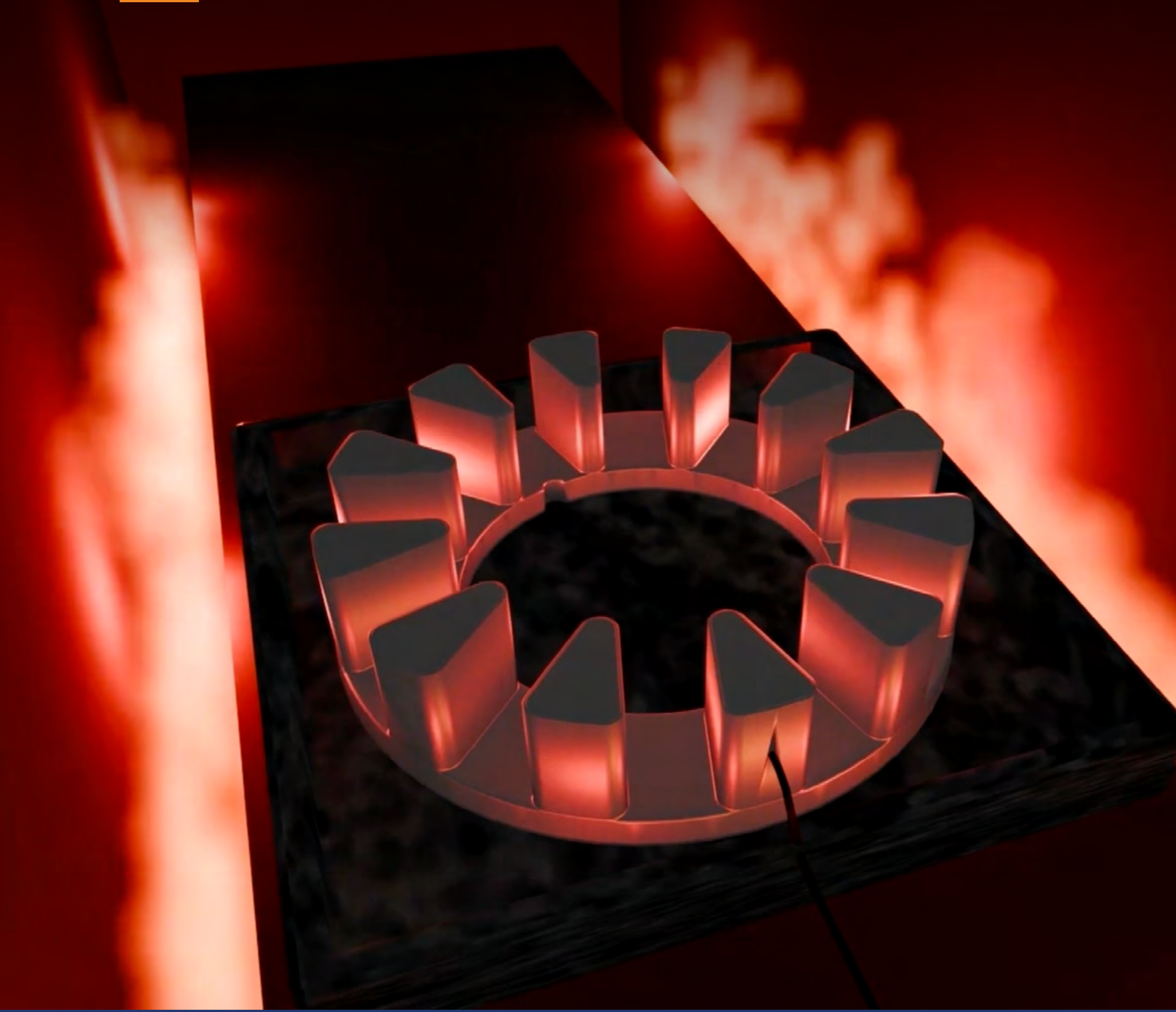
Somaloy® 7P

Processing guidelines



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POWDER THAT EMPOWERS®

Overview

The next generation of sustainable

Soft Magnetic Composites (SMC)

Somaloy® 700 7P represents a breakthrough in the development of SMC, designed to meet the increasing demands for efficient, low-loss materials with minimal environmental impact.

Key Benefits:

Enhanced Performance: It offers lower core losses across a wide frequency range. It is ideal for a wide range of active applications such as electric motors. The material's high permeability and induction contribute further to improved system efficiency.

Sustainability: The water-based coating addresses sustainability in electrification, and the low losses contributes to lower emissions in the use-phase.

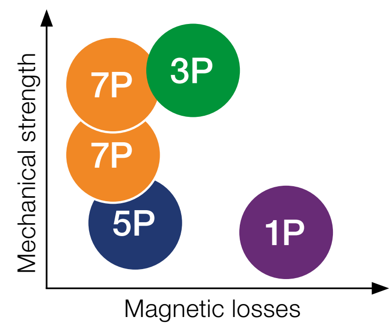
Tunability and Improved Mechanical Strength: T hrough optimized part-curing, the transverse rupture strength (TRS) can be doubled, ensuring durability and reliability in demanding applications.

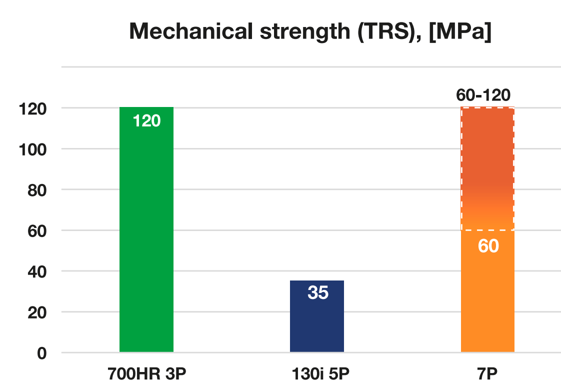
Processing: It can be used with die wall lubrication, maximizing density and minimizing core losses.

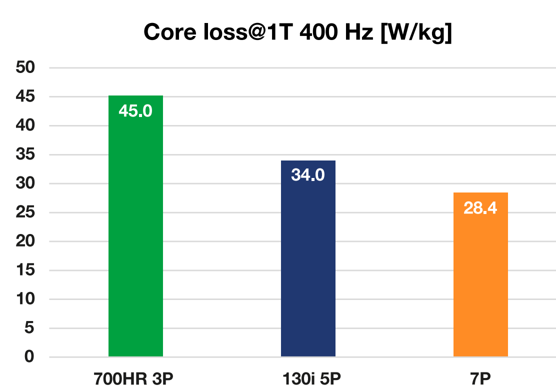
Thermal Properties: It demonstrates excellent thermal conductivity and thermal aging properties.

Benefits of Somaloy 700 7P:

- Innovative water-based coating
- Improved base power
- Low carbon footprint
- Lowest losses while enabling mechanical robustness
- Improved thermal durability enabling higher operating temperatures







Introduction

Purpose of the guideline

This document is intended for PM manufacturers, process engineers, operators and quality control personnel working with Somaloy 7P. For application specific design considerations, including electrical machine design, refer to FAQ section.

This document provides recommended processing parameters for Somaloy 7P materials and is intended as a starting point. The process should be optimized based on component geometry, application requirements, tooling design and press capability. Further details and technical guidance are provided in the following chapters.

About soft magnetic composites

Somaloy 7P is a Soft Magnetic Composite (SMC) material developed for high-performance electromagnetic applications, particularly axial-flux electrical machines where high density, low core losses and controlled resistivity are essential.

The material consists of individually insulated iron particles, enabling true three-dimensional magnetic flux, reduced eddy-current losses, and the ability to produce complex geometries in a single compaction step.

Somaloy 7P is formulated to support reliable industrial processing. However, as with all SMC materials, the final properties depend strongly on the selected compaction, lubrication and heat-treatment parameters.

The following sections describe how these parameters should be controlled and why they matter.

Inputs from designer

To establish a robust and efficient starting point for processing **Somaloy 7P**, a clear definition of key design and application requirements is required. Early alignment with designer reduces development time, limits unnecessary process iteration and helps ensure that density, magnetic performance and mechanical integrity can be achieved consistently.

The inputs listed below should be defined before compaction trials or process optimization are initiated. They form the basis for selecting appropriate density targets, lubrication strategy, compaction mode and heat-treatment parameters.

- Operating frequency of the electrical machine
- Target magnetic induction level
- Component geometry and overall dimensions Engineering drawing available 3D CAD model available
- Mechanical strength requirements
- Operating temperature range in application

Typical density recommendations:

It is recommended to have the density requirements on the component drawing.

- **Minimum functional density:** ≥7.20? g/cm^3
- **Balanced performance:** 7.30–7.40 g/cm^3
- **High-performance:** ~7.50 g/cm^3

Please refer to the **Somaloy 7P – Frequently asked questions** for questions not covered in these processing guidelines

Powder material characteristics

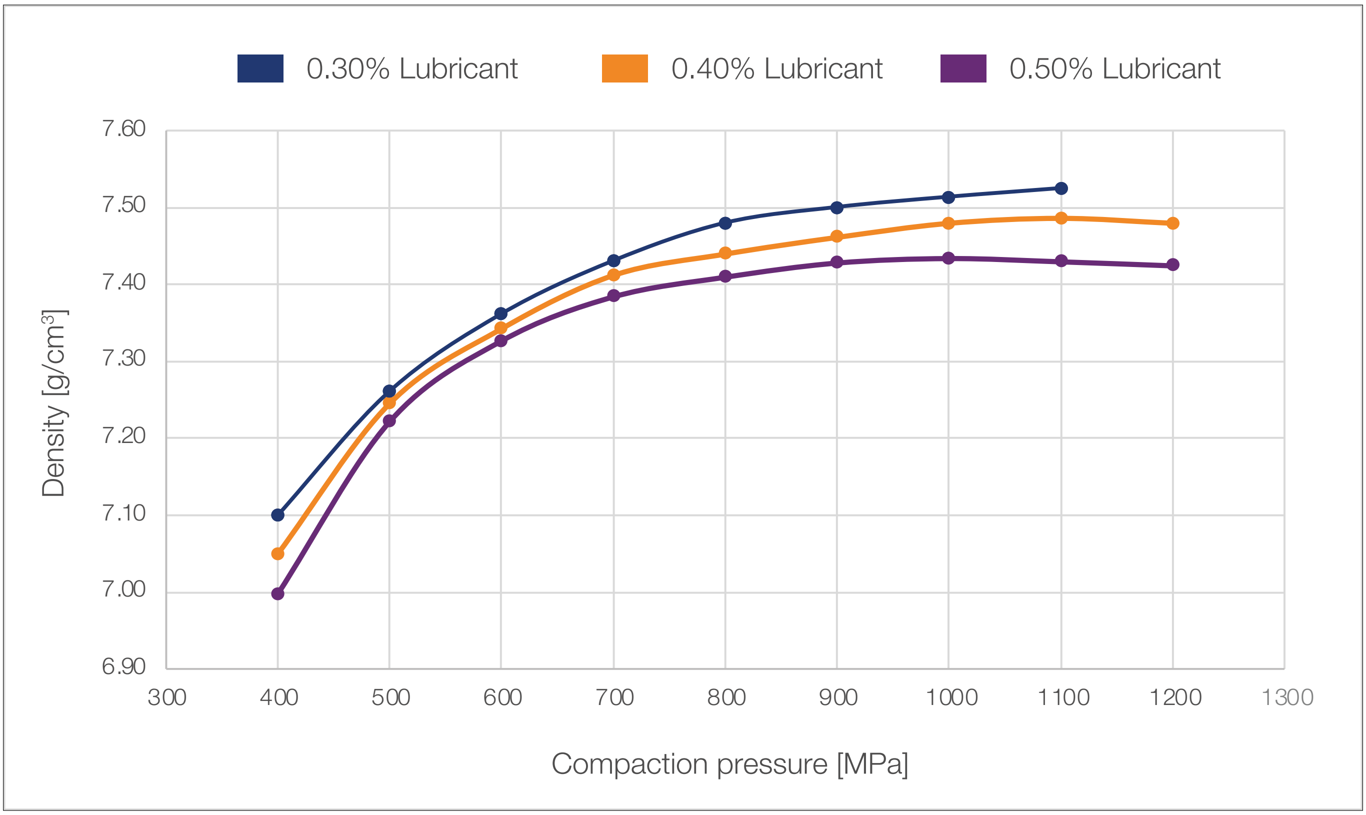


Figure 1. Effect of lubricant on compressibility of Somaloy 7P

Somaloy 7P is formulated to provide high compressibility, stable lubrication response, and robust powder flow behavior, enabling efficient processing of both small and large components. The intrinsic powder properties define the achievable density, the press forces required, and the sensitivity to lubrication and temperature.

The material exhibits a predictable compressibility curve across a range of lubricant contents.

These curves illustrate how lubricant level influences density as a function of applied pressure, and they provide a baseline for selecting appropriate compaction pressures for a given geometry. It is important that Somaloy powders are stored and conditioned according to recommended practices to avoid moisture uptake, temperature variation or material degradation.

For detailed guidelines on powder storage, handling and recommended conditions, refer to the Höganäs Powder Storage and Handling Guideline.

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Compaction

Compaction is a critical step that determines green density, mechanical integrity and the parts final magnetic behavior. **Somaloy 7P** is typically compacted within 600–800 MPa, offering a wide processing window when lubrication, temperature and tool setup are well controlled.

General Principles

Effective compaction depends on stable powder flow, correct tool alignment, and controlled movement of the powder during pressing. Key elements include the use of a floating core with proper neutral-zone movement, consistent under-filling (raising the die approximately 1–2 mm before compaction), an adequate dwell time at peak pressure for density stabilization, and proper counter-force management during ejection. Press speed must be balanced to allow air to evacuate efficiently and to avoid compact instabilities.

Lubrication

Internal lubricant content influences density potential, ejection forces and risk of defects and protects the insulating coating during compaction.

Typical levels are:

- **0.30%:** High density and good magnetic performance
- **0.40–0.50%:** Recommended for large or tall geometries when safer ejection is required..

Both too low and too high lubricant amounts can cause cracks. Low lubrication increases friction and tensile stresses on tool and final part, while high lubrication reduces green strength and promotes laminations or surface damage.

Tooling recommendations

Tool design and material selection have a significant influence on compaction behavior, surface quality and final magnetic performance of **Somaloy 7P** components. To minimize friction between powder and die wall, carbide dies are recommended for compaction of **Somaloy 7P.** Carbide tooling reduces wear and scoring during ejection, resulting in improved surface quality of the compacted part.

Tooling should be designed to allow controlled die pre-heating, typically in the range of 60–100 °C, for Warm Die Compaction. Integrated heating solutions such as cartridge heaters enable stable temperature control and lower ejection forces. Proper die material selection and temperature capability are key factors for achieving consistent density, stable ejection, and repeatable compaction performance. capability are key factors for achieving consistent density, stable ejection, and repeatable compaction performance.

Warm die compaction (WDC)

Somaloy 7P is preferably compacted using Warm Die Compaction (WDC) to take advantage of the material's coating and lubrication system. When using WDC, tool clearance must be considered during tool design, as thermal expansion affects alignment, friction and ejection behavior. Proper allowance for expansion is required to maintain stable compaction conditions and avoid surface damage or scoring.

WDC generally provides:

- Higher achievable density
- Lower ejection forces
- Reduced internal lubrication requirement
- Improved and more consistent surface conditions

Temperature Control

Temperature control is essential for achieving predictable magnetic properties and minimizing surface defects. Temperature must always be measured on the ejected component, as die temperature and component temperature differ.

Recommended part-surface temperatures:

- **< 6 mm:** 100°C
- **6–14 mm:** 80°C
- **> 14 mm:** 60°C

If the part surface becomes too hot, lubricant may liquefy, causing sweating, smearing, and reduced magnetic properties. If temperature is too low, friction increases and the risk of scratches, cracks or coating damage rises.

Heat treatment

Heat treatment of **Somaloy 7P** serves several purposes: controlled removal of lubricant, activation of coating, stress relaxation after compaction and increasing the mechanical strength in the component. The heat treatment should be tailored to the application need, and getting the right temperature profile is crucial for the material properties.

Furnace requirement

Both batch and continuous furnaces can be used. The furnace must support a maximum operating temperature of 750°C and must have several heating zones to be capable to match the required temperature profile. In addition, to prevent oxidization of the part, the cooling zone should be long enough to cool down the components to maximum 180°C before leaving the furnace. A recommendation is to be able to log the data from the furnace parameters.

Temperature control in the component

As the temperature in the furnace does not necessarily correspond to the temperature within the component, it is essential to measure the actual temperature profile inside the part during heat treatment. This is done by drilling a small hole in the component to fit a thermocouple, ensuring proper contact and accurate measurement. The thermocouple must be securely fixed so that it remains in position throughout the entire heat-treatment cycle and does not interfere with transport through the furnace. The thermocouple is connected to a data logger, which records the temperature profile during the heat-treatment. After completion, the logged data is evaluated to verify that the component has reached the required temperatures and dwell times.

Required equipment is needed:

- Thermocouple (K-type recommended)
- Data logger & analysis software
- Drill & HSS drill bit (preferably OD 2 mm)

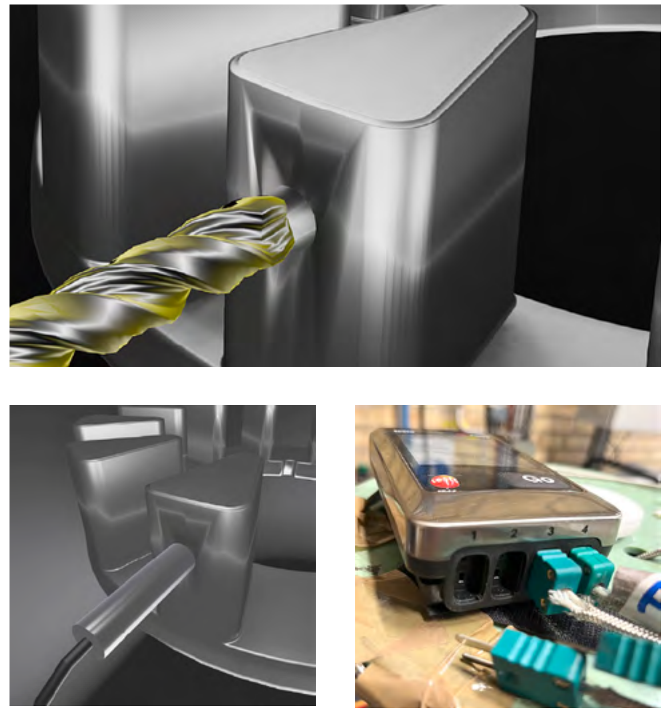


Figure 2. Equipment used to measure the heat-treatment profile inside the component.

For a step-by-step demonstration of the temperature measurement procedure, refer to our **Somaloy Temperature Profile** video.

Temperature recommendations

As size and geometry vary, heat treatment should be tailored to fit the application need. These temperature recommendations should therefore be seen as a starting point.

Small components can typically be heat-treated directly toward the relaxation temperature since their low mass ensures rapid and uniform heating. A maximum temperature of around 615°C is recommended, with limited time above 600°C serving to achieve full stress relaxation without risking coating degradation. A dewaxing plateau is generally not necessary.

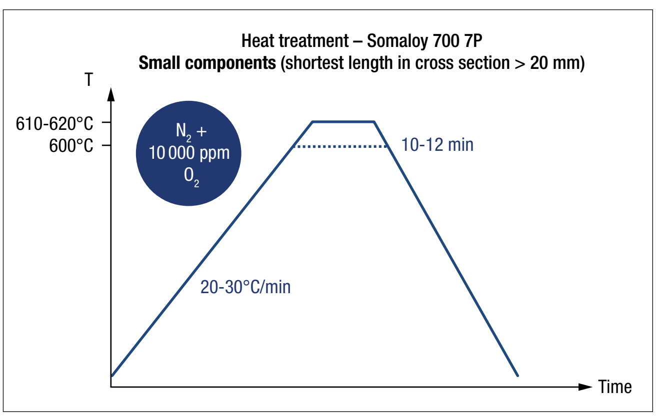


Figure 3. Recommended heat-treatment profile for small Somaloy 7P components.

Large components with thicker cross-sections, require a more controlled heat-up phase.

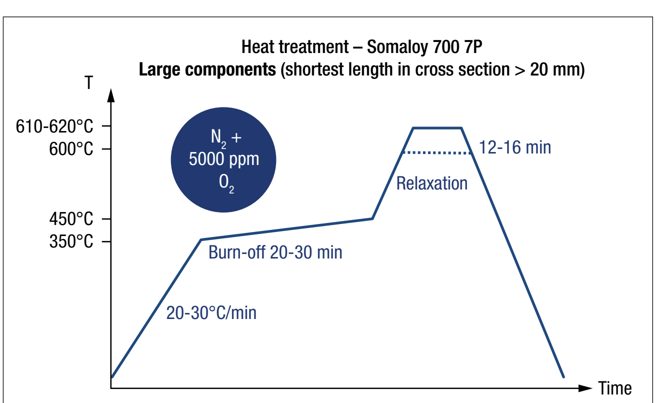


Figure 4. Recommended heat-treatment profile for large Somaloy 7P components.

Atmosphere Control

7P is generally heat-treated in N_2 atmosphere with 1% O_2, see figure 5. If clean surface quality is required heat treatment can be done in pure N_2. Look into FAQ if pure N_2 atmosphere is preferred.

Figure 5. Surface appearance of Somaloy 7P components after heat treatment in controlled O_2 atmosphere (right) and pure N_2 (left).

Carriers for heat-treatment trays

As flatness and parallelism are crucial in many applications, it's important to have the correct carriers to control these properties. Most commonly used carrier materials are:

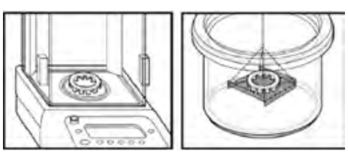
- Ceramic aluminum oxide plates
- Stainless steel plates

Quality control

Quality control of **Somaloy 7P** components ensures that the compaction and heat-treatment processes have produced stable magnetic, mechanical, and dimensional properties. The following inspection steps verify the critical characteristics that determine performance in electromagnetic applications.

Density

Density is directly linked to magnetic performance, influencing both induction, permeability and hysteresis losses. It also reflects how efficiently the material was compacted and whether lubrication, temperature and press parameters were properly balanced. Density is measured following the Archimedes principle according to SS-ISO 2738 using paraffin for impregnation of heat-treated parts. Green density may also be monitored using mass and dimensional measurements to track process stability during production.



Crack control

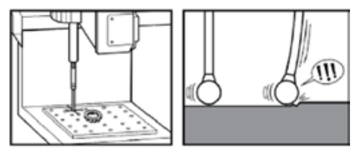
Sectioning the component provides insight into internal consolidation quality and identifies defects that may not be visible on the surface. Lamination, porosity clusters, internal cracks and density gradients are typical indicators of compaction related issues such as air entrapment, insufficient lubrication, improper press speed or uneven powder flow. Crack control is especially important for new tooling setups or when changes are made to lubrication levels, die temperatures and or press parameters. Crack control is only done on sintered components!

Dimensional control

Measurement of component dimensions provides verification that **Somaloy 7P** parts meet the specified geometry and tolerances after compaction and heat treatment. Typical measured parameters include height, diameter, flatness and parallelism, depending on the component design and application requirements.

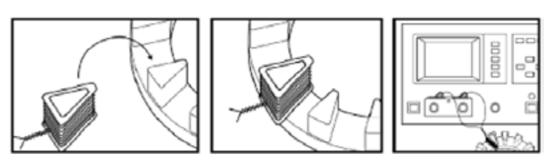
Dimensional measurements are typically performed using precision equipment such as coordinate measuring machines (CMM), calipers or gauges. For more complex geometries or detailed surface inspection, optical measurement techniques such as GOM (optical 3D scanning systems) may also be used. These methods allow evaluation of dimensional accuracy and shape deviations over the full component geometry.

After heat treatment, SMC components are relatively brittle and must be handled with care during measurement. Improper handling or clamping may introduce damage such as chipping or cracking, which can affect both dimensional accuracy and functional performance.



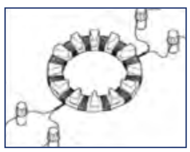
LCR Measurement

Inductance measurements across a frequency range provide an indirect evaluation of the material's AC loss behavior. A stable inductance-to-frequency curve indicates good resistivity and consistent heat-treatment results, while a rapid inductance drop suggests increased eddy-current losses or coating damage. LCR testing is especially useful for validating that heat-treatment parameters are correctly tuned for the specific component geometry and mass. This can be done on any geometry. Measurement should not be seen as absolute values but instead a relative value to compare same geometry with different processing.



Hystograph, including induction, coercive force and losses

Measurement of the magnetic hysteresis loop using a hystograph provides the performance of the material in terms of induction, permeability, coercive force, remanence and core losses. The material is wound according to standards IEC 60404-4 (DC-measurements, the hysteresis loop) and IEC 60404-6 (AC-measurements, losses as a function of frequency) and tested for response in B-field when different H-fields are applied from which all the values are extracted. A low coercive force results in low losses at the lower frequencies which indicate successful relaxation of the material (sufficient heating during heat-treatment), while low losses at higher frequencies indicate sufficient electrical insulation and that the insulating coating is functioning and has not deteriorated during heat-treatment.

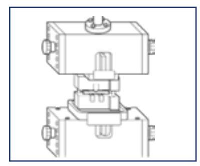


Coercimeter

A coercimeter operating according to IEC 60404-7 is an easy way to obtain the coercive force and hence judge the success of the heat-treatment through placing the component in a strong applied H-field and measuring the required opposite field required to cancel remaining magnetization. Hence the method is a complement to the Hystograph but is quicker, does not require a closed magnetic loop, nor does it require any coil wound. Just as for LCR-meter measurements the method is especially useful when comparing the same geometry with different processing.

Mechanical testing

Mechanical testing is used to evaluate the structural integrity of Somaloy 7P components after compaction and heat treatment. The most common method is transverse rupture strength (TRS) testing, performed on standardized test bars according to ISO 3325, providing a measure of the material's static strength and resistance to cracking. The measured strength reflects the combined effect of density, lubrication level and heat-treatment conditions. Lower than expected strength values could indicate problems with compaction or heat treatment. Mechanical testing can for instance be used to monitor process stability and ensure sufficient strength for handling, assembly and operation.



Starting kit

For new producers or new production lines, a capacity check ensures that compaction and heat-treatment equipment can consistently achieve the required 7P material properties. Standardized ring and bar samples are evaluated for density, mechanical properties and magnetic characteristics. This verifies that furnace capabilities are adequate before series production begins. Contact your local Höganäs representative to receive a starting kit.

Packing and shipment

Somaloy is a brittle material and should be handled with care. The components should be packed separately in tight fitting packing material with damping ability to prevent mechanical damage and maintain part quality.

The fit should be tight enough to prevent components from moving but soft enough to avoid damage (to the components).

For detailed recommendations on packing methods and handling practices, refer to the Somaloy Packing and Shipment Guideline below.

For detailed recommendations on packing methods and handling practices, refer to the **Somaloy Packing and Shipment Guidelines** here.

Driving positive change through material innovation.

Höganäs' vision is to drive positive change through material innovation and become the preferred partner for sustainable powder materials. Powder technology provides endless opportunities; not only does it empower customers to reduce material and energy consumption, but it also enables the use of new and improved techniques that make final products more efficient and cost-effective. In short, powders are a resource-efficient alternative, ideal for a wide range of industries.

World leader in powders

Höganäs is a company with strong local presence around the world and the market leader in advanced ceramic and metal powders. Contact the nearest Höganäs office today — click or scan the QR code to learn more.