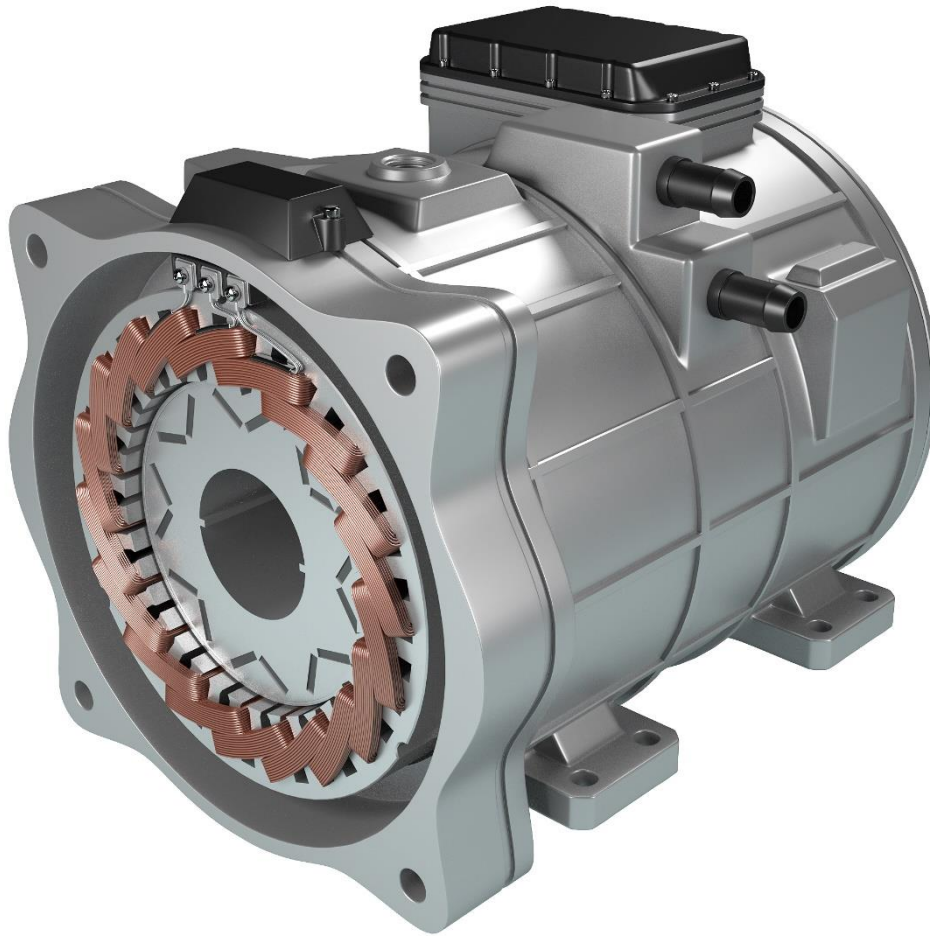


Magnetic Materials by Proterial



- Nd-Fe-B Magnets NEOMAX® with Heavy Rare-Earth Reduction Technology
- Nd-Fe-B Anisotropic Ring Magnets
- High-performance Ferrite Magnets NMF™-12, 15 series
- Permendur YEP™-2V
- Amorphous Alloy for Motor
- Soft Ferrite MaDC-F® and Metal Powder Core
- FINEMET® Common Mode Choke Coils/Cores FT-3K10Q series
- FINEMET® Magnetic Shield for Noise Reduction
- Magnetic Slot Wedge for Motor Application

March 2025, Proterial, Ltd.

NEOMAX, NMF, YEP, MaDC-F and FINEMET are a registered trademark or a trademark of Proterial, Ltd.

Nd-Fe-B Magnets NEOMAX[®] with Heavy Rare-Earth Reduction Technology

Achieve high performance and resource risk reduction by applying Proterial's original "M-diffusion[™]" technology.



Outline

Establish "M-diffusion[™]" technology, which enables a significant reduction in the use of heavy rare-earth, achieving both higher magnetic properties and further resource risk reduction.

Features

Following features achieved by applying Proterial's original "M-diffusion[™]" technology.

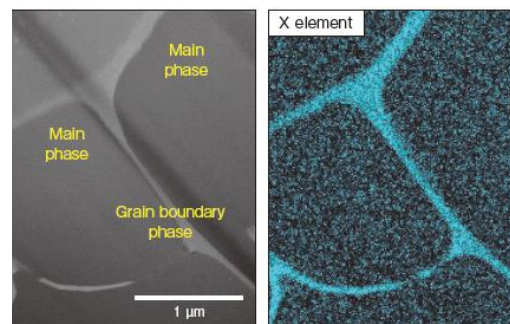
- High remanence (B_r) and coercivity (H_{cJ})
- Significant reduction of heavy rare-earth*
- Reduction of coercivity difference in an individual magnet*

*Compared to our magnet applied conventional diffusion process.

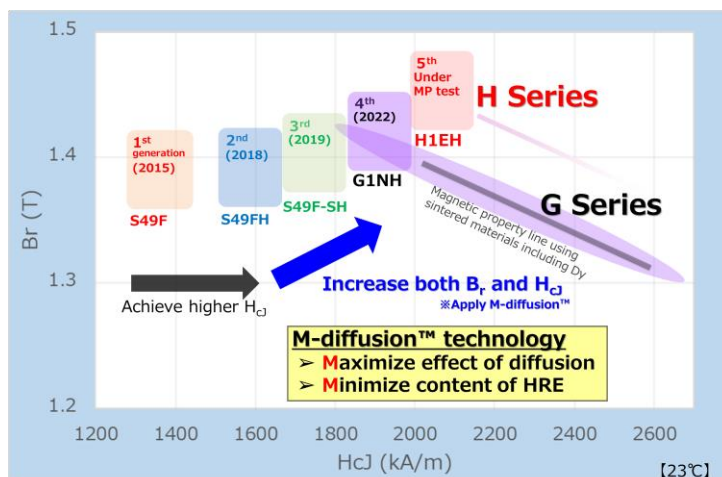
Applications

Motors
Actuators
Generators

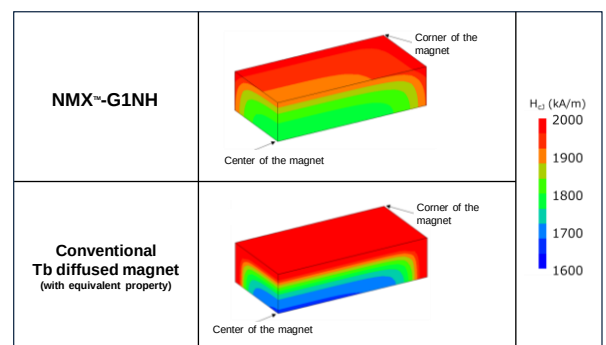
Example of microstructure and X-element distribution



Magnetic properties of magnets applied "M-diffusion[™]" technology



Example of simulation about distribution of coercivity in the magnets



※Examples of calculations and does not guarantee these properties.

- Dimension of the magnet: 5 (easy magnetization direction) × 10 × 20 (mm)
- Calculation about one-eighth region of the magnets using actual magnetic properties



Nd-Fe-B Anisotropic Ring Magnet

Enhancing performance of motors and assembly optimization



Outline

Anisotropic ring magnets contribute to reducing motor assembly processing and enhancing high output density etc.

Applications

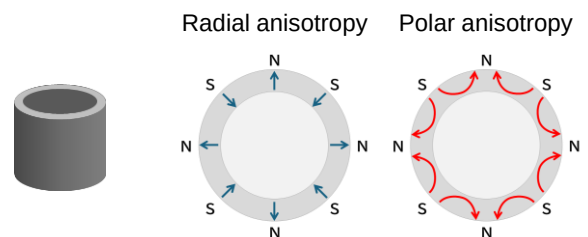
Motors
Actuators

Features

Provides the following benefits when applied to motors and actuators due to features not found in segment magnets.

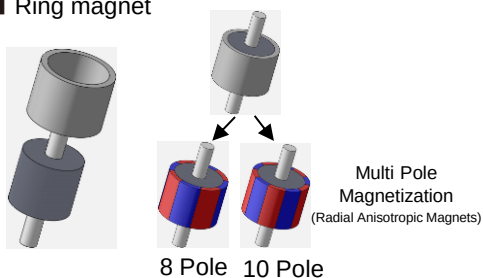
- Reduction of assembly processes
- Increase output density
(High power output and weight reduction)
- Reduce cogging torque

Magnetic flux distribution within the magnets
(Schematic illustration)

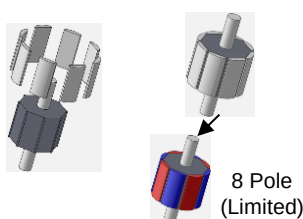


Contribution to reduction of assembly processes

■ Ring magnet

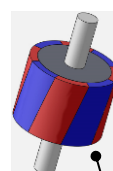


■ (Ref.) Segment magnets

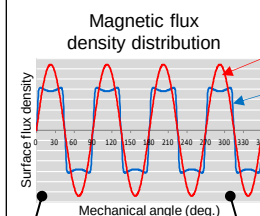
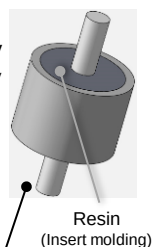


Contribution to motor performance increase

Radial anisotropic magnet (Skew magnetization)



Polar anisotropic magnets



Smooth skew magnetization

Magnetic flux density waveform (sine wave)

High peak magnetic flux density

Rotor weight reduction

Low cogging torque

High output power density

※The number of poles illustrated in this document are representative examples. For more details, please contact us.



High-performance Ferrite Magnets NMF™-12, 15 Series

Proposing for typically rare-earth magnet-applications, such as xEV traction motors, in addition to conventional ferrite magnet-applications.



Outline

Highest-level of magnetic properties among mass-produced ferrite magnets*. This enables us to propose for NMF™-12 & 15 for applications conventionally using rare-earth magnets such as xEV traction motors in addition to auxiliary automotive motors and home appliance motors etc. (*As of September 2024)

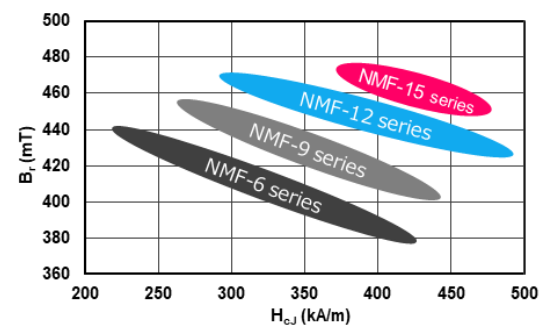
Applications

Motors

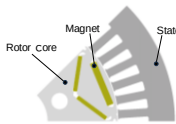
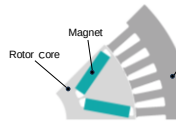
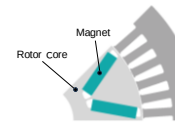
Features

- Highest-level of magnetic properties among mass-produced ferrite magnets.
- Suppressing generation of eddy currents due to that resistivity three orders of magnitude higher than that of rare-earth sintered magnets.

Magnetic properties of NMF™ series



Example of simulation results for xEV traction motors

	Reference (Using Rare-earth magnets)	Proposal ① (Equivalent motor performance)	Proposal ② (Equivalent motor size, high speed rotation)
Magnets in simulation	Rare-earth Magnets	High performance Ferrite magnets NMF™-15 series	High performance Ferrite magnets NMF™-15 series
Motor model "1/8"			
Max. output	110 kW	110 kW	105 kW
Max. rotation speed	10,000 rpm	10,000 rpm	15,000 rpm
Magnet B _r (relative value)	1.0 (ref.)	0.37	0.37
Magnet weight (relative value)	1.0 (ref.)	1.7	1.2
Motor length (relative value)	1.0 (ref.)	1.4	1.0
Motor weight (relative value)	1.0 (ref.)	1.3	1.0



Permendur YEP™-2V

Soft magnetic alloy with high saturated flux density "permendur" contributes to the realization of a compact, lightweight, high-power motor.



Overview

YEP™-2V (Fe-49Co-2V in mass%) has high saturated magnetic flux density, which realizes compact, lightweight, high-power motors and high responsive actuators.

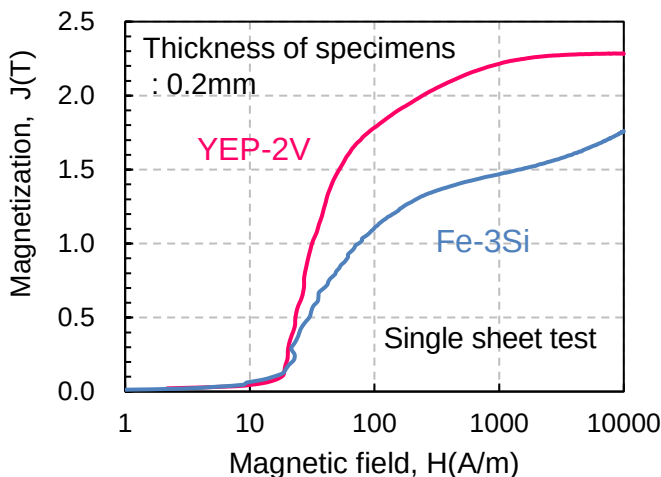
Applications

Motor core
Actuator core

Technology Features

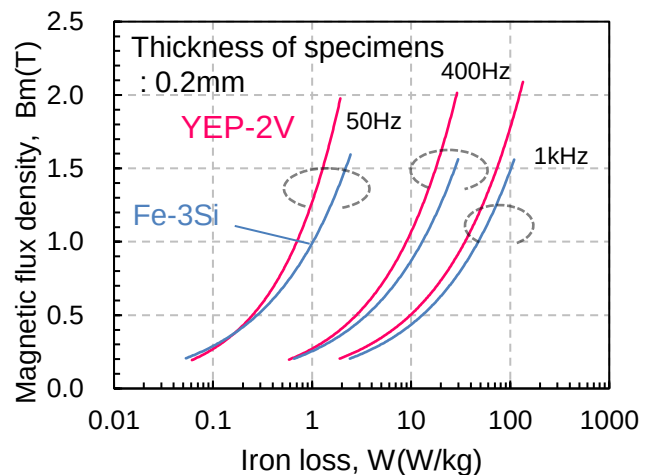
Initial D.C. magnetization curve

- YEP-2V shows higher magnetization than Fe-3mass%Si steel.



Iron loss curve

- YEP-2V shows smaller iron loss than Fe-3mass%Si steel.



Example of laminated core



Segmented core (laser welding)



Permendur YEP™-2V

Soft magnetic alloy with high saturated flux density "permendur" contributes to the realization of a compact, lightweight, high-power motor.



Overview

YEP™-2V (Fe-49Co-2V in mass%) has high saturated magnetic flux density, which realizes compact, lightweight, high-power motors and high responsive actuators.

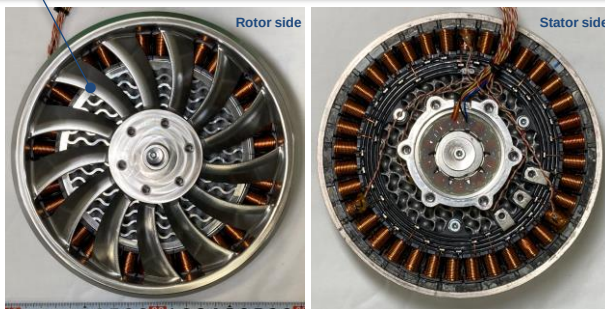
Applications

Motor core

Actuator core

Motor demonstration evaluation

Core Aluminum material 3D molding for the stator fixing part Gyrold structure improves cooling efficiency

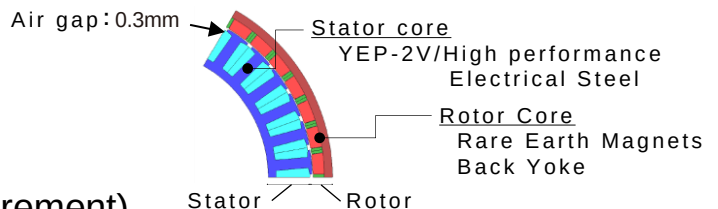


eVTOL Simulated Outer Rotor Motor

Motor Specifications *1

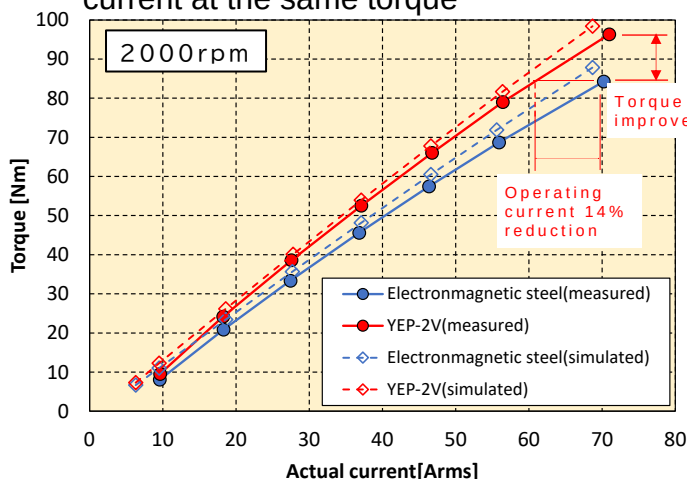
Motor structure : eVTOL Simulated Outer Rotor
Number of position : 42
Core Material : YEP-2V High-performance electromagnetic steel
High-Material Ythickness : 0.1mm
Core Dimensions : OD150mm x Thickness35mm
Output : 15kW [torque : 70Nm] (using YEP-2V)
Rate speed : 2000rpm
Magnet : Rare Earth Magnets / Halbach array
Cooling methos : Air-cooled
(*1 : Yamada Power Unit Co., Ltd. Design & Evaluation)

Analysis Model <1/6>

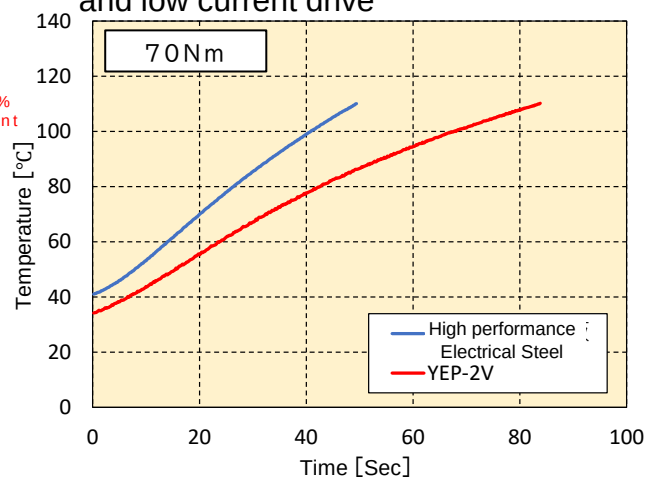


Motor Evaluation Results (Actual measurement)

YEP-2V can drive motors with 14% higher torque at the same current, and 14% lower current at the same torque

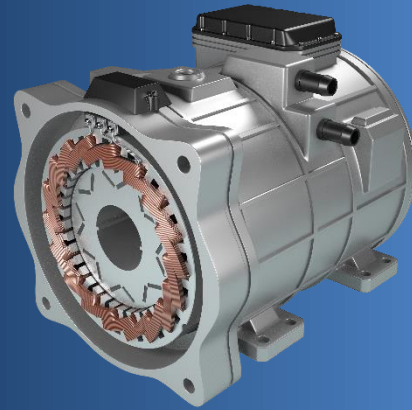


YEP-2V generates less heat and low temperature rise due to its high torque and low current drive



Amorphous alloy for motor

By using an amorphous alloy for the motor core
A high-efficiency motor suitable for high rotation can be realized.



Overview

Motor core iron loss reduction achieved the following effects.

- Energy saving by improving motor efficiency
- Reduction of motor thermal generation

Application

Low Load High rotation speed Motor

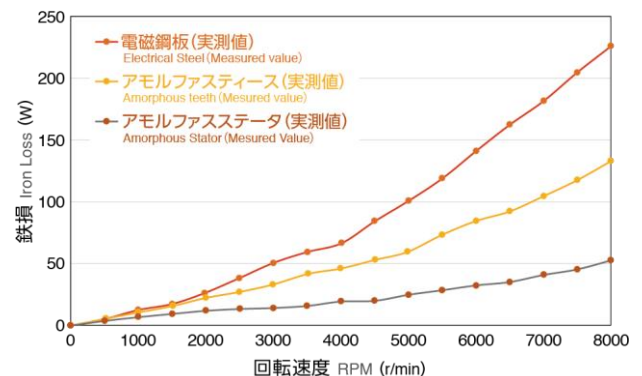
Feature

Confirmed the following with an amorphous stator core.

- Iron loss reduced to about 1/5
- Efficiency improvement of 3% or more in the high rpm range
- Motor thermal generation can be reduced by half

Note: evaluated loss of IPM motor (Φ215mm × 50mm stator core)

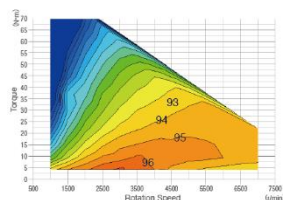
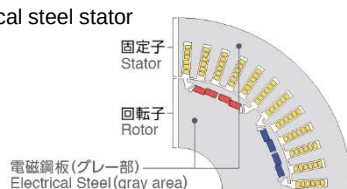
Iron loss evaluation result of prototype motor



Efficiency Comparison of prototype motor

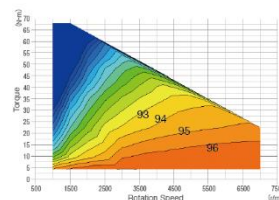
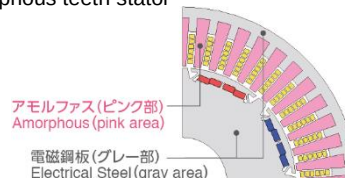
Reference :

Electrical steel stator



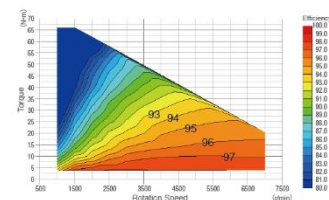
Reference : Electrical steel stator

Amorphous teeth stator



Amorphous teeth stator

All amorphous stator



All amorphous stator

Contact

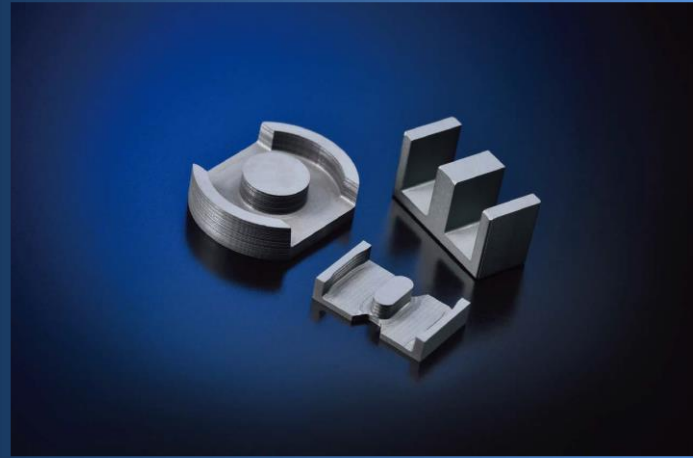
Proterial, Ltd.

Power Electronics Materials Business Unit

Toyosu Prime Square, 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Soft Ferrite MaDC-F® and Metal Powder Core

Material portfolio for various, high performance requirement.



Overview

The series of low loss soft ferrite materials from 300kHz to 3MHz (MaDC-F®), and the high resistance metal materials(HRM) contribute to the miniaturization of high frequency devices and products.

Application

Transformer, Inductor
for datacenter, automotive, etc.

Feature

▪ Soft Ferrite (MaDC-F® Series)

ML27D: 20-100 degC flat low loss material
at the frequency 300kHz to 500kHz

ML95S: Low loss material
at the frequency 500kHz to 1MHz

ML91S: Low loss material
at the frequency 1MHz to 5MHz

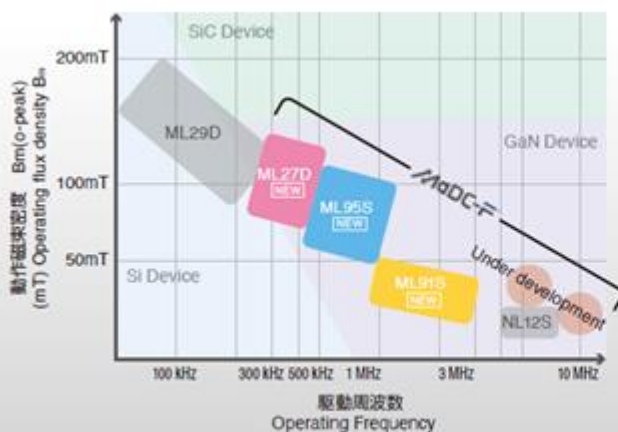
▪ Metal Powder cores

HRM40 : Metal material with high resistivity Complex Shape availability

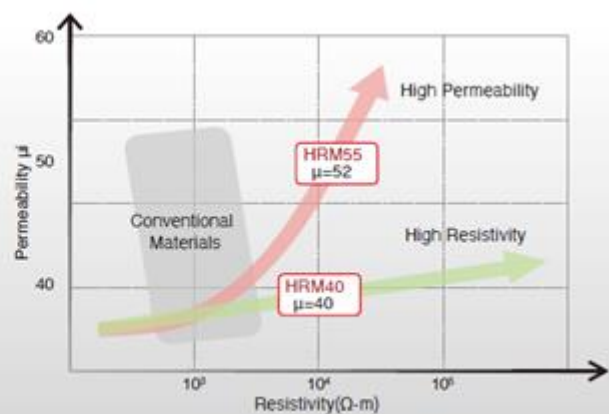
HRM55 : Higher permeability than HRM40 with same resistivity



Relationship between operating flux density and operating frequency



Relationship between permeability and resistivity



Contact

Proterial, Ltd.

Power Electronics Materials Business Unit

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FINEMET® Common Mode Choke Coils/Cores FT-3K10Q series

Contribute to downsizing of noise filter



Outline

- High impedance at wide frequency range.
- Stable impedance under wide temperature range required for automotive parts.

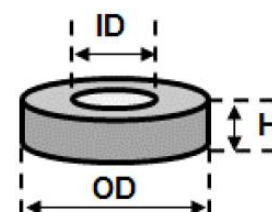
Applications

On board charger for xEV,
Inverter for xEV, etc.

Features

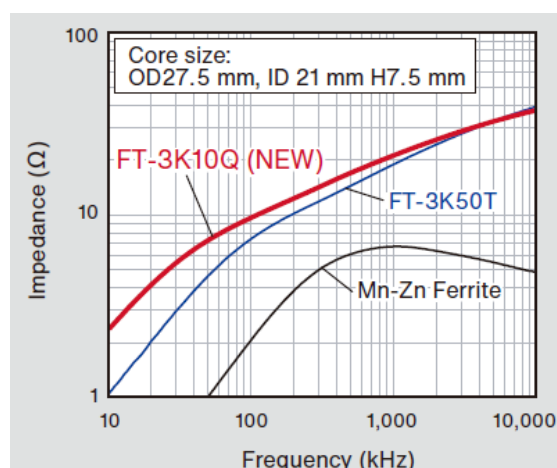
Comparison of "FT-3K10Q" with conventional materials

Material	impedance (Ω)		
	10kHz	100kHz	1MHz
FT-3K10Q	2.32	9.57	21.05
FT-3K50T	1.02	7.31	18.72
Mn-Zn Ferrite (Our material MP70D)	0.19	2.05	6.73

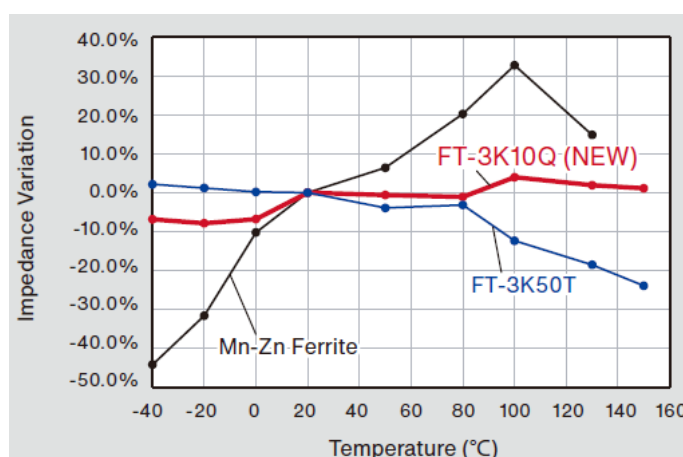


Core size:
OD27.5 mm, ID 21 mm H7.5 mm

Frequency characteristics of impedance



Temperature dependence of impedance



Finemet® Magnetic shield sheet for noise reduction

High heat resistant products do not deteriorate in characteristics with temperatures of 130°C.



Overview

A thin, lightweight, flexible, and easy-to-handle magnetic shielding sheet made Finemet® FT-3 with protective film.

Applications

Measures against magnetic noise inside xEV

Feature

You can select the suitable product from two types: a standard specification product and a high heat resistant product with a heat resistance temperature of 130°C.

- Compared to standard specification products, high heat resistant products do not deteriorate in characteristics even in environments with temperatures of 130°C.
- The high heat-resistant product is thin at 0.05 mm (40% compared to conventional products), so it can be used even in narrow spaces.
- It easy to process into curved surfaces and various shapes.

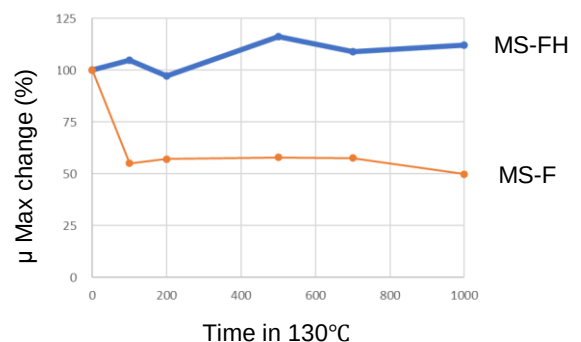
Characteristic

Type	Standard specification products		Highly heat-resistant products	
Dimension	470mm x 100m	460mm x 610mm	470mm x 100m	460mm x 610mm
P/N	MS-FR 470-100M-T0	MS-F SD-460x610-T0	MS-FHR 470-100M-T0	MS-FH SD-460x610-T0
Thickness	0.13 mm		0.05 mm	
Magnetic flux density B ₈₀₀ (DC H=800A/m)	≧ 1.1T			
Maximum permeability, μ max (DC)	≧ 70,000			
Operating Tempreture range	-40 ~ +80 °C		-40 ~ +130 °C	

Characteristic comparison

Characteristic	High heat resistant products	Standard specification products
Saturation Magnetic Flux Density B ₈₀₀ (DCH=800A/m)	≥ 1.1T	
Maximum permeability μ max (DC)	≥ 70,000	
Thickness	0.05mm	0.13mm
Temperature range	-40 ~ +130 °C	-40 ~ +80 °C

Comparison of high heat-resistant products and standard products



Comparison of μmax rate of change after 130°C storage

Magnetic slot wedge for motor application

High-efficiency motor is realized by inserting magnetic slot wedges into the slot opening. Significantly improved magnetic permeability, strength, and heat resistance compared to conventional magnetic wedges.



Overview

Our resin-less magnetic slot wedges, which are high-density compacted powders, contribute to higher motor efficiency with high magnetic permeability, high strength, and high heat resistance compared to conventional resin magnetic slot wedges.

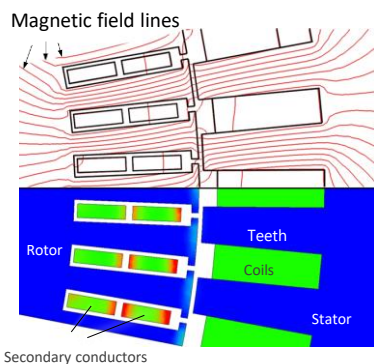
Applications

Various motors

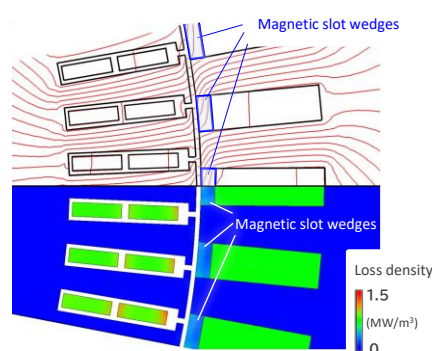
Feature

Broadening magnetic flux distribution reduces losses on the rotor surface.

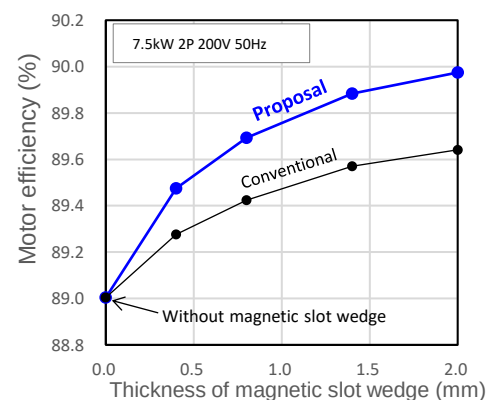
Without magnetic slot wedges



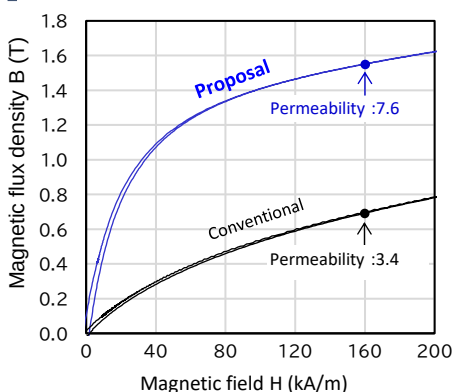
With magnetic slot wedges



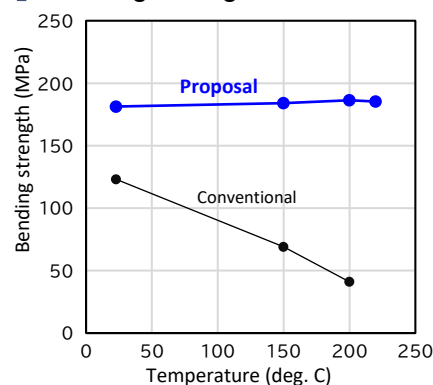
Simulated motor efficiency.



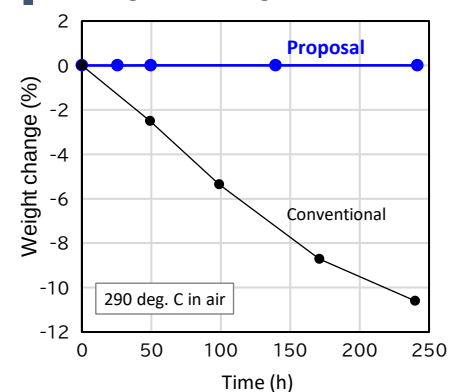
D.C. magnetization curves.



Temperature dependence of bending strength.



Weight reduction during heating at 290 deg. C.



Contact

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