

**Manufacturing process**
Pressing and sintering in oxidising atmosphere

**Particular properties**
Hard ferrite magnets have these advantages:
- economical raw materials
- very good resistance against corrosion and chemicals
- easy to magnetise

**Mechanical properties**
As ceramic materials, ferrites are brittle and sensitive to impact and bending loads. Under impact, they splinter easily. Processing, such as grinding and cutting, require diamond tools due to the hardness of the ceramics (Mohs 6–7). Water-jet cutting is also possible.

**Magnetic ratings**
Depending on the material and geometry, the possible operating temperatures of hard ferrite magnets vary between -40°C and +250°C. Matrix-pressed magnets of various shapes and sizes may differ in their magnetic ratings.

>>> On our website at www.ms-schramberg.de, you will find all of the magnetic characteristics, measured on standard samples in conformance with IEC 60404-5 as well as other physical data.
Chemical properties/corrosion resistance

Ferrite magnets have the composition stoichiometry $\text{BaFe}_2\text{O}_4$ or $\text{SrFe}_2\text{O}_4$ and are oxide ceramics. They consist of about 90% iron oxide ($\text{Fe}_2\text{O}_3$) and about 10% alkaline earth oxide ($\text{BaO}$ or $\text{SrO}$) – raw materials that are abundantly and economically available. Typical for oxide ceramics, they are relatively resistant to moisture, solvents, alkaline solutions, weak acids, salts, lubricants and noxious gases. Normally, hard ferrite magnets can be used without additional protection, such as a coating. Resistance to strong organic and inorganic acids, such as oxalic, hydrochloric, sulphuric or hydrofluoric acid, depends on the temperature, concentration and time of exposure to the medium.
Type of material
Metallic

Manufacturing process
Pressing and sintering in a protective gas

Particular properties
Rare earth magnets display very high energy density and are always to be found wherever maximum force and magnetic flux density are required in smallest space. For instance, in sensor technology their high energy densities allow for miniaturisation or a reduction of the component size in motor construction.

Mechanical properties
As typical sintered metals, rare earth magnets are brittle under impact and bending loads. SmCo₅ is the most brittle. Because of their specific hardness, grinding and cutting processes are only possible with diamond tools. Processing with spark erosion or water-jet cutting is also possible.

Magnetic ratings
The maximum operating temperatures for NdFeB magnets vary between 130°C and 220°C, with SmCo-magnets between 250°C and 350°C. Depending on shape and dimension there may be deviations in the magnetic characteristics.

On our website at www.ms-schramberg.de, you will find all of the magnetic characteristics, measured on standard samples in conformance with IEC 60404-5 as well as other physical data.
Chemical properties/Corrosion resistance

Rare earth magnets display the usual properties of metallic materials. Acid environments lead to their dissolution, while the magnets are largely resistant to alkaline media.

SmCo$_5$- and Sm$_{12}$Co$_{17}$-magnets

Since they consist of stable intermetallic phase material, these magnets are relatively resistant to moisture, solvents, alkaline solutions, lubricants and neutral noxious gases. Acids and salt solutions, however, attack the magnets. Sm$_{12}$Co$_{17}$, in contrast to SmCo$_5$, contains iron and can exhibit red rust. Samarium-Cobalt magnets are usable without protection for most applications.

NdFeB-magnets

The microstructure of sintered NdFeB materials is characterised by Nd$_2$Fe$_{14}$B grains as a magnetic main phase and an intermetallic grain boundary phase. In traditional NdFeB materials, the grain boundary phase consists of corrosion-sensitive, free neodymium. In our NdFeB materials, this free neodymium is replaced as far as possible by a stable intermetallic phase (corrosion-stabilised). The corrosion susceptibility of the material is thus significantly reduced. NdFeB is in principle relatively resistant to most solvents, but salts and acids have a very corrosive effect on it. Hydrogen embrittles the material. Corrosion-stabilised NdFeB magnets are usable without protection for many applications.

For critical ambient conditions or applications, the chemical resistance of rare earth magnets can be further improved by metallic or plastic coatings. Further details are available on our website in our download area at www.ms-schramberg.de.
Plastic bonded magnets are made of NdFeB-powder only.

Type of material
Composite material

Composite material
As plastic composite material for pressed magnets epoxy resin is being used. The maximum application temperatures depend on the magnetic material and the magnet geometry. For NdFeB these are up to 160°C.

Production
Plastic bonded NdFeB-magnets are being pressed axially within the tooling. By the very high filling level, up to 97% NdFeB-powder (mass percent), considerably higher magnetic values can be achieved compared to plastic bonded injected magnets. The toolings are simpler and less expensive compared to toolings for injected magnets.

Shapes
In contrast to sintered magnets, for plastic bonded pressed magnets are already considerably more delicate shapes producable. So, for example thin-walled rings with Ø 27 x Ø 24 x 30 mm and diameter tolerances of only approx. ±0.05 mm can be produced. Normally afterwards no mechanical machining is needed. In the case of very high demands the magnets can however also be grind to tighter tolerances.

Particular properties
By the low participation of plastic compared to plastic bonded injected magnets, higher magnetic characteristics can be achieved when using the same magnetic powder.

Magnetic ratings
The magnetic characteristics vary in the case of plastic bonded pressed magnets depending on the used magnetic powder. The possible maximum application temperatures vary between +130°C and +160°C. In the case of unfavourable geometries, especially for thin wall thicknesses and tight pole divisions, there could occure deviations from the material characteristics.
Chemical properties/corrosion resistance

The chemical resistance of plastic bonded magnets, as usual for composite materials, depends on both the plastic matrix and the magnetic filler. The chemical resistance must be checked for each case. Pressed magnets show a plastic participation of approx. 10-20 vol.-% and can, contrary to injected magnets, not be produced as dense bodies. Though the resin does cover the magnetic particles, but in the case of corrosive conditions these offer more contact surfaces as injected magnets.

In most of the cases plastic bonded pressed magnets are being applied non protected. In the case of critical applications the chemical characteristic and corrosion resistance can additionally be improved by a plastic coating.

In bushings/pots joint plastic bonded magnets

In the past magnetic rotors have been produced in several complex consecutive production processes. Magnetic rings have been produced and in a second production step glued with the shaft. Additionally, according to the customer’s requirement, a bursting protection, by a stainless steel bushing has been shrunk or glued on the magnets. Thanks to our new production technique, it is now possible to unify all production steps in only one work step.

Advantages:
- no gluing connection
- no additional work step
- inexpensive production
- high motor revolution possible

>>> On our website at www.ms-schramberg.de, you will find all of the magnetic characteristics, measured on standard samples in conformance with IEC 60404-5 as well as other physical data.
For plastic bonded injected magnets ferrite- and rare earth compounds are being used.

Type of material
Composite material

Composite material
As plastic composite material for injected magnets polyamide 6 (PA 6), polyamide 12 (PA 12) and polyphenylenesulfid (PPS) are being used. The maximum application temperatures depend on the magnet- and matrix material. These are at 160°C for qualities bonded with PA 6, 140°C for qualities bonded with PA 12 and 220°C for qualities bonded with PPS. Due to the magnetic characteristics, the maximum application temperatures can deviate from above mentioned values.

Production
In the case of injected magnets, the filling levels vary between 84% and 94% magnetic powder (mass percent). The magnetic values are therefore below the plastic bonded pressed magnets. Plastic bonded injected magnets can be produced in complex geometries and in combination with insert parts in one process step.

Shapes
One of the significant advantages of plastic bonded, injection-moulded magnets is the enormous variety of shapes that are made possible by the injection mould process. Geometries similar to those attainable in the manufacture of technical plastic parts are possible. In addition, the high filling degree (50–70% by volume) and the associated minimal shrinkage enable close tolerances in comparison with technical plastic parts.

Mechanical properties
Plastic bonded magnets are significantly more elastic than sintered magnets, but because of the high filling ratio, they do not reach the mechanical properties of technical plastics. For example, it is possible to produce injection mould toothed parts directly with plastic bonded magnetic material. However, they can stand only slight loads, since the friction properties are less favourable than for unfilled plastics.
Magnetic ratings
The magnetic characteristics vary in the case of injection molded magnets depending on the filling degree and the used magnetic powder. The possible maximum application temperatures vary, depending on the magnetic- and composite material between +120°C and +200°C. In the case of unfavourable geometries, especially for thin wall thicknesses or tight pole divisions, there can occur deviations to the material characteristics due to a too fast freezing procedure or too low direction field strength.

Chemical properties/corrosion resistance
The chemical resistance of plastic bonded injection-moulded magnets, as usual for composite materials, depends on both the plastic matrix and the magnetic filler. Compared to magnets bonded with PA, magnets bonded with polyphenylene sulphide (PPS) have a significantly better resistance to chemicals (oils, greases, fuels, etc.). Its resistance to chemicals must however be checked in each case.

Plastic bonded, overmoulded magnets
By overmoulding inserts with magnet compound, magnets with axes, bushings or other functional elements can be combined.

Multistation-/ multi step injection moulding technique
If the injection process is being considered generally, it can be noted that the main part of the cycle time is being needed for the cooling, whereas the cooling time increases approximately quadratically with the part wall thickness. As for plastic bonded magnets the wall thicknesses can not be reduced variably due to the needed magnet volume, the needed cooling times for the freezing of the compound are partially very high.

To reduce the cycle times for magnets with very high wall thicknesses, the „multi step injection“can be applied. Here, the needed wall thickness is being produced in stages, so that the cooling times can be reduced drastically due to the quadratical influence. This procedure is for example being applied for the production of rotors on the base of hard ferrite.

A further optimisation of the cycle time can be achieved by the „multi-station-injection“. By additional stations the insertion of insert parts as well as the removal of finished parts can be effected parallelly to the injection process. Further, additional cooling stations can be included.

Further details can be gathered from our website under www.ms-schramberg.de/Kompetenzen/Spritzgießen

>> On our website at www.ms-schramberg.de, you will find all of the magnetic characteristics, measured on standard samples in conformance with IEC 60404-5 as well as other physical data.
Successful with technical plastic parts

Sintered and plastic bonded magnets are often overmolded with plastics and additionally combined with shafts, bushings or other elements.

Due to our highly automated production we are able to guarantee an economically advantageous production at a high quality level. The technical solutions in terms of automated production equipment are being developed, designed and assembled in our in-house engineering department.

By the use of rheological filling- and deformation simulations we can guarantee that a technical plastic component fulfills the customer requirements already in the phase of designing the component. By using this technology we can make sure that one fits to another.

Technical plastic parts

We process all common thermoplastics. Furthermore, high-temperature plastics, like PPA, PPS, PSU, PEEK, or high-filled plastics, which contain up to 60% and more fibres and fillers, are shaped into precision parts.
Tooth systems to satisfy highest demands
Perfection is required when it comes to the meshing of parts like gears. We design and build the most demanding tooth systems for you with up to grade eight gear tooth quality. This is also possible for extremely small parts.

We carry out gear tooth calculations and set up entire gear units in collaboration with experienced external service providers.

The CAD data is fed directly into the machine tools. The quality control is conducted with gear tooth measuring machines and double flank gear rolling checks.

Overmoulding or injection moulding
We automatically feed and overmould insert parts, like sintered or plastic bonded magnets, axles, bushings, etc. If required, the finished part can be qualified with an integrated 100% test.

Multi-component injection mould technology
The multi-component injection enables us to efficiently combine magnet compound material and technical plastic with a high degree of precision.
Definition
By magnet assembly we mean a “product”, which through the processing of sintered and plastic bonded permanent magnets becomes a customer-specific “magnetic system”. We combine magnets with other technical components, which significantly simplify further assembly for you. Because of their brittleness and, in part, enormous magnetic forces, the handling and processing of permanent magnets is very critical. We have at our disposal various equipment necessary for the processing of magnets, or we can develop and custom build equipment in our special machine shop. Due to many years of experience we are in the position to offer efficient and total solutions.

Manufacturing processes
- Adhesive technology
  The following adhesives are processed:
  - Anaerobic adhesives
  - Cyanoacrylate and methylmethacrylate
  - Epoxide and polyurethane (1 and 2 component)
  - Radiation-curable adhesives
- Other joining technologies
  - Pressing in or on components (joint in bushings/pots)
  - Shrink fitting
  - Banding
  - Clinching
  - Clipping in
  - Laser welding
  - Ultrasonic welding
  - Casting
  - Press fitting
**Adhesive technology**
Sintered and plastic bonded magnets can best be joined with other technical components using adhesives—without force closure and over a wide temperature spectrum. We possess many years of broad experience in the area of industrial serial production. Employees specially trained in adhesive technology guarantee the appropriate expert processing and the corresponding high quality.

The most modern facilities are available to guarantee an efficient and high-quality production:
- Water-based industrial cleaning systems
- Plasma, laser and sand blasting systems for pretreating components
- Automatic dosing and feeding machines
- Curing ovens for temperatures up to +250°C
- Systems to harden adhesives using UV light or induction
- Complete assembly lines for the automatic assembly of large series

**Quality control of the adhesive bonding is accomplished by:**
- Surface roughness measurement
- Adhesive quantity monitoring
- Tensile and pressure testing (random sampling)
- Surface tension control
- Cataplasm testing

**Other joining technologies**
For certain assemblies, fixing techniques such as ultrasonic welding, pressing components in or on, shrink fitting, laser welding, clinching, clipping in, casting or press fitting are to be preferred to adhesive technology. You benefit directly from the know-how which we have acquired from the widest range of projects. Based on your specific needs you can always count on an optimal product and processing recommendation.
**Mechanical damage**
Sintered magnets are very brittle. This property makes it impossible to avoid occasional slight mechanical damage during manufacture. The magnetic and mechanical properties are only slightly influenced by this. Final inspection for magnets and systems routinely includes optical surface inspection. Fine fissures and damages to up to 2% of the pole surface do not constitute failure in the inspection. On request, adverse tolerance parts can be agreed upon.

**Adhering particles**
From the manufacturing process, a small amount of dust and magnetic particulate matter may adhere to magnets.

**Shape and position tolerances**
If no special conditions have been agreed upon, tolerances will satisfy DIN ISO 2768 T1/T2.

**Dimensional tolerances**
For raw magnets, tolerances will satisfy DIN IEC 60404-8-1.

**Magnetic properties**
The magnetic values given on our website are binding, unless other values have been established in writing. The magnetic ratings follow DIN IEC 60404-8-1, measured on finished samples following IEC 60404-5. Depending on shape and dimensions, they may deviate from our magnetic specifications. If special applications require 100% magnetic testing, this must be agreed upon.

**Packaging**
We value environmentally friendly packaging. Therefore, we generally avoid using disposable blister packaging and ship our magnets in cut and layered cardboard. If it is necessary to pack an item in a plastic tube or protected on metal plates, we will discuss this with the customer and send it as returnable packaging. On request, load carrier and Gallia or bar code labels can be used. We are happy to advise you on packing and handling of magnets, to implement with you an economical, ecological, and practical packaging concept.

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**Instructions for Magnet Handling**

Everyone who handles magnetic materials, especially rare earth magnetic materials, must know and observe these rules!

**HAZARD WARNINGS AND HANDLING GUIDELINES!**

**Risk of injury from splintering and crushing.** Always work with protective glasses or other protective equipment!
Sintered magnets are hard and brittle. They shatter upon impact into many sharp fragments. Always avoid impact for this reason. Because of the strong attractive forces, magnets should be moved with great care when approaching other magnets or magnetic parts, to avoid crushing the skin. For persons with allergies to contact with ceramic or metallic substances, the same reactions would be expected from contact with magnet materials of the same kind. They should not work with magnets without protection.

**Hazards of strong magnetic fields – Keep a safe distance!**
The basic restrictions related to human exposure to electromagnetic fields (0 Hz – 300 GHz) are defined in the DIN EN 50392. Strong magnetic fields can disrupt and destroy magnetic data carriers, such as credit cards, and electronic and mechanical components and devices. Please consult the user guides to these devices about this or ask the manufacturers.

**Explosion and fire hazard!**
Magnets must not be handled in spaces with risk of explosion, since they can emit sparks on impact. When mechanically processing rare earth magnets, the grinding dust and shavings are a fire hazard. Therefore never work dry, always work with plenty of water. Even dried-out wheel swarf can ignite. In case of fire, only use sand or a powder fire extinguisher with metal fire powder!

**Operating temperatures and radiation!**
The highest allowed operating temperatures of our magnet materials vary between 120°C and 350°C. For the maximum operating temperatures in different cases, please see our specification sheets or our catalogue. Permanent magnets should not be exposed to ionising radiation for long times. They would lose their magnetisation.

**Use in different media!**
Permanent magnets, especially those made with rare earth metals, are partially soluble in various media, depending on the magnet material. They must not be put into service untested.

**STORAGE AND TRANSPORT GUIDELINES!**
Rare earth magnets must be stored dry, so that they do not oxidise. For transport as air cargo, observe the regulations for stray magnetic fields (IATA Dangerous Goods Regulations). These regulations also apply to magnet assemblies.

If you have further questions about handling and using our magnet materials, please ask us. We are very happy to provide you with further information.