Polymer Bonded Magnets
A New World of Application Opportunities

Polymer bonded magnets have opened a new world of application opportunities; the demand for such products is steadily increasing. There are two basic forms:

- Injection molded and
- Compression bonded magnets

The **processing temperatures** employed to blend and mold the material mixture is low enough to allow **many different magnet powders** to be used in combination with the polymer binders to achieve a unique range of properties.

![Diagram showing temperature and energy product with materials like PPS, PA6, PA12, NdFeB, SmCo, Ferrite]

Plastic Bonded rare-earth magnets are a particularly popular choice for new product developments of our customers. They can either increase performance or reduce costs.

Their high magnetic values make them ideal for **miniaturization** where reducing weight and space are crucial. We have produced magnets as light as 0.04 g. In addition to our standard grades, new isotropic and anisotropic powders are becoming available that have been optimized for high temperature, high density or low cost. For instance, anisotropic NdFeB magnets can achieve $B\text{H}_{\text{max}}$ of 17 MGOe, they can even replace some sintered magnets.

Another benefit of the injection molding process is that magnet material can be directly molded into, onto, or against other assembly components eliminating subsequent assembly steps. This is called insert injection molding. Injection molded magnets can be of very simple shapes but they can also be very complex. All or only part of the device may be magnetized. It is sometimes cost advantageous to make an entire part out of the magnet material and just magnetize the portion requiring magnetic output.
Advantages of MPCO’s Polymer Bonded Rare-earth Magnets

- Cost effective use of magnet material – parts pressed to size (‘net shape’)
- Low electrical conductivity to reduce eddy current losses
- High temperature Dysprosium free raw materials
- Simple to complex multi-pole magnetization
- Excellent mechanical strength and surface finish

- Tight tolerances
- Very small magnets and thin-walled rings
- Complex shapes
- Wide range of magnetization options
- Insert molding or over molding, value-added assemblies

Materials / Magnetic Compounds

Magnetic compounds consist of two components: magnet powder (Hard Ferrite/Rare Earth materials) and thermoplastic matrix material (PA6, PA12, PPS). They are produced by embedding magnetic powder in plastic.

First, the magnet powder is compounded with thermoplastic binders and afterwards the compound is granulated. Veekim is equipped with modern machinery for production such compounds. In order to fulfill many different requirements, we developed a very wide range of compounds.

Our research team is constantly pursuing further developments of magnetic compounds in order to

- improve physical strength,
- maximize recommended operating temperatures
- improve corrosion resistance, esp. for rare earth magnetic materials
- improve dimensional stability in the presence of water and solvents
- achieve greater ease of processing
Temperature Characteristics

Maximum operating temperature is a function of both the magnetic alloy powder and of the binder. For example, ferrite powders in Nylon 6 or PPS have tested satisfactorily at 180°C. On the other hand, Nylon 12 melts above 170°C and is not recommended for use above 150°C.

Magnetic material such as the highest energy NdFeB grade, with intrinsic coercivity of 9500 Oersteds (760 kA/m), suffers significant irreversible magnetic loss above 120°C in most magnetic circuits, regardless of which binder is used. Maximum use temperatures are listed on each product's specification sheet.

Tolerances

An important characteristic of injection-molded magnets is that they conform dimensionally to the mold cavity, which is precisely machined, the result being close tolerances in the finished product. What little dimensional variability there is a result from shrinkage of the polymer during cooling. This depends upon part thickness and shape. Typical tolerances are +/-0.003 mm/mm. Closer tolerances on critical dimensions can be discussed with our customer.

Example: production process for magnet over molding of metal part

- NdFeB powder (Ningbo plant)
- PPS binder (supplier)
- Extrusion
- Crush 'noodles'
- Bonded magnet pellets
- Metal parts (supplier)
- Heating mold & metal part
- Injection over-molding
- Parting
- Deburring
- Cleaning, inspecting
- Magnetizing
- Tool design
- Tool manuf. & assembly (partly external)
- Mold
Coatings

Epoxy coatings offer protection against corrosion for many applications. In more demanding operating conditions, e.g. in high temperature and/or humid conditions, a different coating may be necessary; Veekim provides a number of different coatings, which have different merits. We’d like to discuss these considering the customer’s specific applications.

Magnetization

Magnetization is a key step in the manufacture of any permanent magnet component. Plastic bonded magnets can be multi-pole magnetized as a complete ring or assembly in a single operation. Even Halbach magnetization is feasible. For anisotropic magnetic compounds an alignment field around the mold cavity is used, which in some cases is sufficient for magnetization. Otherwise the magnetization follows in a subsequent step, which is how it is always done using isotropic compounds.

For ring magnets there is some flexibility to adjust the surface flux density wave form, and in contrast to multi-magnet rotor assemblies using a skew angle that minimizes cogging and torque ripple doesn’t increase the cost.

Injection Molds

Our partner company is producing the tools for injection molded magnets. They design and produce tools at a high level, providing solutions to meet requirements in terms of feasibility, de-molding properties, mold filling, cooling and handling of the plastic part packaging process.
Product Examples

Overmolded plasto-ferrite magnet (automotive sensor application)

Magnetic coupling assembly (pump application)

Motor rotor for moving headlights (automotive application)