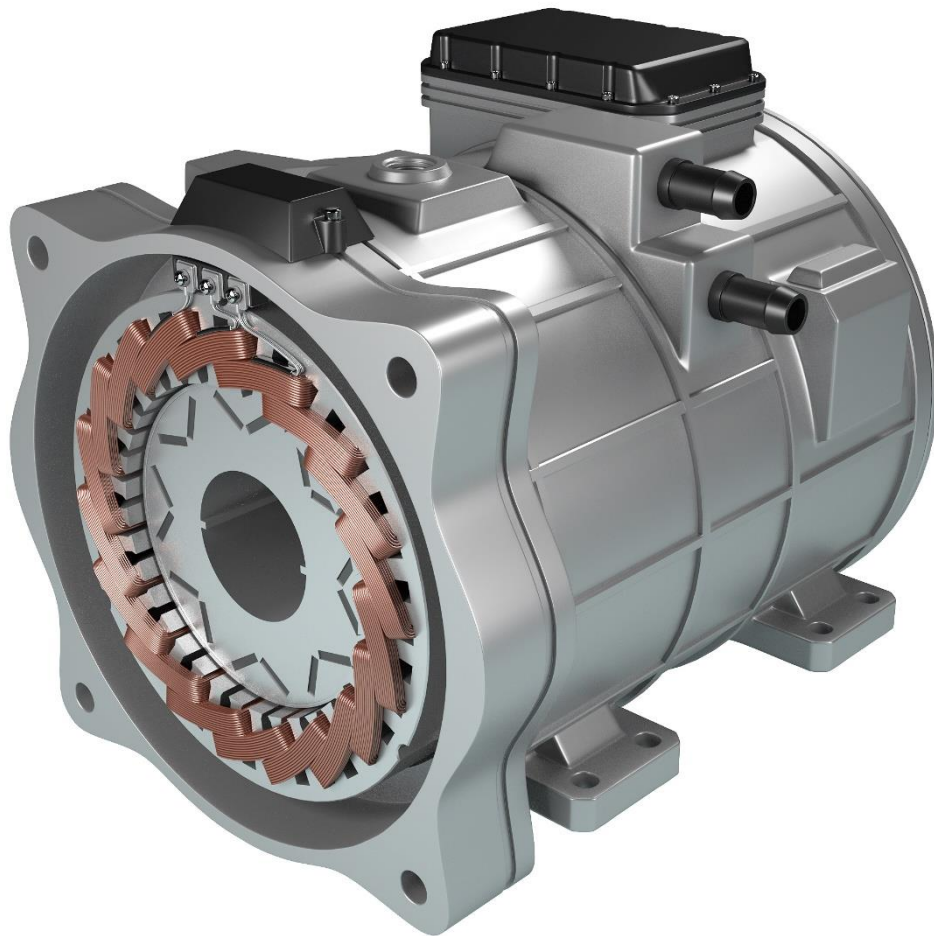


Magnetic Materials for High-performance Motor



- Nd-Fe-B magnets NEOMAX® with heavy rare-earth reduction technology
- High-performance ferrite magnets NMF™-12, 15 series
- Amorphous alloy for motor
- Magnetic slot wedge for motor application

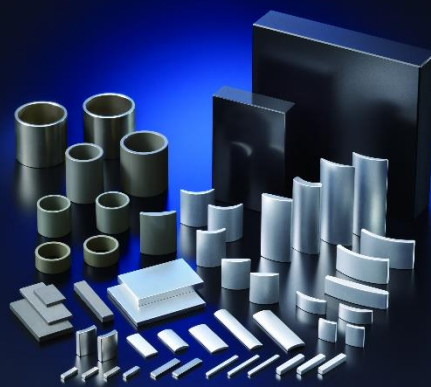
December 2024, Proterial, Ltd.

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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.

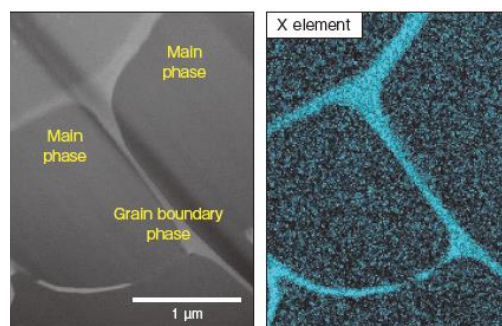
- High remanence (B_r) and coercivity (H_{cJ})
- Significant reduction of heavy rare-earth*
- Reduction of coercivity difference in an individual magnet*

*Compared to our magnet applied conventional diffusion process.

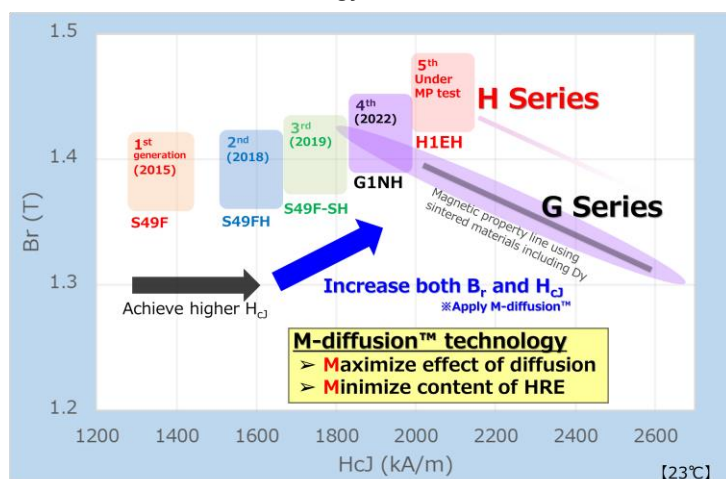
Applications

Motors
Actuators
Generators

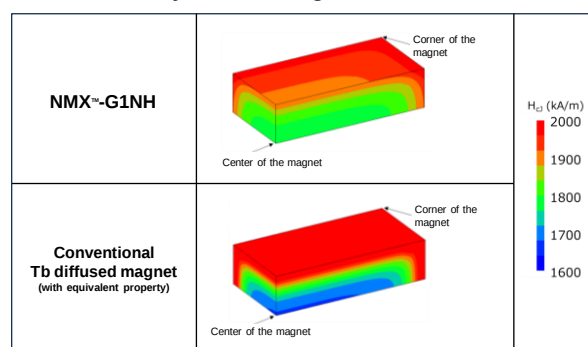
Example of microstructure and X-element distribution



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



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)

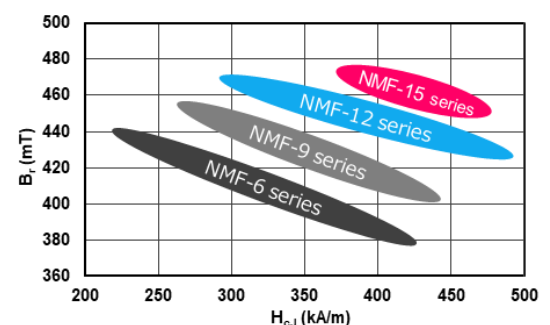
Features

- 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.

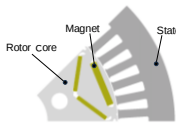
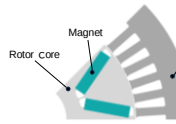
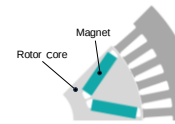
Applications

Motors

Magnetic properties of NMF™ series



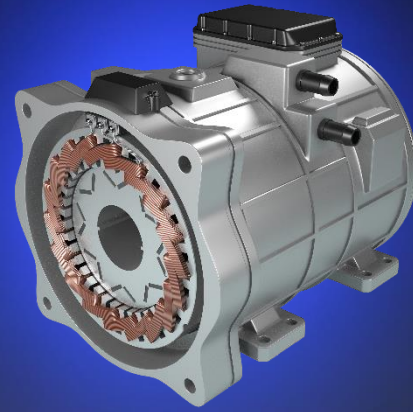
Example of simulation results for xEV traction motors

	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



Amorphous alloy for motor

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



Outline

Motor core iron loss reduction achieved the following effects.

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

Applications

Low Load・High rotation speed Motor

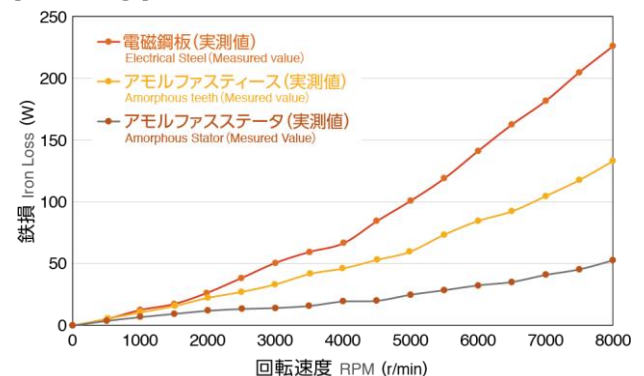
Feature

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

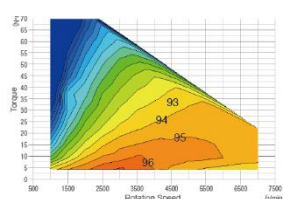
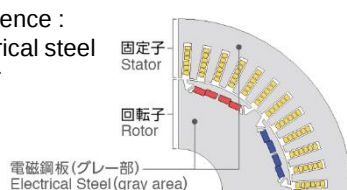
Note: evaluated loss of IPM motor (Φ215mm × 50mm stator core)

Iron loss evaluation result of prototype motor



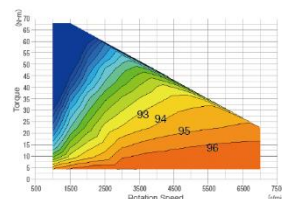
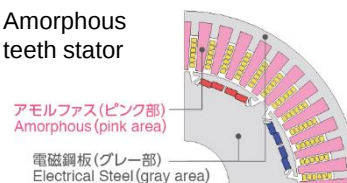
Efficiency Comparison of prototype motor

Reference :
Electrical steel stator



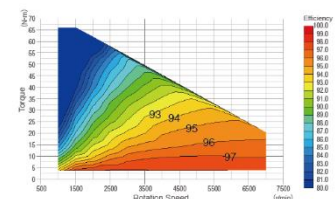
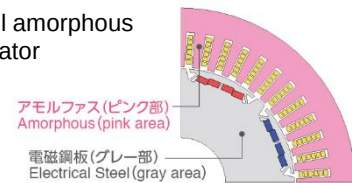
Reference : Electrical steel stator

Amorphous teeth stator



Amorphous teeth stator

All amorphous stator



All amorphous stator

References: Yuji Enomoto, Mamoru Kimura, Yasuhiro Marukawa, Hirohisa Sano, "Distributed winding IPM motor with an entire stator core made of amorphous metal," Proceedings of the 2021 Industrial Applications Division Conference of the Institute of Electrical Engineers of Japan, 3-4, ppⅢ-133-138 (2021)



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.



Outline

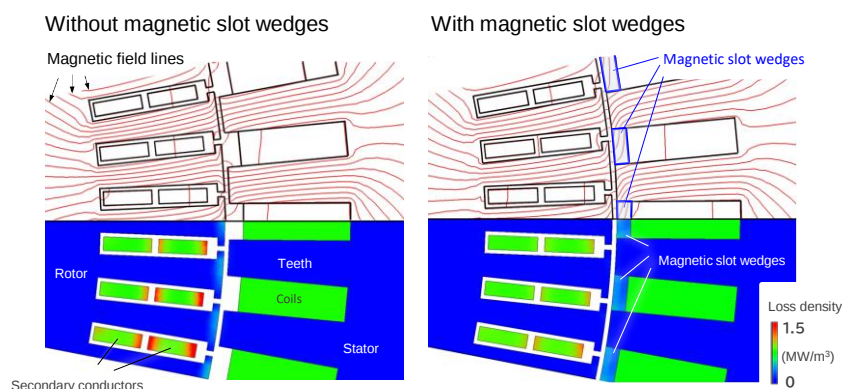
- Our resin-less magnetic slot wedges, which are high-density compacted powders, contribute to higher motor efficiency with high magnetic permeability, high strength, and high heat resistance compared to conventional resin magnetic slot wedges.

Applications

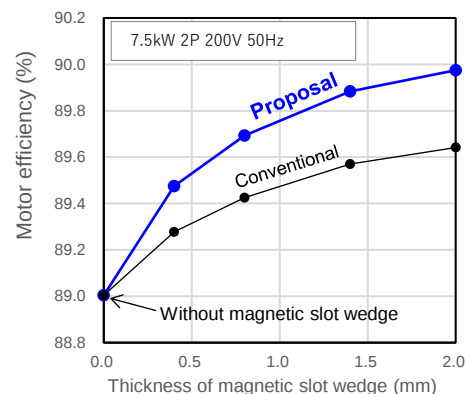
Various motors

Feature

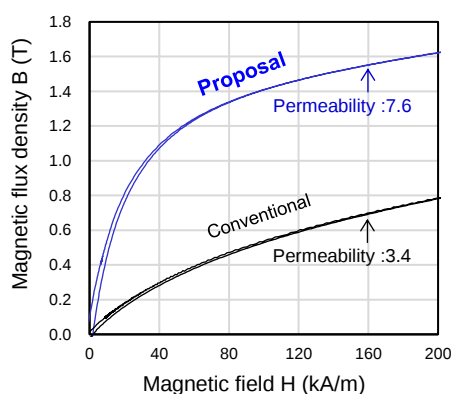
Broadening magnetic flux distribution reduces losses on the rotor surface.



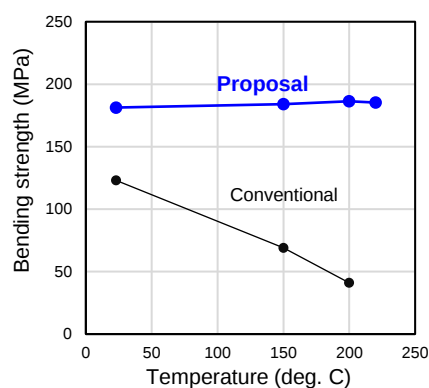
Simulated motor



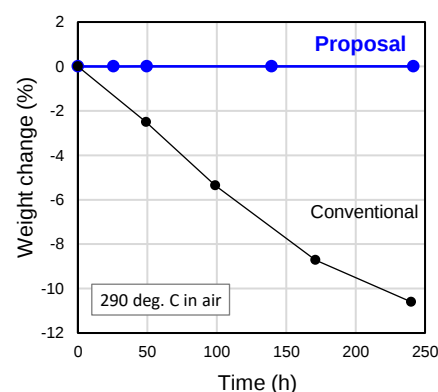
D.C. magnetization curves.



Temperature dependence of bending strength.



Weight reduction during heating at 290 deg. C.



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