FAQs

Soft Magnetic Composites in Motor Applications

What are soft magnetic composites?

Soft magnetic composites (SMCs) are components made by applying powder metallurgy techniques to metal powders with magnetic properties. SMCs are generally made by compressing metal powder in a tool and following up with a heat treatment.

The metal powders that form the basis of SMCs consist of high-purity iron particles individually coated with an electrically insulating coating. One example is Somaloy from Höganäs AB (Sweden). The powder metallurgy process combines with the powder's specific properties to create parts with three-dimensional magnetic properties.

Where can they be used in motors?

SMCs have been used to improve the performance of claw pole motors that appear in applications like automobile alternators, consumer appliances, and printers. In these motors, SMCs form precisely shaped claws or inductors that fit these space-saving designs.

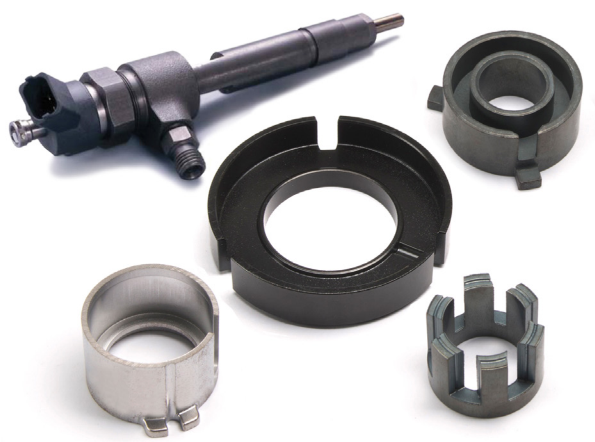
Linear tubular motors also use SMCs in their inner and outer stators in applications that call for precise and repeatable linear actuation. In these applications, they provide a broader spectrum of position control than pneumatic actuators.

In axial flux motors and yokeless axial motors, the magnetic flux paths are parallel to the motor axle as opposed to radial through the air gap between the rotor and the stator. These flat motors work well with the 3D flux paths made possible through SMCs. Designers are turning to these motors for their high power and torque densities and space-saving design that make them ideal for electric vehicles (EVs), pumps, fans, compressors, valve control, hoists, and power and wind generators.

How do SMCs improve magnetic performance?

The materials that make up SMCs, like Somaloy, aren't hindered by the two-dimensional flux paths that form in stacked magnets or sheet metal laminations. A 3D flux path creates high flux density and high magnetic permeability, allowing for a more compact motor design and simplified assembly.

The individual particles that form SMCs are coated with an electrically insulating material, so parts made from the powder have high resistivity. This keeps the bulk eddy current in the material low, so less energy is



lost to heat. This effect is compounded at high operating frequencies, making them an ideal choice to minimize losses.

For example, Somaloy 700HR 3P, compressed to 7.52 g/cm3 density, has a resistivity of 600 μΩ-m and a permeability, μmax, of 770. Its magnetic flux density, B, is 1.57 T at a field strength, H, of 10,000 A/m. Under those conditions, the power loss is approximately 9.5 W/kg at 50 Hz.

How do SMCs improve physical design?

With SMCs, two aspects of three-dimensional design open up design options for motor engineers. First, the material's 3D flux capability lets designers think outside the box when shaping their motors' magnetic components.

Secondly, powder metal processing techniques make it easier to manufacture complex 3D parts. Like polymer injection molding and metal casting, powder metallurgy enables part consolidation for parts that are ultimately lighter and take up less space.

The Somaloy 700HR 3P material mentioned above, for example, has a transverse rupture strength (TRS) of 120 MPa. No change in strength is seen when testing the material at an elevated temperature of 150°C.

How do SMCs improve assembly?

In addition to giving designers more freedom to shape motor components to their specific applications, SMCs make motors easier to assemble. The laminated stacks of sheet metal stampings that are used in many motors are time-consuming to assemble. In addition, each assembly must be checked to ensure it has the right number of layers in each stack to maintain uniform motor performance.

Components made from SMCs, on the other hand, permit error-proof assembly and optimize part geometry. SMCs let designers take advantage of the material's improved magnetic properties to save space. Some designers have used SMCs to take the winding step out of the assembly process by sliding pre-wound bobbins over the legs of the stator or other SMC object.

How are motor components created from SMCs?

The process of manufacturing motor components from SMCs is similar to other powder metallurgy processes. These processes always begin with precise blending of a variety of powders to achieve the desired properties. In the case of SMCs, the refined, coated-particle powder arrives pre-blended from the powder supplier.

The SMC powder is loaded into part-specific tools that ensure it is compacted to the desired shape. Compaction pressures and temperatures vary depending on the powders, geometries, and end properties desired. For SMCs, compaction pressures and temperatures vary to achieve densities as high as 7.57 g/cm3.

After molding, the "green" part needs to be heat treated to bond the individual metal particles together. Heat treatment temperatures can range from 530°C to 650°C depending on the material system used. Different heat treatment atmospheres—including air, steam, and nitrogen—can yield different results.

How can I learn more about SMCs?

More and more motor designers are considering the performance, form factor, and cost benefits of SMCs for magnetic motor components. However, the range of available materials and design options can be daunting. Look for material specs on the websites of material suppliers like Höganäs AB

Also consult with companies like Symmco that are experienced in powder metal manufacturing in general and with SMCs for motor components in particular. They have information about the manufacturing process, part options, and material selection on their websites. They also have engineers available to answer your questions about designing with SMCs.