PROTERIAL

For Motors

For Power Devices and Batteries

For Other Applications

Proterial, Ltd.
Proterial Europe GmbH

PROTERIAL

Achieving a compact, lightweight, and high-power motor

Permendur YEP™-2V

Technology Features

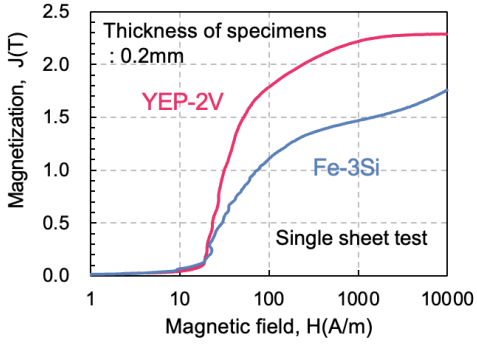
- **YEP-2V (Fe-49Co-2V in mass%) has high saturated magnetic flux density, which realizes compact, lightweight, high-power motors and high responsive actuators.**

Applications

- **Motor core**
- **Actuator core**

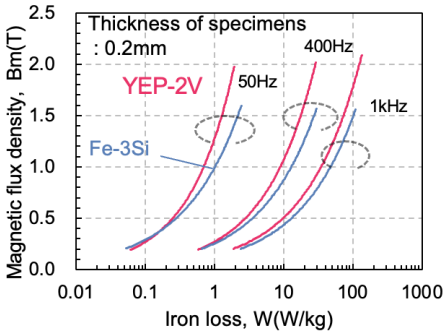
■ Initial D.C. magnetization curve

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



■ Iron loss curve

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



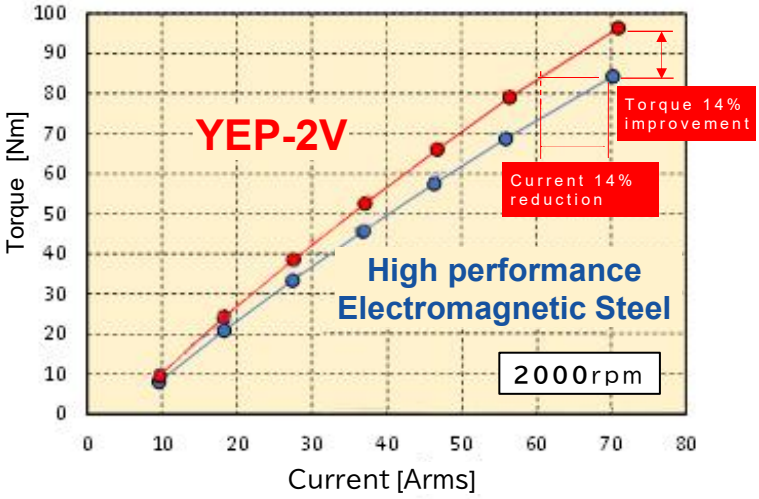
■ Example of laminated core

■ Segmented core (laser welding)

Inquiry | Proterial, Ltd.
Industrial Materials Dept., Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

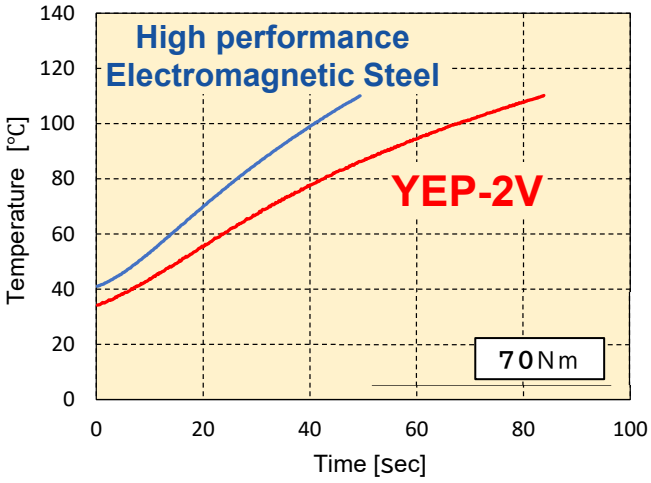
Motor demonstration evaluation 1

Torque / Current



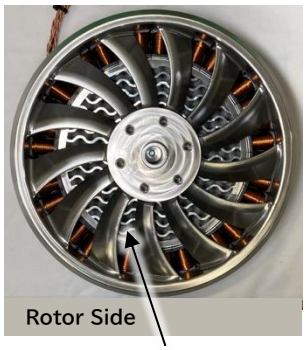
Compared to high-performance electromagnetic steel sheets, YEP-2V delivers 14% higher torque at the same current, and 14% lower current at the same torque.

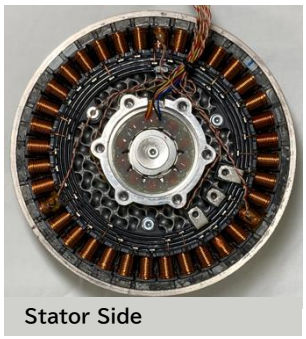
Temperature rise per hour



Since YEP-2V operates with low current, it generates less heat and results in lower temperature rise.

Specifications of the simulated outer rotor motor for eVTOL used in the evaluation analysis *1



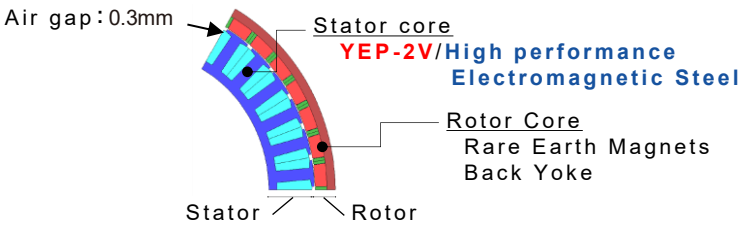


Core Aluminum material 3D molding for the stator fixing part Gyroid structure improves cooling efficiency

Number of position : 42
Core Material : YEP-2V, High Performance Electromagnetic Steel
Material Thickness : 0.1mm
Core Dimensions : OD150mm x Thickness35mm
Output : 15kW[torque : 70Nm]〈using YEP-2V〉
Rate speed : 2000rpm
Magnet : Rare Earth Magnets / Halbach array
Cooling method : Air-cooled

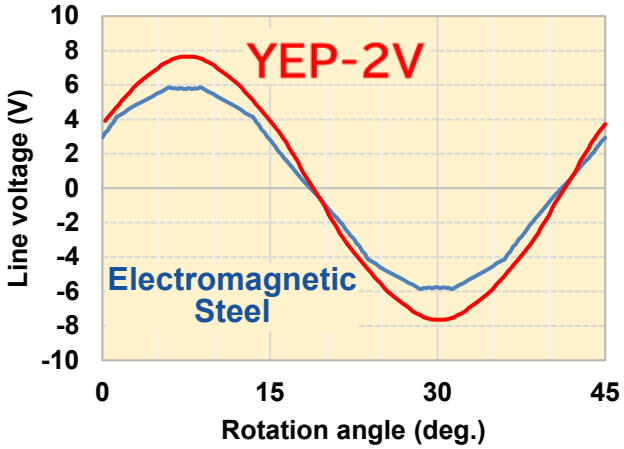
(*1 : Yamada Power Unit Co., Ltd. Design & Evaluation)

■ Analysis Model



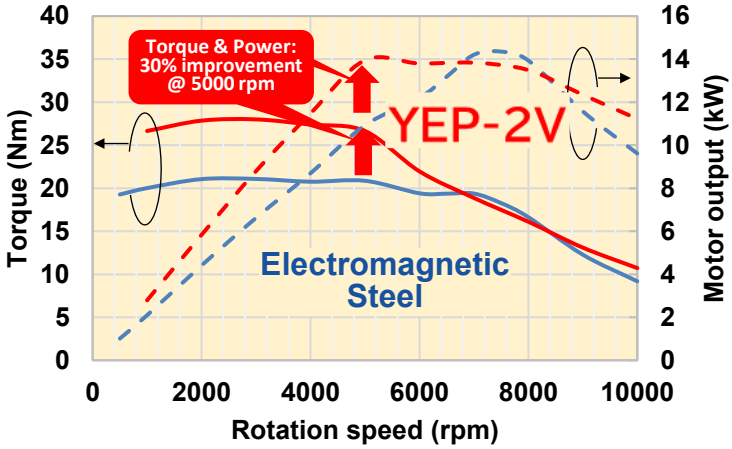
Motor demonstration evaluation 2

No-load induced voltage (Analysis)



Achieving both high voltage (torque) and low distortion

Motor characteristic evaluation results (Measured Values)



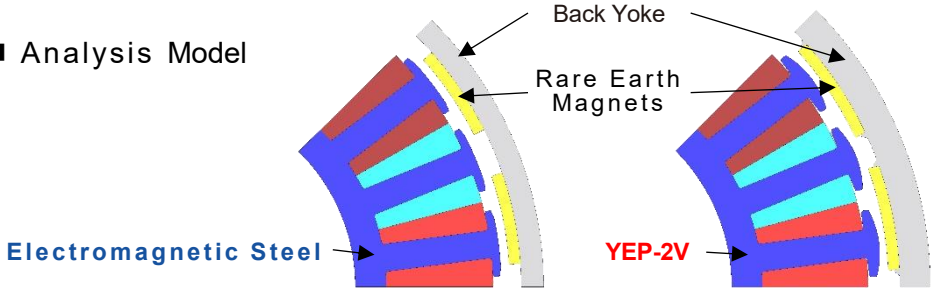
Higher torque enables increased power output in the low-speed range.

Specifications of the simulated outer rotor motor for competitive EV drive used in performance analysis *2

Number of position : 16
Number of slots : 24
Core Material : YEP-2V, Electromagnetic Steel
Material Thickness : 0.2mm
Core Dimensions : OD123mm
Power supply voltage: 50.4 Vdc (Typ.), Power supply current: 400 Adc
Rate speed : 10000rpm
Magnet : Rare Earth Magnets

(*2 : Mitsuba Corporation, Design & Evaluation)

■ Analysis Model

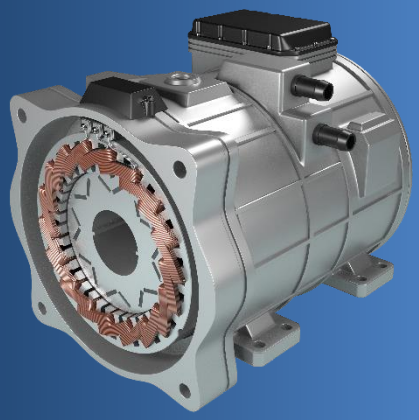


Electromagnetic steel -based motor

YEP-2V -based motor

Realization of high-efficiency motors for higher rpm

Amorphous Alloy for Motor



Technology Features

- Iron loss reduction with the amorphous core achieve the following effects to the motor.
- Energy saving by improving motor efficiency.
- Reduction of thermal generation.

Applications

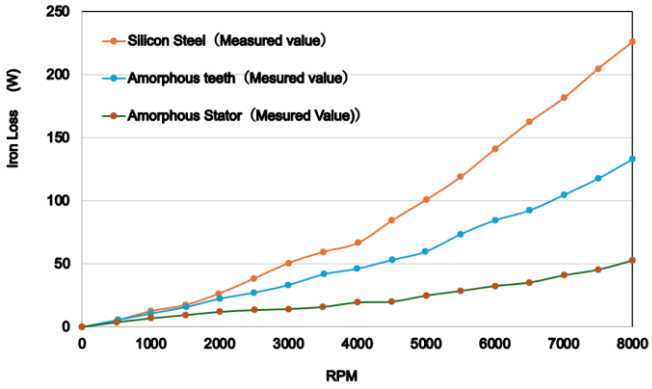
- Low Load･High rotation speed Motor

■Confirmed the following with an amorphous stator core.

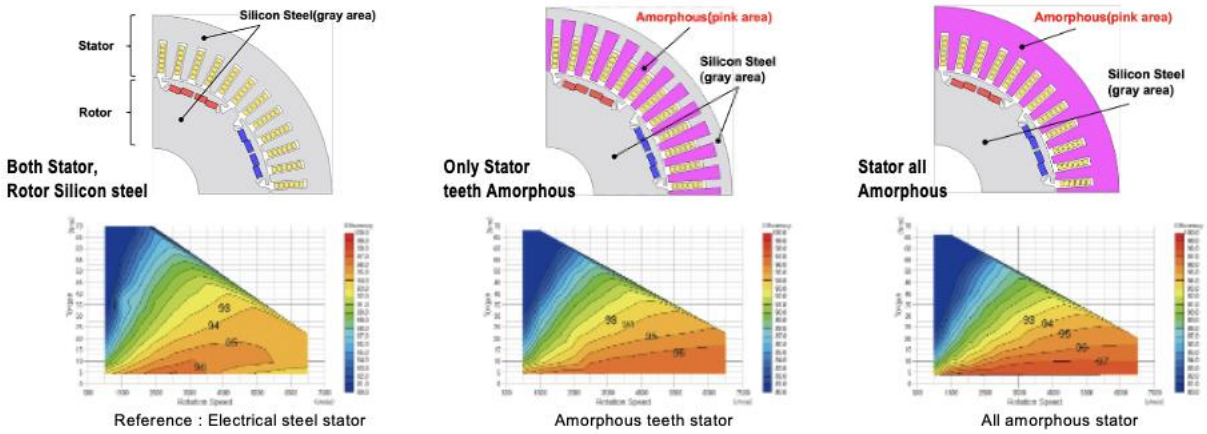
- Iron loss reduced to about 1/5
- Efficiency improvement of 3% or more in the high rpm range
- Motor heat generation can be reduced by half

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

■ Iron loss evaluation result of prototype motor



■ Efficiency Comparison of prototype motor

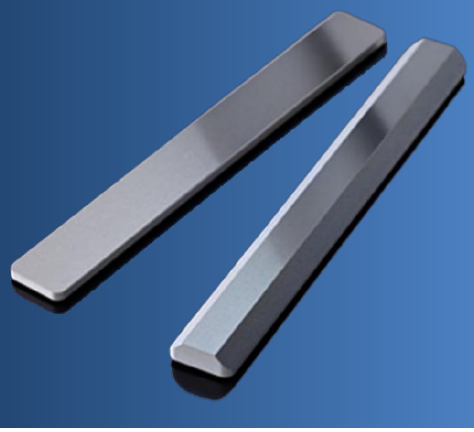


References: Yuji Enomoto, Mamoru Kimura, Yasuhiro Marukawa, Hirohisa Sano, "Distributed winding IPM motor with an entire stator core made of amorphous metal."Proceedings of the 2021 Industrial Applications Division Conference of the Institute of Electrical Engineers of Japan, 3-4, pp Ⅲ-133-138 (2021)

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Significantly improved permeability, strength, and heat resistance

Magnetic Slot wedge for Motor Application



Technology Features

- **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.**

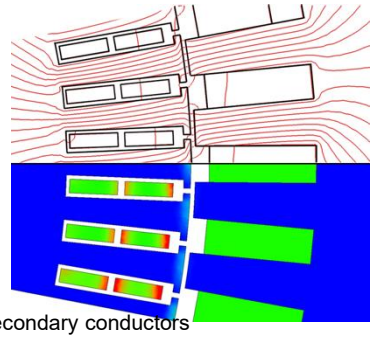
Applications

- **Various motors**

■ Broadening magnetic flux distribution reduces losses on the rotor surface

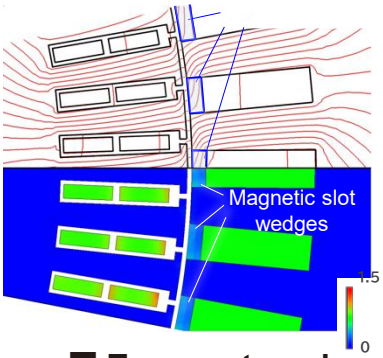
Without magnetic slot wedges

Magnetic field lines

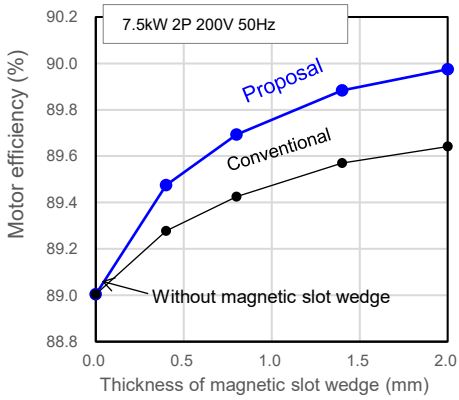


Secondary conductors

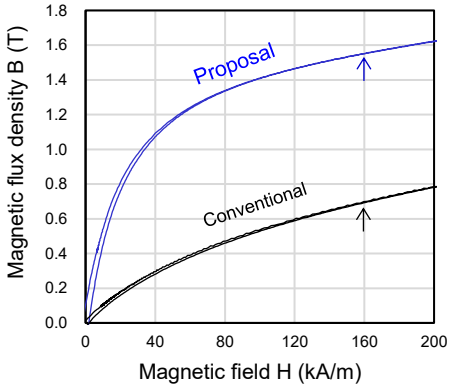
With magnetic slot wedges



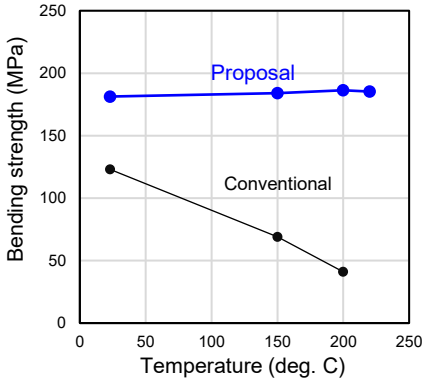
■ Simulated motor efficiency



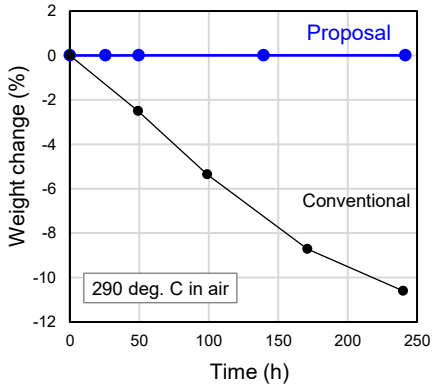
■ D.C. magnetization curves



■ Temperature dependence of bending strength



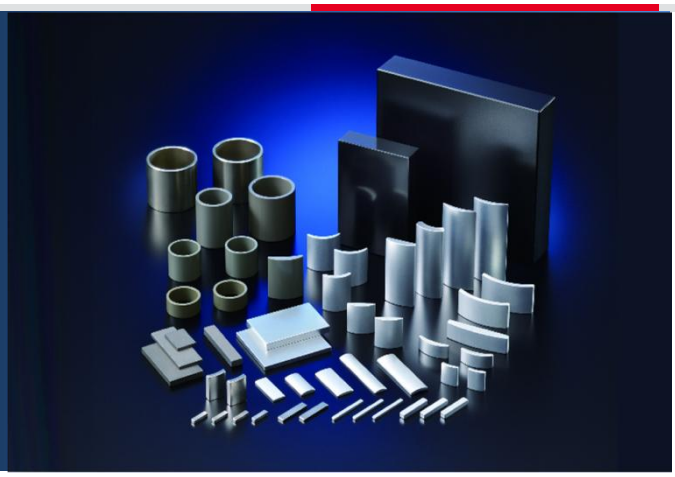
■ Weight reduction during heating at 290 deg. C



Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Achieve high performance and reduce risk of supply chain shortages

Nd-Fe-B Magnets NEOMAX® with Heavy Rare-earth Free Technology



Technology Features

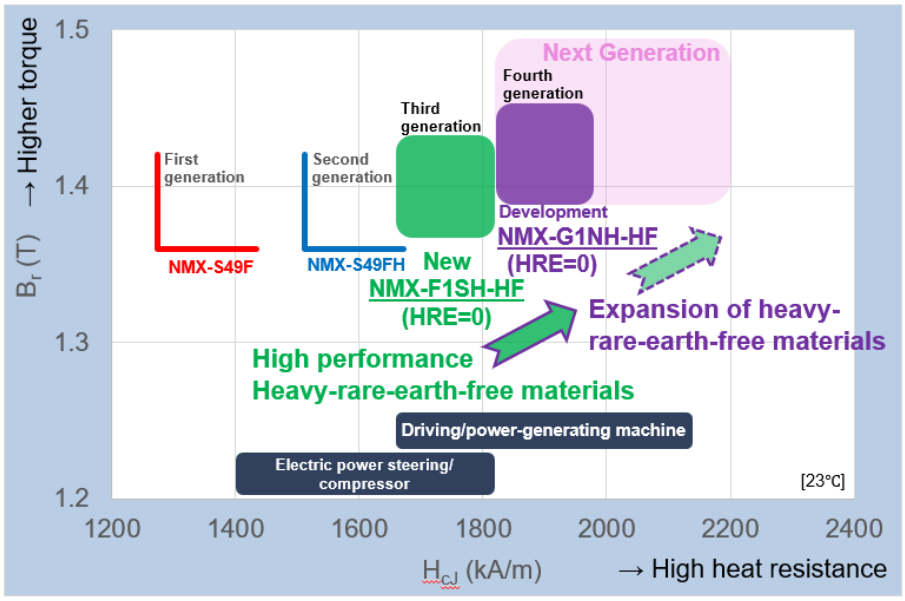
- No use of heavy rare-earth elements
- High remanence (B_r) and coercivity (H_{cJ})
- Suitable for EV traction motors and generators

Applications

- Motors
- Actuators
- Generators

Magnetic properties of heave rare-earth free magnets

Achieve heavy rare earth free composition and high performance by controlling impurities through Proterial's unique manufacturing method and refined process design.



NMX-F1SH-HF (HRE=0)
Br=1.40T
HcJ≥ 1671kA/m(21kOe)
Sample release

NMX-G1NH-HF (HRE=0)
Br=1.42T
HcJ≥ 1830kA/m(23kOe)
Apr.2026 Sample

HRE: Heavy Rare Earth

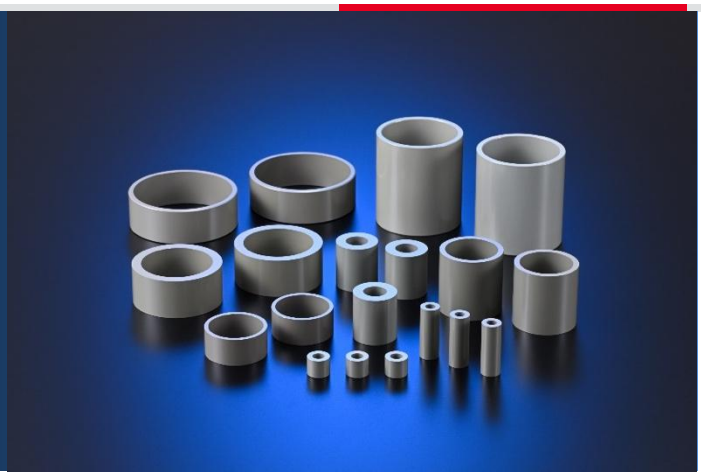
＊ These are representative values and do not guarantee specific characteristics.

＊ NEOMAX and NMX are registered trademarks or trademarks of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Magnetic Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Enhancing performance of motors and assembly optimization

Nd-Fe-B Anisotropic Ring Magnet



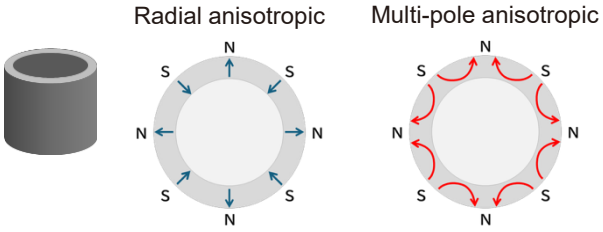
Technology Features

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

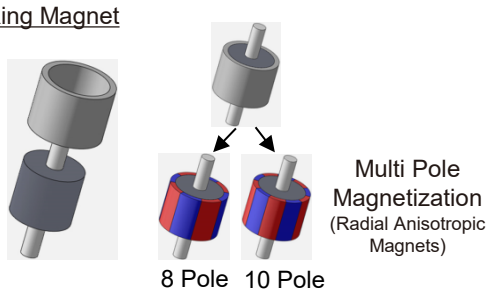
Applications

- Motors
- Actuators

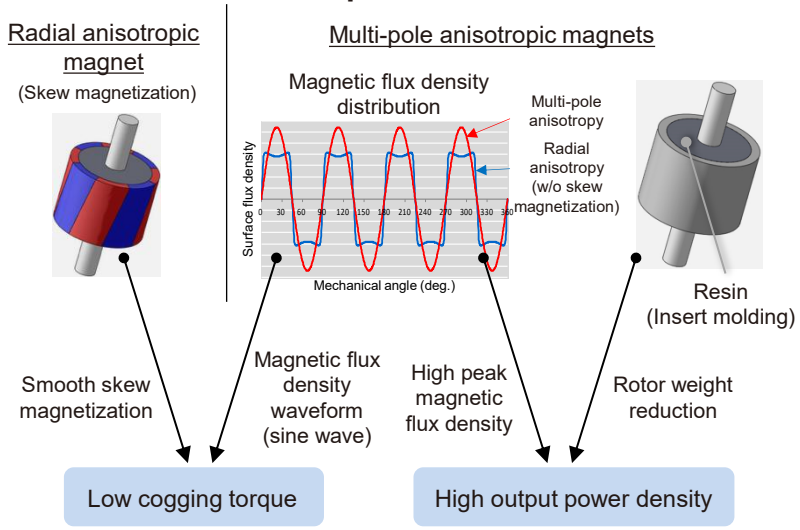
■ Magnetic flux distribution within the magnets (Schematic illustration)



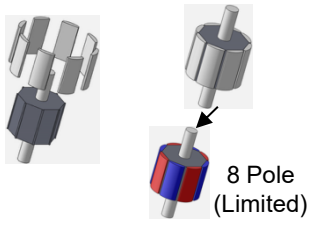
■ Contribution to reduction of assembly processes



■ Contribution to motor performance increase



(Ref.) Segment Magnets



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

Inquiry | Proterial, Ltd.
Magnetic Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Delivering “More Power” to Compact Motors

Nd-Fe-B Isotropic Compression-Bonded Magnet

HIDENSE™ , NEOMAX-P

Technology Features

- Magnetic performance comparable to anisotropic bonded magnets
- High electrical resistivity (≈ 50 μΩ·m), which reduces eddy current losses
- High geometric freedom, such as intricate concave and convex shapes
- Flexible magnetization enabled by isotropic magnets
- Capable of being integrally molded with metal parts
- Heavy rare-earth-free

Applications

- Compact Motor
- HDD Spindle Motor
- Cyclone Vacuum Cleaner Motor
- Automotive Sensor

etc.

■ Magnetic Properties

Material	Residual Magnetic Flux Density: B_r		Coercive Force: H_{cJ}		Coercive Force: H_{cB}		Maximum Energy Product: $(BH)_{max}$	
	(mT)	(kG)	(kA/m)	(kOe)	(kA/m)	(kOe)	(kJ/m^3)	(MGOe)
HIDENSE™-700	760～830	7.6～8.3	670～770	8.6～9.8	470～530	6.0～6.8	95～105	12.3～13.6
HIDENSE™-1000	720～790	7.2～7.9	950～1050	11.9～13.2	470～530	6.0～6.8	87～97	10.9～12.2
NEOMAX-P11	690～730	6.9～7.3	≧ 716	≧ 9	445～478	5.5～8.0	79～88	10～11
NEOMAX-P9	630～710	6.3～7.1	≧ 636	≧ 8	374～454	4.7～5.7	63～80	8～10
NEOMAX-P8H	570～650	5.7～6.5	≧ 875	≧ 11	374～454	4.7～5.7	55～72	7～9

＊ These are representative values and do not guarantee specific characteristics.

＊ HIDENSE is a trademark of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Magnetic Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Proposed for typically rare-earth magnet applications

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

Technology Features

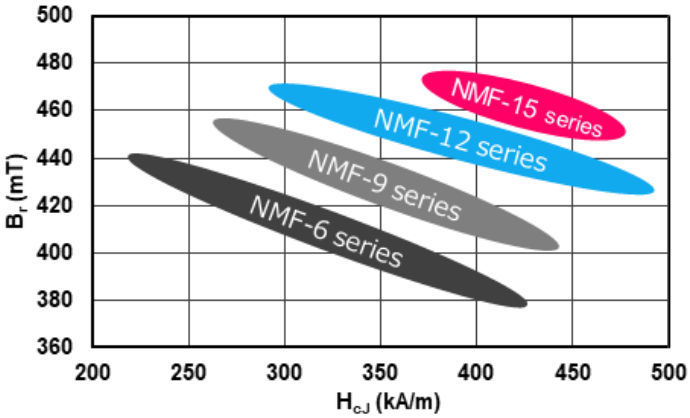
- **Highest-level of magnetic properties among mass-produced ferrite magnets**
- **Suppressing generation of eddy currents due to resistivity three orders of magnitude higher than that of rare-earth sintered magnets**

Applications

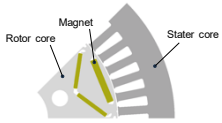
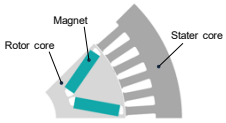
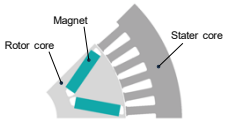
- **Motor**

■ Magnetic properties of NMF series

Lineup up to the NMF™-15 series with the world's highest-level of magnetic properties among mass-produced ferrite magnets.



■ Example of simulation results for 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

∗ NMF is a trademark of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Magnetic Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

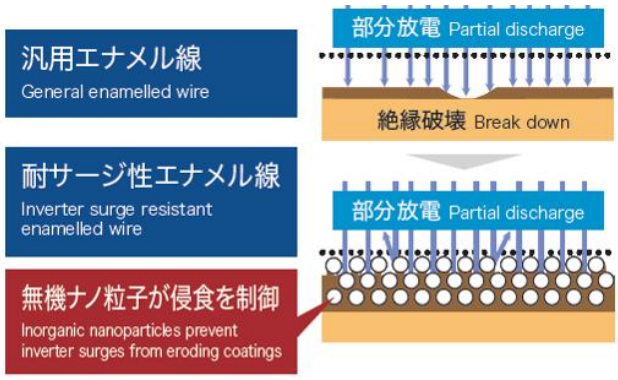
Lifetime improvement of inverter-fed motor, greatly improved reliability.

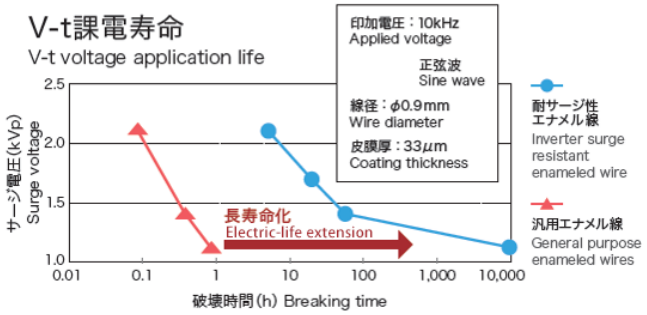
Enameled Wire for EV/HEV Inverter-Fed Motor

Technology Features

- **Inverter surge resistant enameled wire**

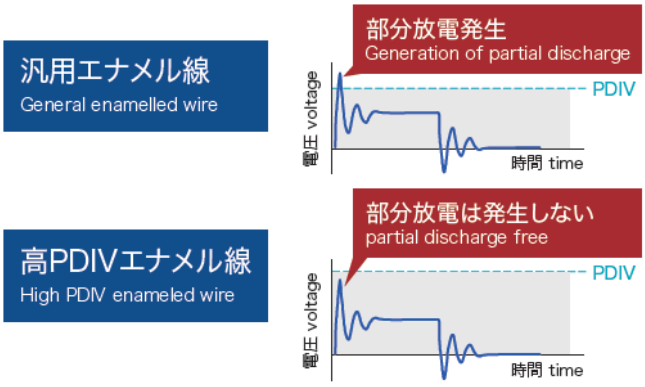
  Increasing the life span by suppressionof insulation coatings erosion due to partial discharge.

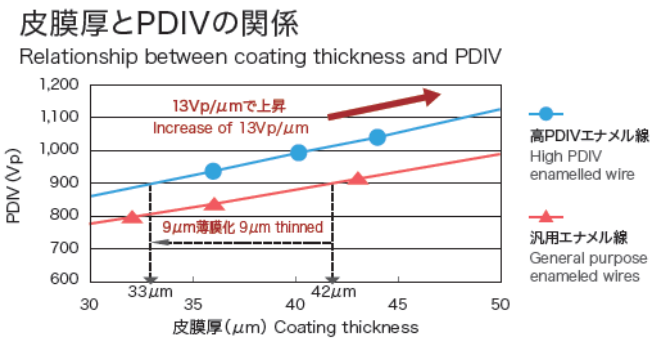




- **High PDIV enameled wire**

  Increasing the life span enameled wire by suppression of partial discharge and improvement in PDIV.

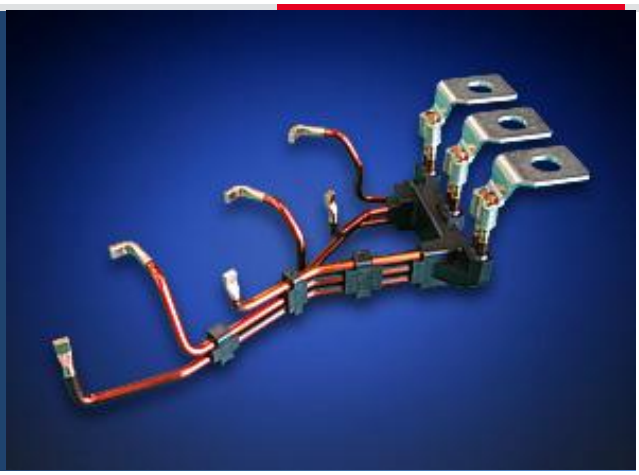




Inquiry | Proterial, Ltd.
Electric Wire & Cable Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Customized design according to the required layout

Wiring Component for Inside of Electric Motor SRC：Semi-rigid Connect

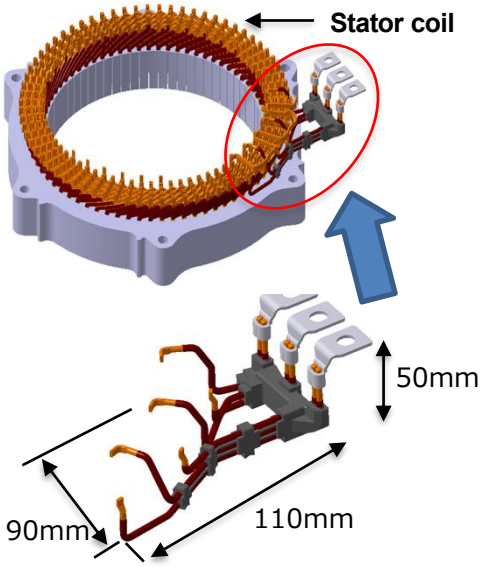


Technology Features

- By using in-house enamel wire, enamel coating can be selected according to conductor size and usage environment. （AIW, PI, etc)
- By using round wires, three-dimensional bending is possible, and the free layout. ⇒ Customized design according to the required layout.
- By Forming only the welded parts into a flat shape, excellent welding quality and high dimensional accuracy are realized.
- Assembly workability is improved by enabling automatic assembly during welding process. (Patented by Proterial)

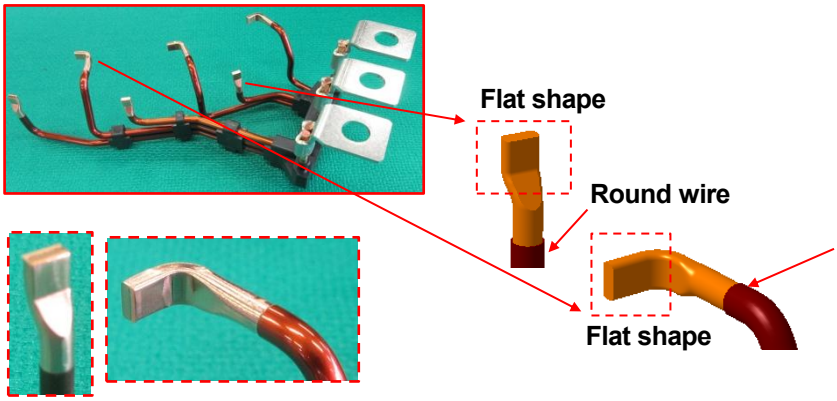
Applications

- Wiring parts for distributed-winding motor, or drive motor, etc.



■ Product Examples

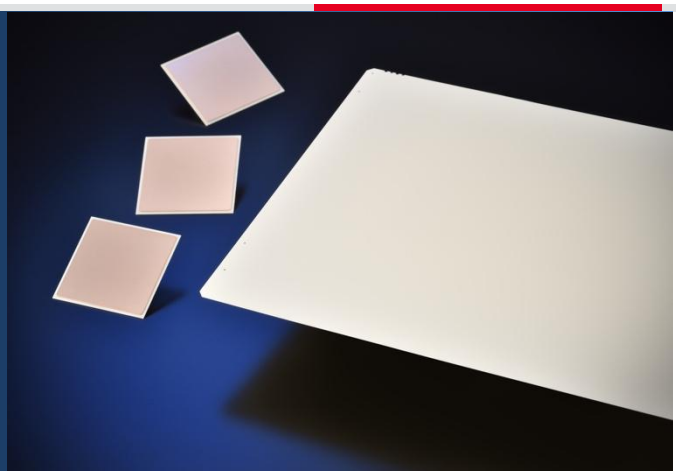
The welded parts are formed from round wires to flat shapes to achieve stable connections and good weldability. (Patented by Proterial)



Inquiry | Proterial, Ltd.
Automotive Components Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Combining heat dissipation and strength

Silicon Nitride Substrate for Power Module



Technology Features

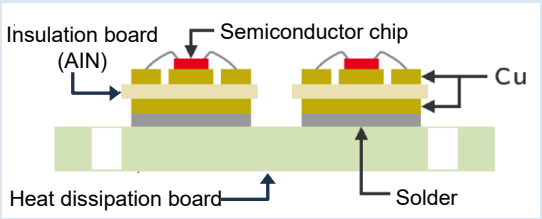
- Having high bending strength, fracture toughness and thermal conductivity
- Contributing to the miniaturization and weight reduction of power modules
- Thicker Cu can be bonded on the Silicon Nitride Substrate

Applications

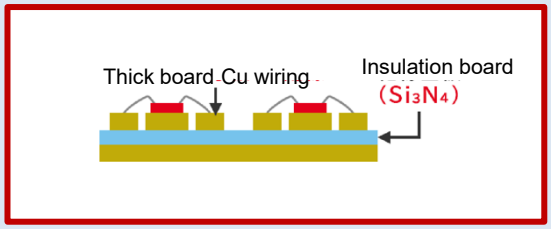
- Power Module
- Inverter

■ Structural comparison of power semiconductor modules

Conventional Structure



By using the newly developed high-strength, highly heat conductive Si_3N_4 in the insulation board, we have been able to simplify the module structure



■ Basic characteristics

Item	Unit	Si_3N_4	AlN
Bending strength	MPa	700	300 - 500
Fracture toughness	MPa-m	6.5	2.0 - 3.0
Thermal conductivity	W/m-K	130	180
Thermal expansion coefficient	ppm/K	2.5	4.8
Volume resistivity	Ω-m	> 10^{12}	> 10^{12}
Dielectric strength	kV/mm	≫ 18	17 - 37
Dielectric constant (@ 1MHz)	—	8	9

■ Breakdown voltage

Thickness	0.2 mm	0.3 mm	0.6 mm
Breakdown voltage (kV)	8.2	11.8	15.7

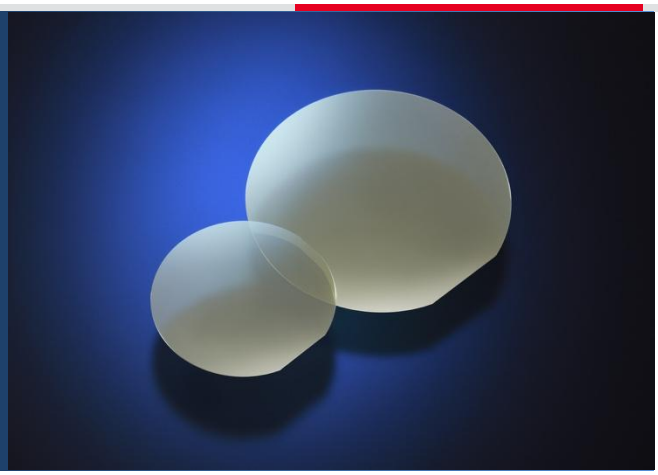
This is an insulating substrate for power module. It features excellent thermal conductivity（130 W/m・K） and mechanical strength（700 MPa）.

It is suitable for use as insulating substrate for high-power semiconductors, such as IGBTs and SiC, which require high reliability

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

The high-precision polishing technology and unique CMP

SiC Epitaxial Wafer



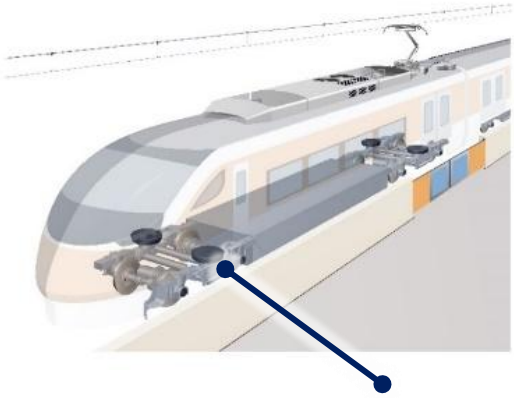
Technology Features

- High flatness achieved by high-precision polishing technology
- Minimizing hidden scratches of SiC wafer by unique CMP
- Contributes to improving the productivity of SiC devices

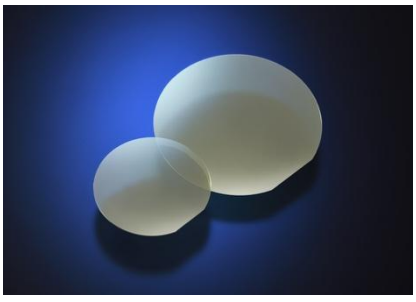
Applications

- Power semiconductors modules

・xEV power semiconductor modules



・Power semiconductor modules for railway vehiclesa

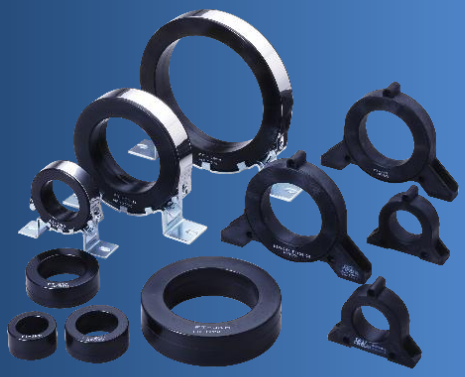


Our SiC epitaxial wafers, which utilize the high-precision polishing technology and distinctive CMP techniques we have developed over many years, will help improve the productivity of our customers' SiC devices.

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Contributes to the miniaturization of EMI filters

FINEMET®
Common Mode Choke Core



Technology Features

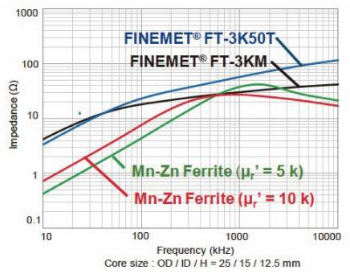
- High impedance across a wide frequency band enables countermeasures against inductive. interference in a wide range of safety equipment.
- Higher impedance than conventional Mn-Zn ferrite contributes to the miniaturization and weight reduction of EMI filters.
- Contributes to reduced power consumption and CO_2 emissions in low-load transformers.

Applications

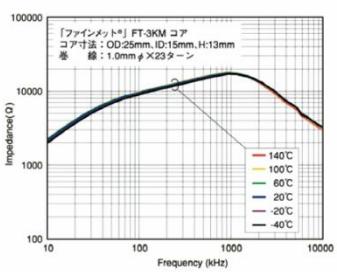
- On board charger
- Inverter, etc.

■ Excellent impedance characteristics

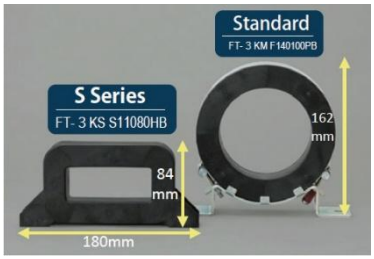
High impedance across a wide frequency band



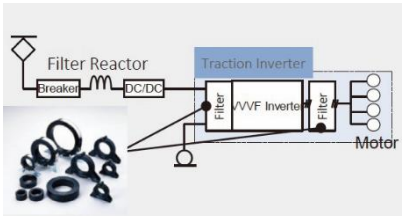
Good temperature characteristics



■ Low-profile models also available



■ Applications for drive inverters



FINEMET® EMI Filter

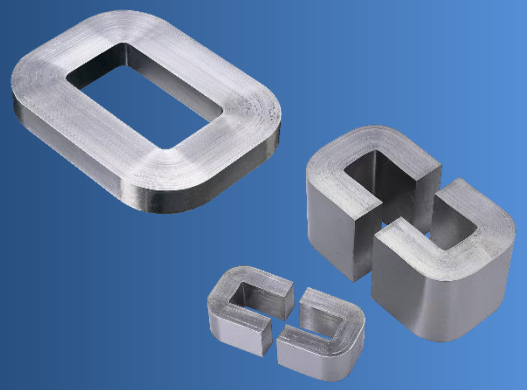
∗ FINEMET is registreted trademarks of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Reduces loss in high-frequency transformers

FINEMET®

Cut Cores and Non-cut Cores for High-frequency Transformers



Technology Features

- **Low loss and high saturation magnetic flux density**
- **Reducing loss in high-frequency transformers, contributing to increased efficiency and compactness of auxiliary power supplies**

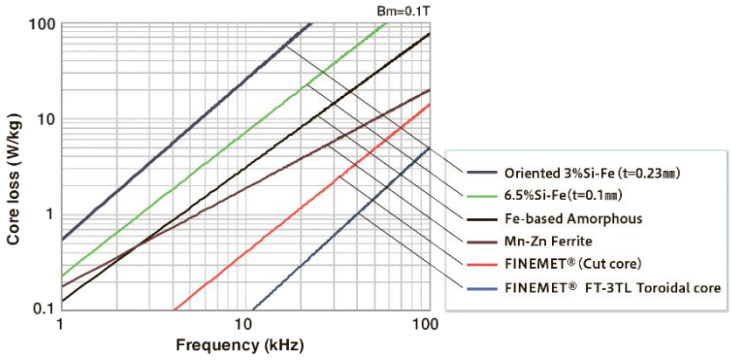
Applications

- **Aux power supply of train**
- **Extreme fast charger**
- **Isolated Alternative power conditioner**

■ Low core loss and high saturation magnetic flux density

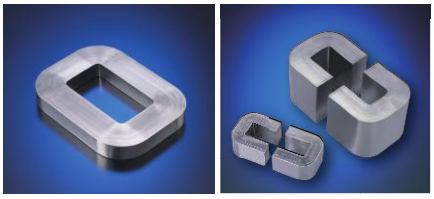
At 10 kHz, these cores reduce volume by approximately 50% and weight by approximately 40% compared to transformers using Mn-Zn ferrite.

Materials	Bs (T)	Pcm (W/kg)	Tc (deg C)
FINEMET®F3CC	1.23	0.4	570
FINEMET®FT-3TL	1.23	0.1	570
Mn-Zn Ferrite	0.53	2.0	230
3% Si Fe	1.90	25	750



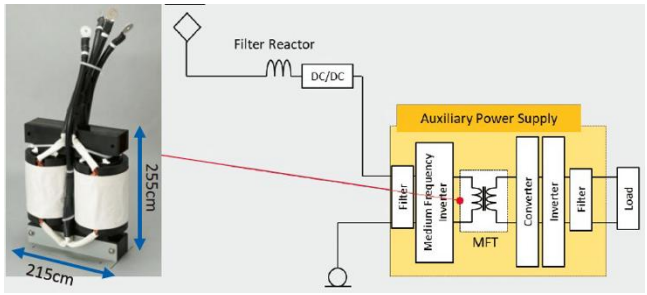
■ Application examples for auxiliary power supplies

FINEMET® cut and non-cut cores for high-frequency transformers



FINEMET®FT-3TL FINEMET®F3CC

FINEMET® high-frequency transformers (100 kVA)

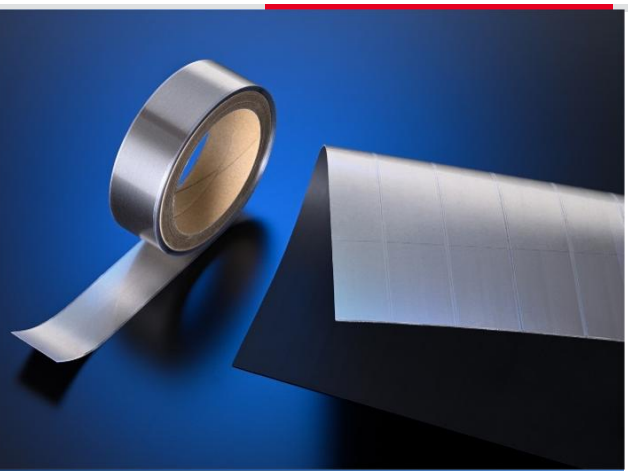


∗ FINEMET is registreted trademarks of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Shielded yoke sheet with both low loss and High magnetic permeability

Shield Yoke Sheet MS-HiQ Series for Wireless Chargers



Technology Features

- Started supplying samples of the MS-HiQ series, which improved the Q value of conventional products by controlling magnetic permeability.

Applications

- Thin and light shield yoke sheet

- Magnetic permeability control significantly improves the Q value of the conventional MS series
- It has excellent flexibility and impact resistance and achieves high mechanical reliability.
- Excellent workability (cutting, punching, etc.)
- With the high saturation magnetic flux density (1.23T), it is possible to reduce the thickness and weight of the sheet.
  (50% thinner and 35% lighter than Mn-Zn ferrite (our company's ML29D: 0.54T))

■ Characteristics

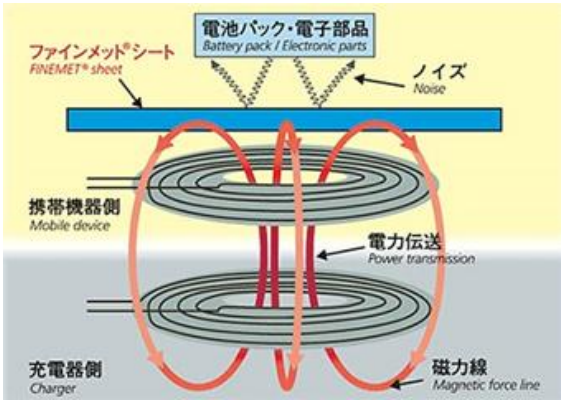
Coil Characteristics

25% improvement in Q value compared to conventional MS series, contributing to improved charging efficiency and reduced heat generation

Item		permeability	Ls (μH)	Rs (mΩ)	Q
Coil		-	1.0	71.0	7.7
MS-HiQ series	(a)	1100	5.6	48.0	62.6
	(b)		5.2	40.1	68.5
	(c)		5.2	38.7	71.5
MS series		13000	5.7	61.8	49.7

Measurement conditions: f=85kHz, V=0.03V

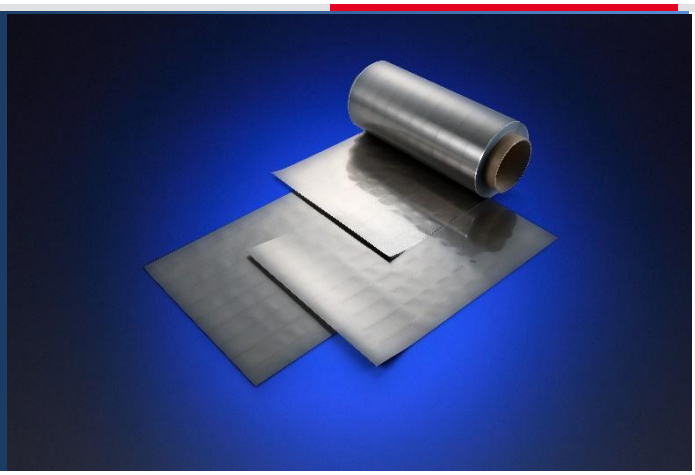
Schematic diagram of a wireless charging system



Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Heat resistance temperature of 130℃

Magnetic Shield Sheet for Noise Reduction



Technology Features

- **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**

■ 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℃.

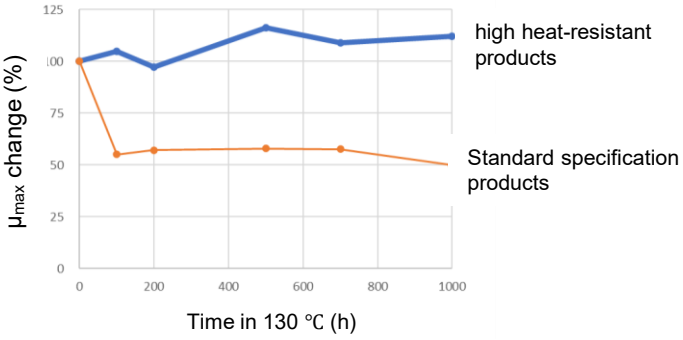
- Compared to standard specification products, high heat resistant products do not deteriorate in characteristics even in environments with temperatures of 130℃.
- The high heat-resistant product is thin at 0.05 mm (40% compared to conventional products), so it can be used even in narrow spaces.
- It 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 ℃		-40 ～ +130 ℃	

■ Characteristic comparison

- Ideal for measures against noise in high-temperature environments such as automotive.
- Contributing to the miniaturization and weight reduction of electronic devices, etc.

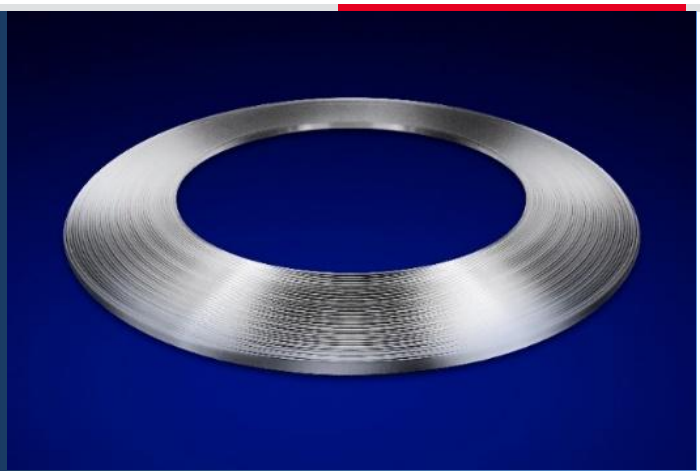


Comparison of μ_{max} rate of change after 130℃ storage

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

"Connecting" technology
to give you a solution !

Electric Resistance Materials for Current Sensing (NC,NRH,MC)



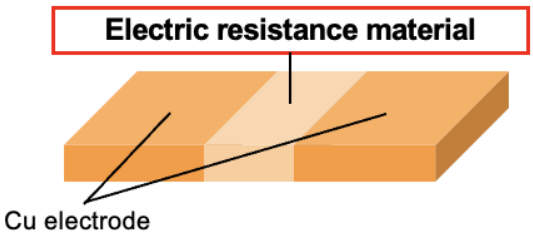
Technology Features

- Stable electric resistivity over temp. & thickness
- Low electric resistivity enables large current detection with a high accuracy
- The material thickness is available from tens of μm to a few mm

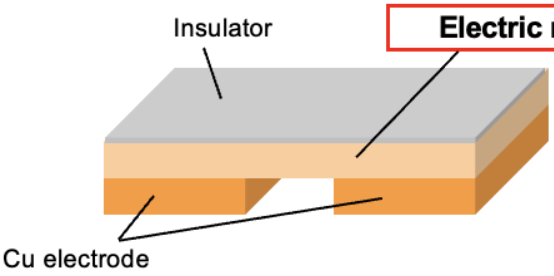
Applications

- xEV battery control system
- xEV inverter
- LIBs for smartphones

■ product shape samples



Edge-lay type shunt resistor



Over-lay type shunt resistor

■ Lineup of various electric resistance materials

- Stable electric resistivity over temp. & guaranteed thickness though advanced melting (composition control) and rolling technologies
- A wide variety of desired electric resistance: 5~130×10^{-8} Ω・mA- Low TCR, low EMF against copper

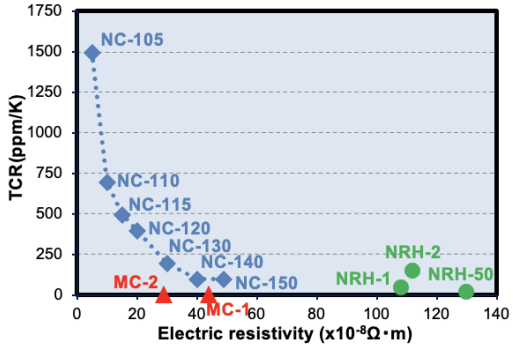


Fig. Electrical resistivity and TCR

*TCR: Temperature Coefficient of Resistance, EMF: Electromotive Force against copper

Alloy Systems	Code	Chemical Composition (mass%)	Electrical Resistivity (×10^{-8}Ω・m)	TCR (23~100℃) (ppm/K)	Thermal EMF against Copper (0~100℃) (μV/K)
Ni-Cu	NC-105	2Ni-Cu	5	1500	-13
	NC-110	6Ni-Cu	10	700	-18
	NC-115	9Ni-Cu	15	500	-25
	NC-120	14Ni-Cu	20	400	-
	NC-130	23Ni-Cu	30	200	-32
	NC-140	33Ni-Cu	40	100	-
	NC-150	45Ni-Cu	49	0	-40
Ni-Cr Ni-Cr-Fe	NRH-1	20Cr-Ni	108	100	+5
	NRH-2	60Ni-17Cr-Fe	112	150	+1
	NRH-50	20Cr-2Al-3Cu-Ni	130	0	+2.5
Cu-Mn	MC-1	12Mn-3Ni-Cu	44	0	-1
	MC-2	7Mn-2.3Sn-Cu	29	0	-1

* Please note that the composition and properties cited in this document are typical data only, and are not guaranteed

Inquiry | Proterial, Ltd.
Electronic Materials Department, Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

"Connecting" technology to give you a solution !

Alloys, Clad Metals & Metal Processing Technologies

Technology Features

- Wide line ups of Pure Metals and Alloys
- High precise, Ultra-thin foils, Wide strips are available.
- Enhanced product reliability through various bonding technologies
- Reduced CO_2 emissions by eliminating part counts and processes
- Customized component design to meet your needs

Applications

- Semiconductor package components
- Metal processing components for wide range applications, including Secondary battery materials

■ Wide Clad metal line ups

By combining different metals, we achieve excellent properties that cannot be obtained with a single alloy

The combination of cold roll boding and diffusion heat treatment enables strong and versatile bonding, expanding the range of processing options

Material technology	・Alloy Design ・Clad technology ・Copper Strip	Overlay & Inlay Clad strip
Surface treatment technology	・Plating ・Oxide film treatment	Striped plating strip
Metal processing technology	・Forming modified cross-section shape ・Machining ・Bending ・Welding ・Punching ・Drawing press ・Heading ・Granulation ・Brazing ・Magnetic annealing ・Forging	Inlay Clad busbar Ni-P fine particles Seal Ring Clad terminal CLAMET™

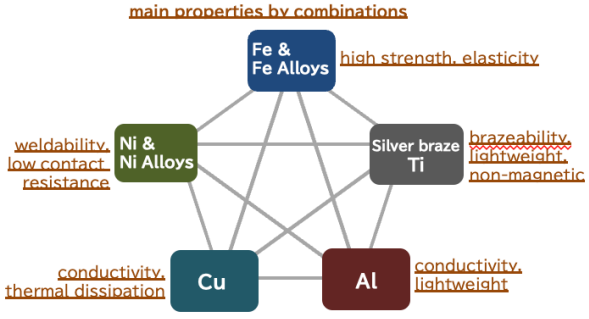
■ Diverse materials & processing technologies

We provide a wide range of materials & processing parts, from alloy design through Clad Metals, Dual-gauge strips, Surface treatments, and 1μm-class Granulation, utilizing various processing technologies

Fe and Fe Alloys					Ni and Ni Alloys				Cu	Al	Others	
Austenitic Stainless	Ferritic Stainless	Fe-36Ni Alloy	Fe-42Ni Alloy	Fe-Ni-Co Alloy	Pure Nickel	Ni-Cr Alloy	Ni-Cu Alloy	Permalloy	Oxygen-Free Copper	Aluminum	Silver braze	Titanium

<all above combinations of different metals are available>

main properties by combinations

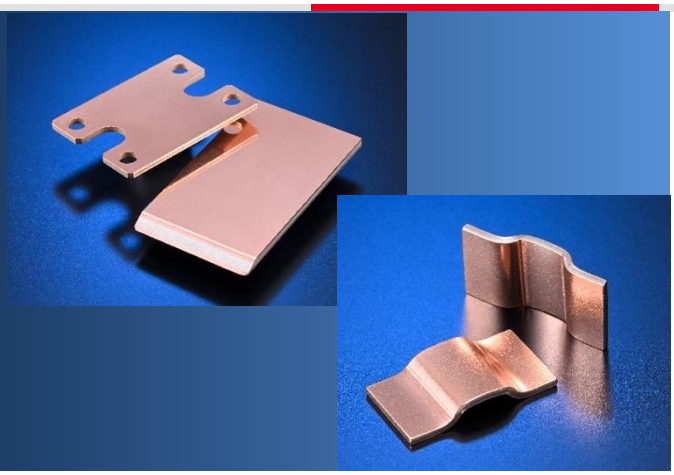


＊ CLAMET is is a trademark of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Sales Dept., Electronic Materials Sub Business Unit., Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

"Connecting" technology
to give you a solution !

Low Thermal Expansion High Thermal Conductivity Material (Cu/Fe-36%Ni/Cu)



Technology Features

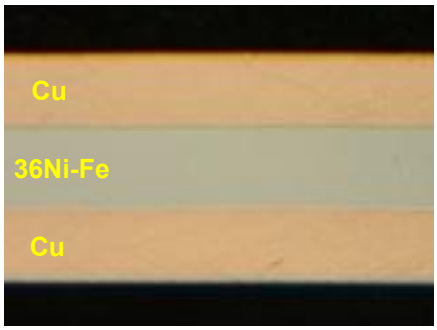
- Low thermal expansion coefficient and high thermal conductivity
- The reliability Improvement of power modules by reducing the thermal stress

Applications

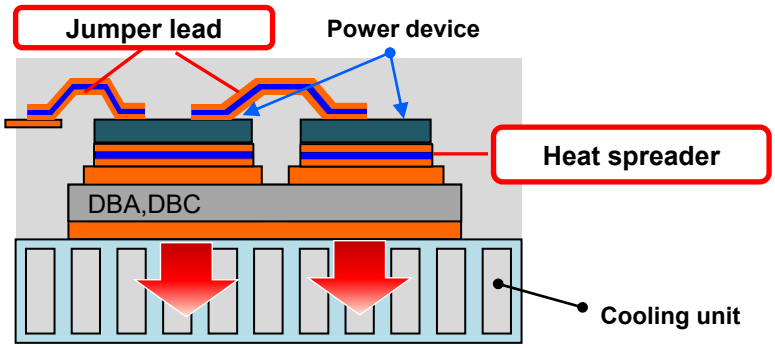
- Jumper lead
- Heat spreader

- Clad material consists of low thermal expansion material (Fe-36%Ni) and high thermal conductivity material (Cu).
- The thermal expansion coefficient is close to that of SiC semiconductor die & insulation substrate, and the thermal and electrical conductivity are high.

■ Cross-sectional structure (CIC-3)



■ Applications of power module (Image)



■ Characteristics table of the representative materials

Name	Thickness ratio			Thermal conductivity (calculated values) (W/m・K)		Thermal expansion coeffient in 30-200℃ ($\times 10^{-6}$/K)	Electcical resistivity ($\times 10^{-8}\Omega$・m)
	Cu	36Ni-Fe	Cu	Parallel direction to plate surface	Vertical direction to plate surface		
Cu	1	0	0	391		17	1.7
CIC-3	1	1	1	262	36	7.6	2.5
CIC-1	1	3	1	164	21	3.6	4.1
36Ni-Fe	0	1	0	13		2.5	79.8

Inquiry | Proterial, Ltd.
Electronic Materials Department, Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

"Connecting" technology to give you a solution !

Dual Gauge Copper Strip

Technology Features

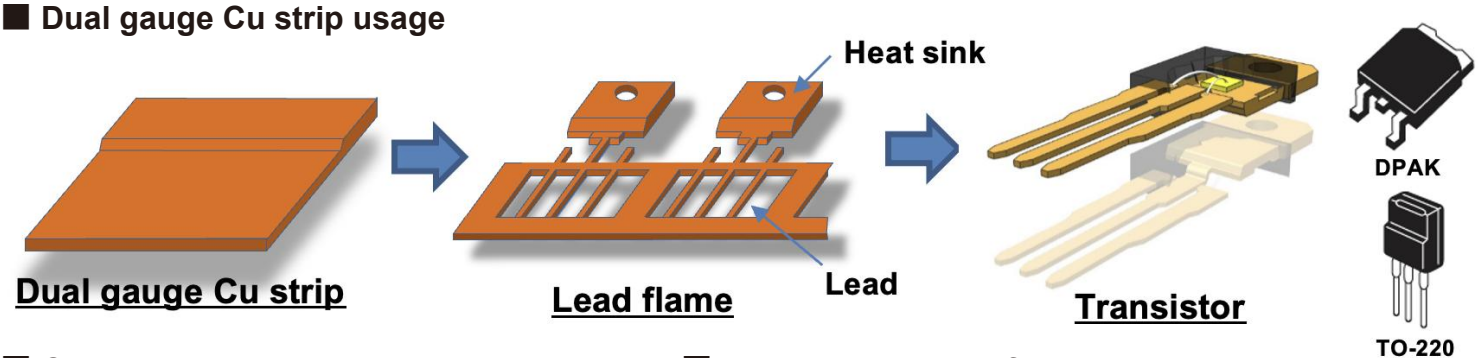
- High quality and high reliability through integrated production from casting
- A wide variety of highly difficult shapes are available
- We have many experiences of manufacturing inverters and many other automotive-related products

Applications

- We have many experiences of manufacturing inverters and many other automotive-related products
- Power modules for automotive applications

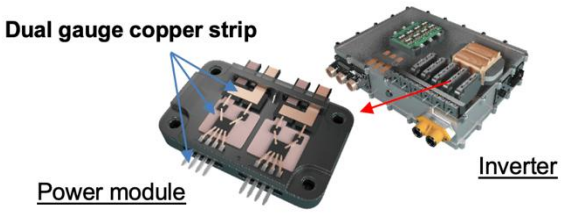
- Dual gauge Copper strips have shapes with different thicknesses in the width direction by rolling molding
- The integration of the heat sink and lead improves the reliability of the power semiconductor package and contributes to cost reduction
- It is widely used as a standard material for general-purpose power transistor lead frames and a semiconductor material with a history of more than 30 years

■ Dual gauge Cu strip usage



■ Cross section

■ Use case example for Power module



Inquiry | Proterial, Ltd.
Electronic Materials Department, Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Iron loss is about 1/10 of that of electrical steel sheets

Magnetic Domain Controlled Low Loss Fe-based Amorphous Alloys

MaDC-A®

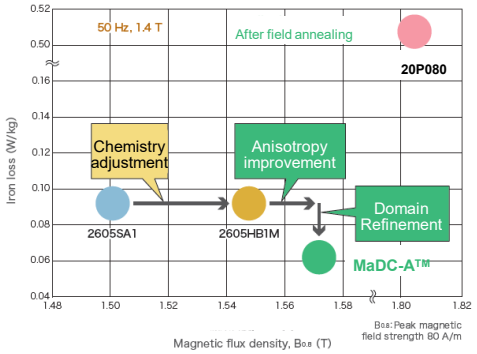
Technology Features

- Enabling compact and high-performance transformers
- Reducing standby power to cut CO_2 emissions
- Achieving domain control at mass production level

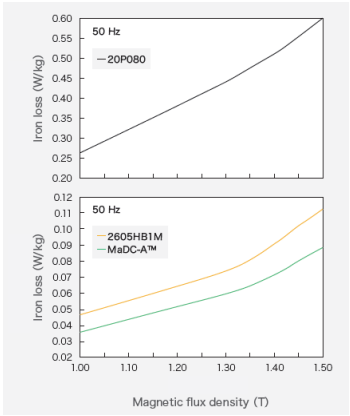
Applications

- Distribution transformers (pole/ground installation)
- Industrial transformers / Distributed power transformers (solar power generation, wind power generation, etc.)
- Rectifying transformer / Small industrial ransformer

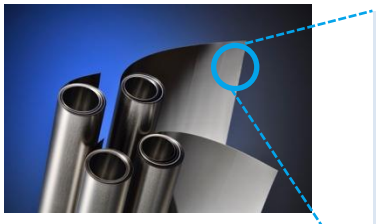
■ Relationship between iron loss and magnetic flux density (single plate)

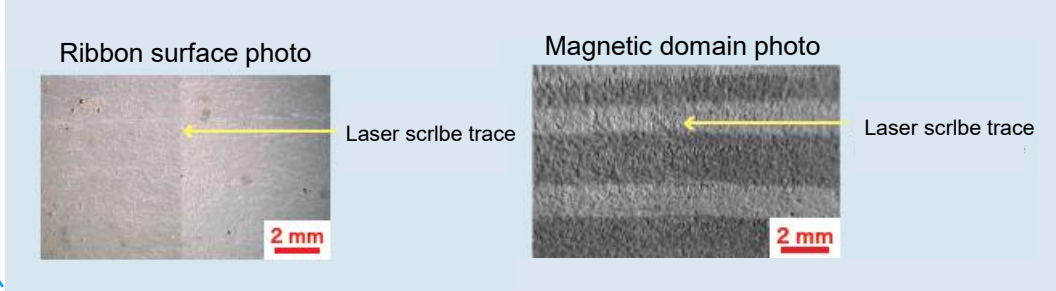


■ Magnetic flux density dependence of iron loss (single-phase distribution transformer core)



■ Surface and magnetic domain



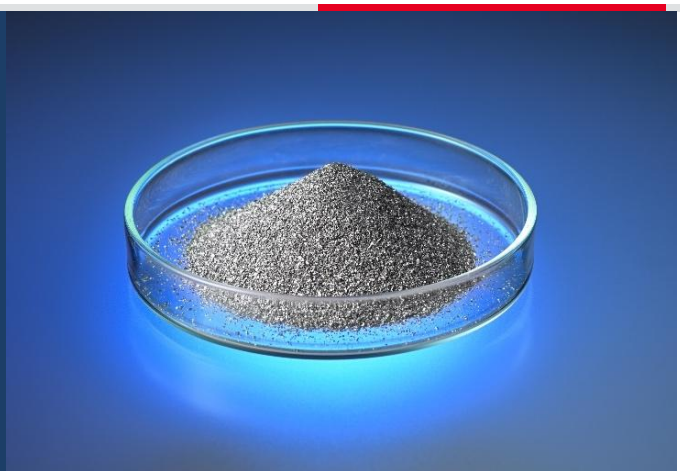


＊ MaDC-A is registered trademarks or trademarks of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Compressing hydrogen volume to 1/1000 at room temperature

Hydrogen Storage Alloy



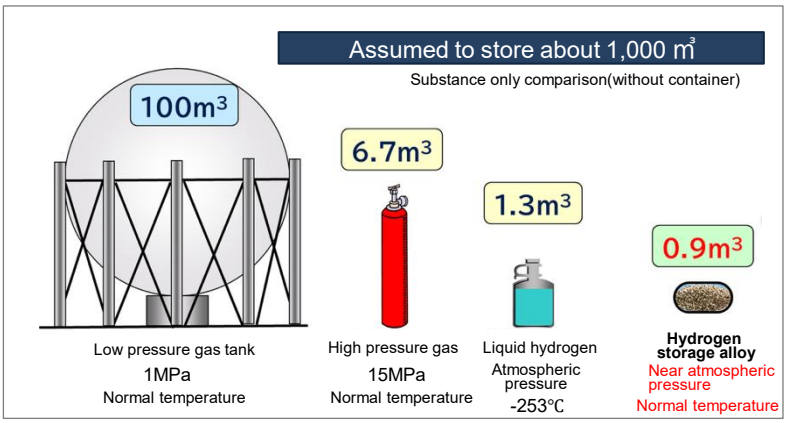
Technology Features

- Compact hydrogen storage
- Safe storage at room temperature and low pressure
- Capable of storing large amounts of hydrogen with cost-effective, free from nickel and cobalt

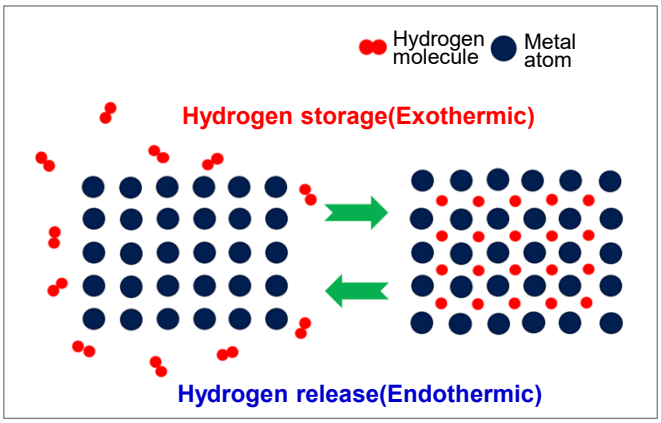
Applications

- Hydrogen storage tank
- Hydrogen storage canister

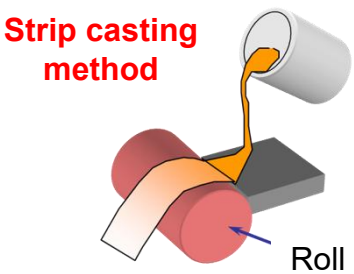
■ Comparison of hydrogen storage volume by storage method



■ Hydrogen absorption/desorption image



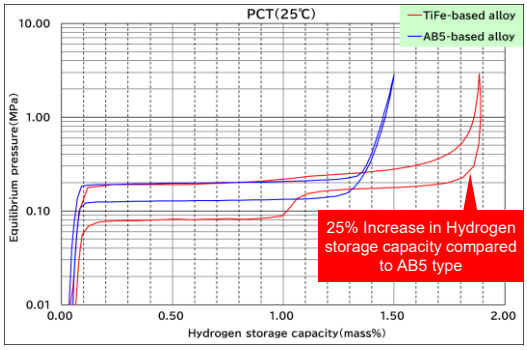
■ An image of our manufacturing process



The strip casting method achieves:
•High hydrogen storage capacity
•Minimal pressure fluctuations during hydrogen absorption and desorption

■ Hydrogen storage capacity of developed products (TiFe-based)

※Example original manufacturing method



Inquiry | Santoku Corporation 4-14-34 Fukaekita-machi, Higashinada-ku, Kobe, Hyogo, Japan

Adaptable to “production", "storage" and “utilization" hydrogen

Hydrogen-Related Materials

ZMG™232G10,SUH660, ACD™602,ACD™627

Technology Features

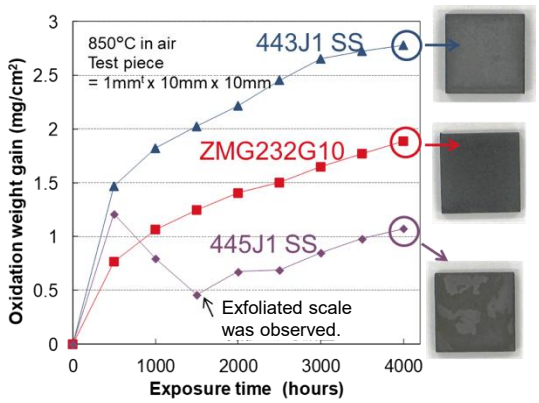
ZMG™232G10	High oxidation resistance and stable electrical conductivity
SUH660	Can be used in high-pressure environments
ACD™602, ACD™627	High hydrogen embrittlement resistance

Applications

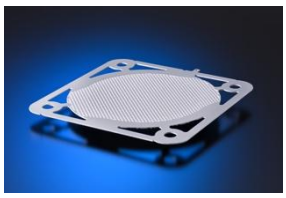
- 「Production」SOFC/SOEC
- 「Storage」Hydrogen compressor
- 「Utilization」Hydrogen engine

■ Oxidation resistance of ZMG232G10 and examples of applications

Oxidation resistance, electrical conductivity, and low coefficient of thermal expansion contribute to long-term stable operation of SOFC/SOEC operating at 700~800˚C.



Interconnector (Separator material)



Tube

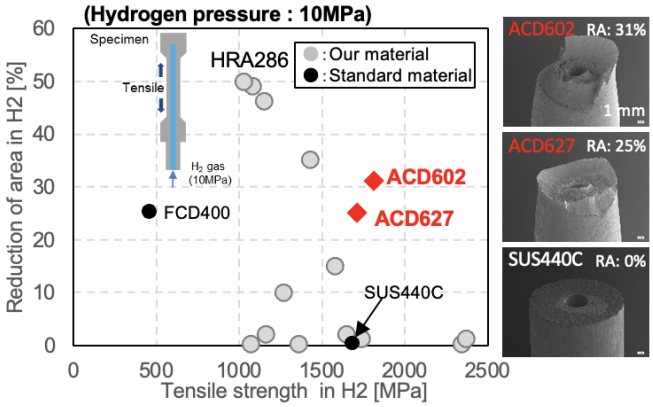
■ Proterial SUH660

It is possible to accommodate a wide range of dimensions.
(Actual production results : φ5.5~φ450 mm)
High ductility is achieved to ensure safety.

	0.2% Yield strength (MPa)	Tensile strength (MPa)	Elongation (%)	Reduction of area (%)
Φ450 mm Actual production	677	1037	30.4	49.5

■ Hydrogen embrittlement resistance alloy of ACD602and ACD627

Achieves high strength and high ductility in a high-pressure hydrogen environment of 20 MPa or less.



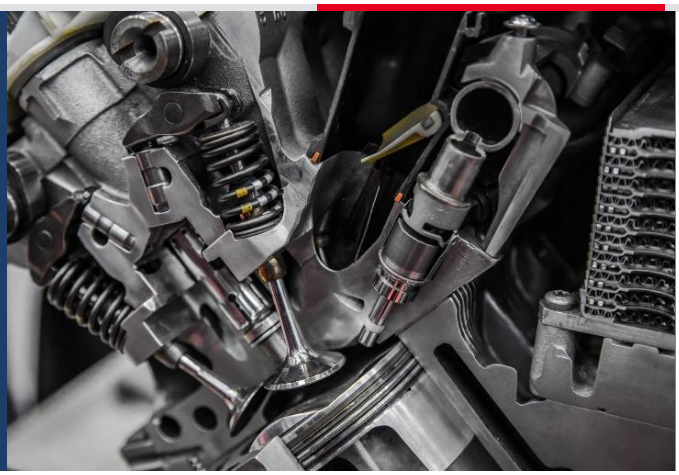
∗ ZMG and ACD are trademarks of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Industrial Materials Dept., Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Adaptable to “e-fuel” and “biofuel”

High Hardness and High Corrosion Resistance Alloy

ACD™602N / ACD™627N



Technology Features

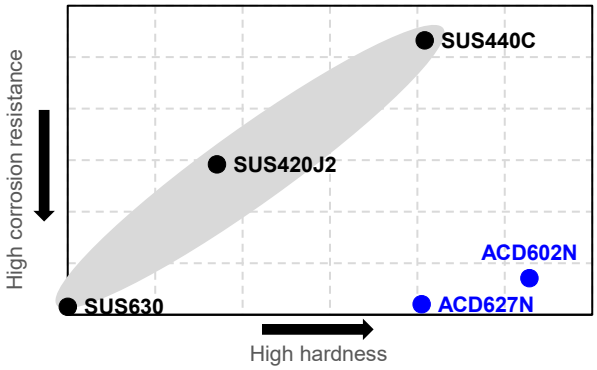
- Adaptable to “e-fuel” and “Biofuels”
- Surface hardening layer by solution nitriding
- Contributes to the longevity of parts

Applications

Internal combustion engine parts
Bearings, gears
Medical knives

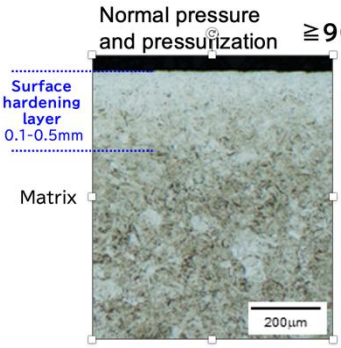
■ Positioning of development materials

・Combined with high hardness and high corrosion resistance



■ Features of solution nitriding

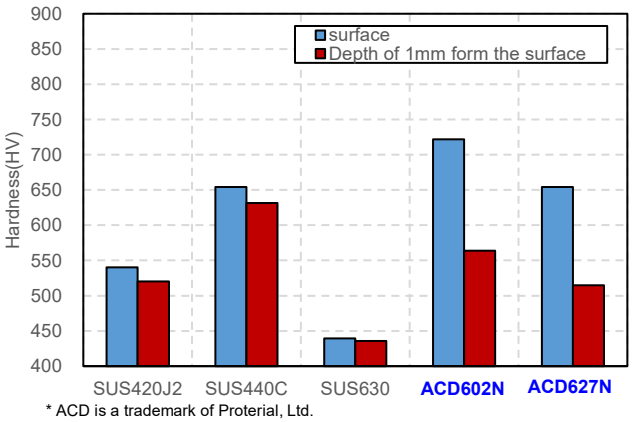
・New heat treatment method for quenching in nitrogen



(Features)
Comparison with general gas carburizing
- **No need for finishing after quenching**
- **Potential for low CO_2 emissions**
- **High hardness and corrosion resistance**
- **Heat treatment variable size is small**

■ Hardness test results

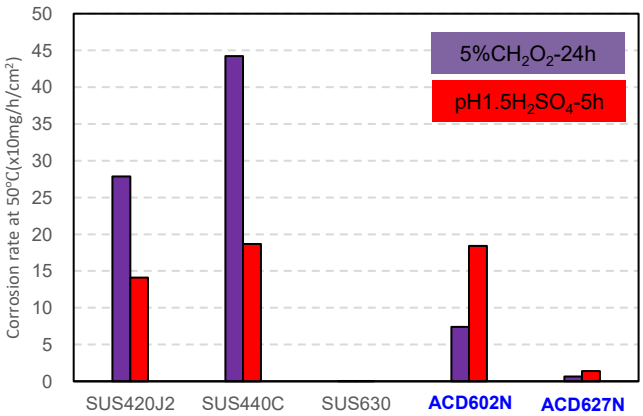
・Surface hardness is higher than SUS440C



* ACD is a trademark of Proterial, Ltd.

■ Corrosion resistance test results

・Corrosion rate in 5% formic acid is about 1/20 of SUS420J
・Corrosion rate in pH1.5 sulfuric acid is about 1/9 of SUS420J



Inquiry | Proterial, Ltd.
Industrial Materials Dept., Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Contributing to the improvement of die-cast mold

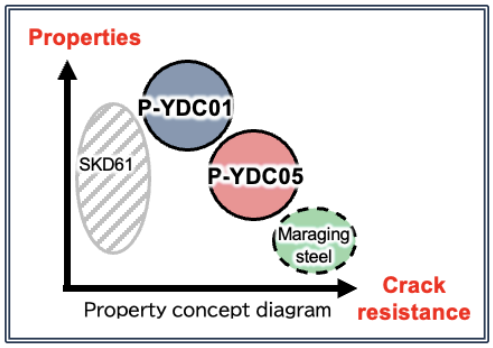
Metal Powder for 3D Printers ADMUSTER® Series Die Steel Powder P-YDC01, P-YDC05

Technology Features

- Less prone to cracking during additive manufacturing compared to standard die casting mold steel (SKD61) powders
- Can be tempered to hardness levels used in conventional molds, with excellent toughness
- Contributing to higher efficiency and longer life of die casting molds, in combination with additive manufacturing, which has a high degree of freedom in design flexibility for internal channels

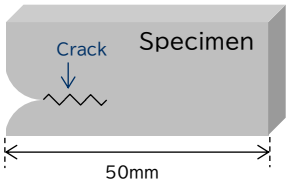
Applications

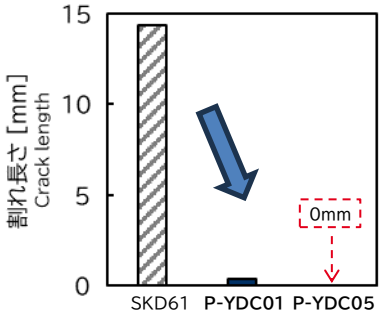
- Die casting molds



■ Crack resistance during additive manufacturing

Measurement of crack length after printing.

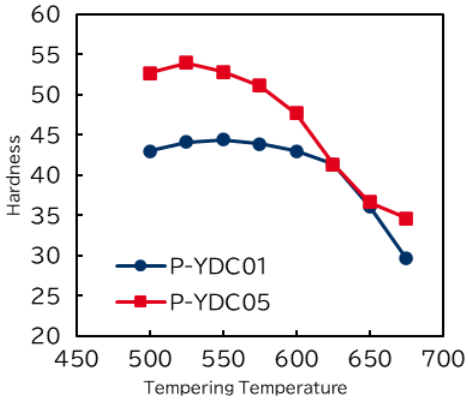




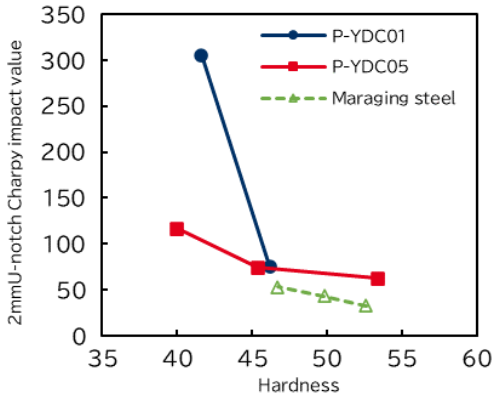
■ Thermal conductivity

Steel Grade	Hardness [HRC]	Thermal Conductivity [W/m·K]			
		23.5℃	200℃	400℃	600℃
P-YDC01	44	30.2	32.2	31.8	33.1
P-YDC05	45	18.7	22.7	24.9	28.8

■ Hardness Range



■ Toughness



＊ ADMASTER is a registered trademark of Proterial, Ltd.

Inquiry | Proterial, Ltd.
Electronic Materials Sub Business Unit, Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Contributing to CO_2 reduction through streamlined processes

Amorphous Alloy for Brazing Filler Metals

Technology Features

- **Usage is approximately half that of the paste**
- **Few defects and high joining reliability**
- **Long-term storage is possible**

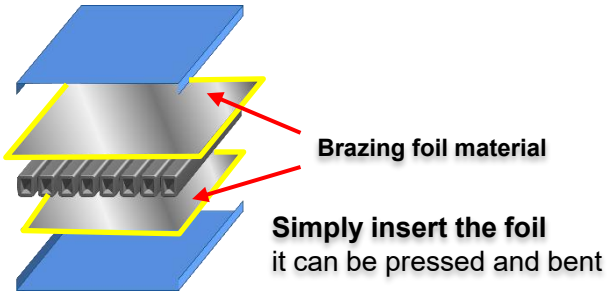
Applications

- **EGR cooler**
- **Plate heat exchanger**
- **Metallic Catalytic Substrates**

■ Comparison of Joining Processes (Example of EGR Cooler)

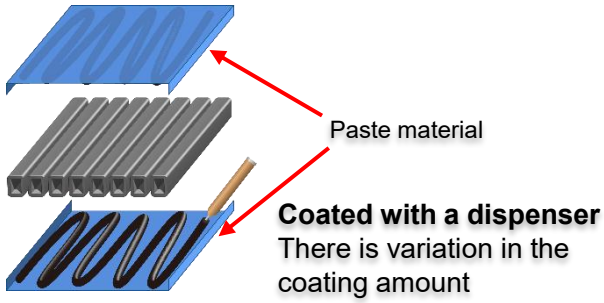
Brazing foil material

Usage reduction with a foil thickness of 25 μm. Since it does not contain binders, processes can be omitted, and it will not damage the vacuum furnace



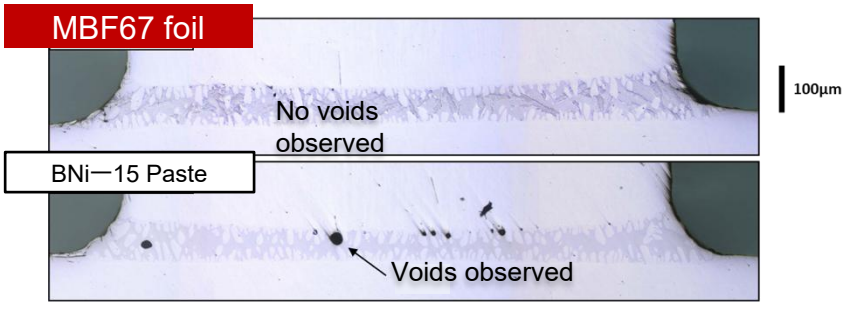
Paste material

The particle size of Ni powder is larger than Φ50 μm, resulting in increased usage. A debinding process is necessary.



■ Comparison of voids on joint surfaces(brazing foil material vs paste material)

Figure: Cross section of stainless steel SUS316 after welding (our comparison)



■ Comparison of usage reduction rate(compared to our company)

Ni-based solder material	Thickness (μm)	Net usage amount (g)	Reduction rate of usage amount(%)
MBF67 foil	38.1	2.309	30
MBF67 foil	25.4	1.560	53
BNi-15 Paste	-	3.308	100

Inquiry | Proterial, Ltd.
Power Electronics Materials Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Eco-friendly process without precursor production

Cathode Material (CAM) Production Technology for Lithium-ion Battery CALISMAT™

Technology Features

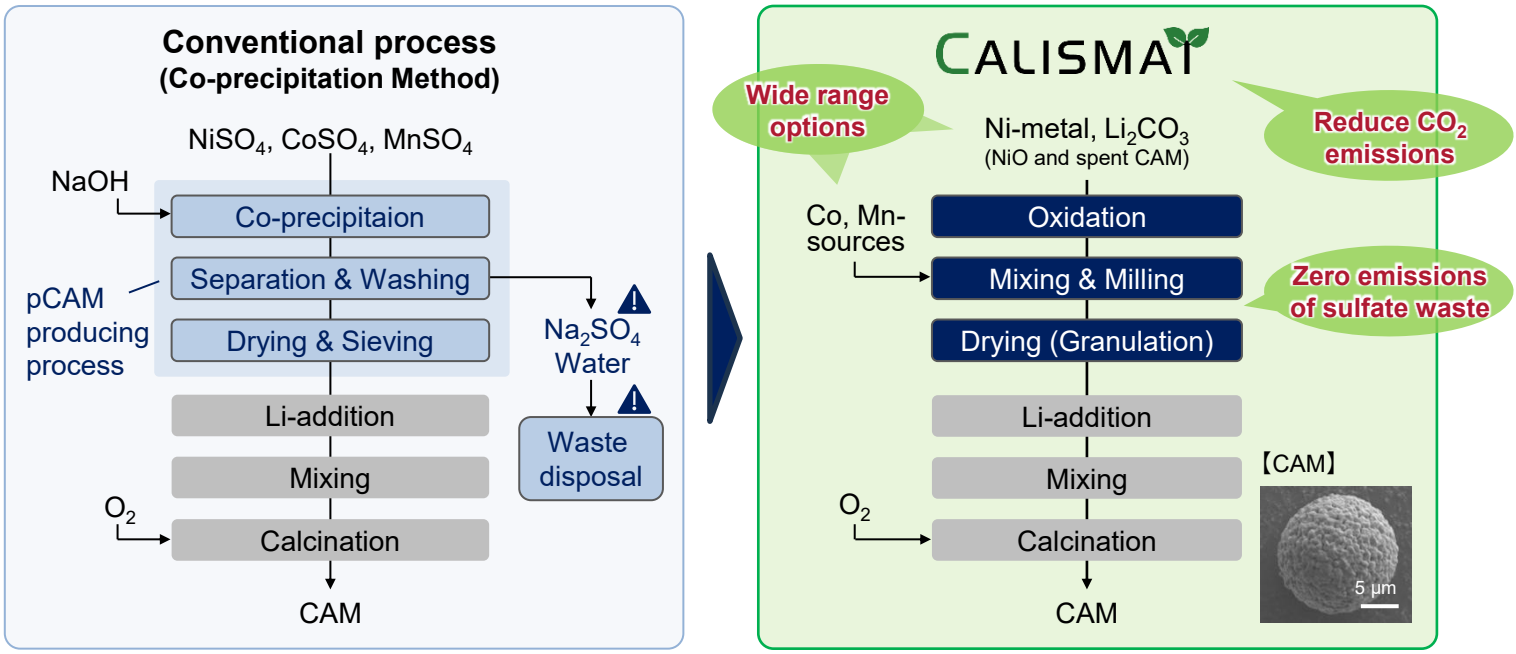
CALISMAT is a precursor (pCAM)-free CAM production technology that overcomes key issues of conventional co-precipitation process[1]:

- **Carbon footprint** (CFP) is reduced by 36%
- **Water consumption** is reduced by over 85%
- **CAM cost**, which makes up around 40% of battery cell cost, is reduced by 6%[2]
- **No sodium sulfate** is generated, simplifying wastewater permitting and accelerating plant startup

FEV CONSULTING

The environmental and economical benefits over the conventional process were validated in a joint project with FEV Consulting which offers dedicated consulting services for material manufacturers.

■ Comparison of CAM production processes



・We contribute to the sustainable society by providing our “CALISMAT” as solutions.

1) The validated values represent the proportion in the entire CAM production process.
2) Based on raw material prices from early 2025

Inquiry | Proterial, Ltd.
Technology Alliance Dept., Marketing & Sales Div.
5200 Mikajiri, Kumagaya-shi, Saitama 360-8577, JAPAN

"Connecting" technology
to give you a solution !

Conductive Ni-P Particle Plating Technology
(Nickel-Phosphorus)

Technology Features

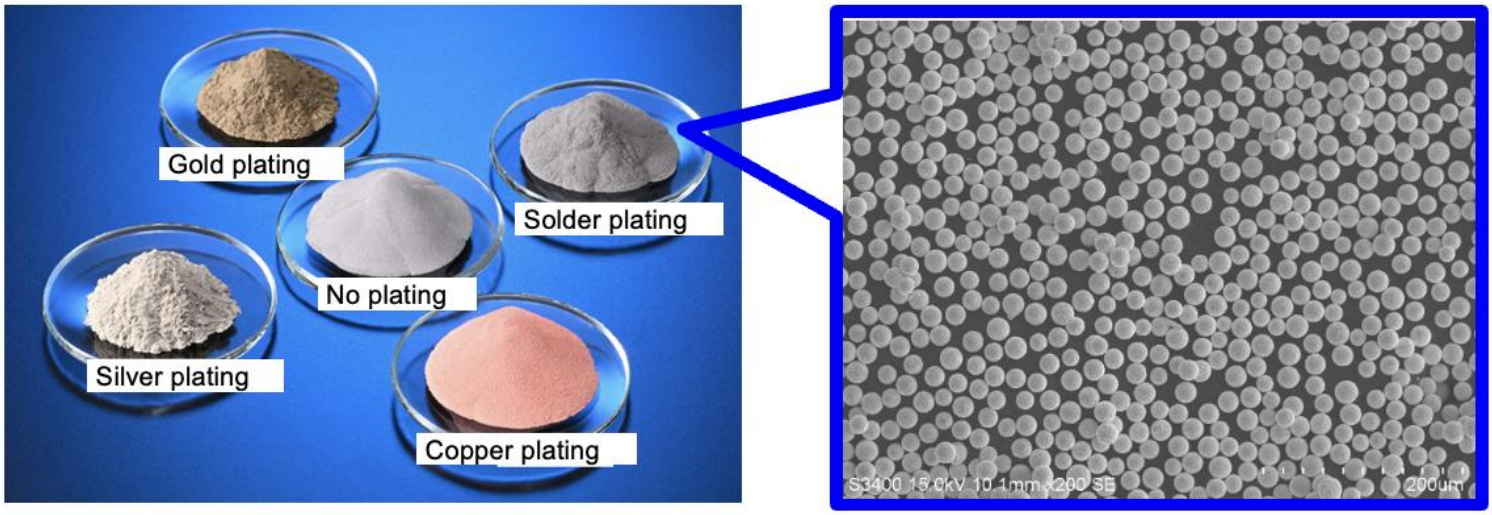
- High sphericity and uniform particle size
- Low electrical resistance with various plating types
- Heat resistance and high hardness of Ni-P particle core

Applications

- Chiplet 2.5G mounting materials
- Gap materials for die attach paste
- Conductive particles for anisotropic conductive film

■ Appearance and SEM image of plated Ni-P particles

High spherical, smooth surface, monodisperse, uniform particle size (1～30μm)



■ Characteristics of Ni-P particles

Various functions such as "low resistance," "metal bonding," and "corrosion resistance" are provided by various plating types

Types of plating	None	Gold Au	Silver Ag	Copper Cu	Solder Sn-Bi
Volume resistivity ($x10^{-5}\Omega \cdot m$) *1	21.1	0.6	0.13	0.07	0.5 *2
Melting point (ºC)	-	-	-	-	≈140

*1 Volumetric resistivity varies depending on particle size, plating film thickness, and bonding state
*2 Volumetric resistivity of solder is the value before soldering

Inquiry | Proterial, Ltd.
Electronic Materials Department, Specialty Steel Business Unit
Toyosu Prime Square 5-6-36 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Advanced surface coating

Aluminum Electroplating Technology

ALectro™

Aluminum die-cast plate with color anodizing applied after ALectro™.

Technology Features

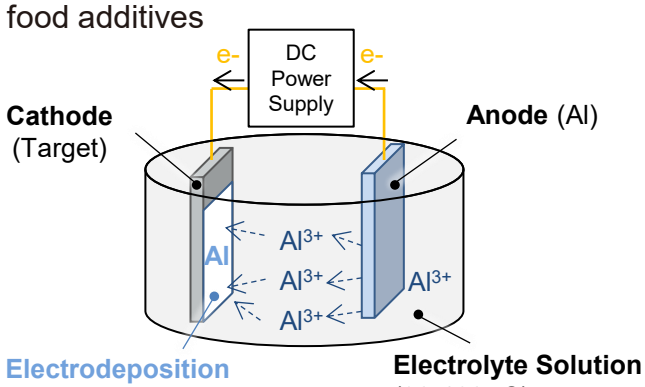
- **High-purity, dense aluminum coating process**
- **Thicker films than vapor deposition**
- **Improved corrosion resistance & aesthetics by anodizing**

Applications

- **Paint-free solution for exterior components**
- **Corrosion resistance coating**
- **Aluminum-coated foil or film**

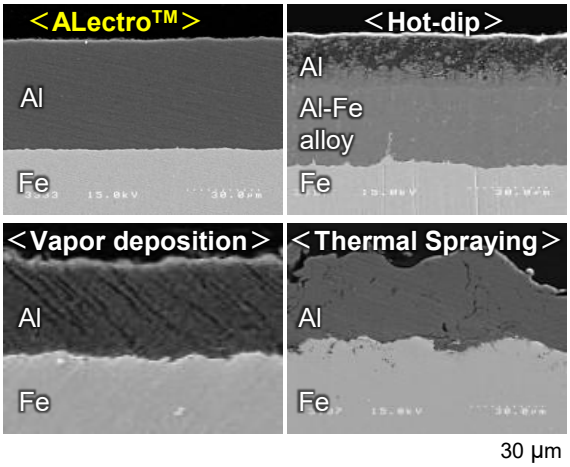
■ Non-aqueous electrolytes using eco-friendly solvents

Uses organic substances that are also used in food additives



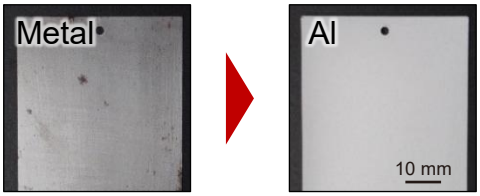
■ High purity(>99%Al) , dense, uniform thickness

Comparison of Al coating methods



■ Application examples

Addition of electrical conductivity and corrosion resistance



Design features metallic texture and elegant coloring finished by anodizing

■ Basic Specifications

Thicker films can be formed vs. vapor deposition

Substrate	Metals: Mg, Al, Fe, Cu, ・・・ Resins: CFRP・・・
Thickness	3-100 μm
Shape	Simple：easy (plate, foil)
	Complex：negotiable

Inquiry | Proterial, Ltd.
Technology Alliance Dept., Marketing & Sales Div.
5200 Mikajiri, Kumagaya-shi, Saitama 360-8577, JAPAN

Proterial, Ltd.
Official Website

Proterial, Ltd.
LinkedIn
Official Account

Proterial, Ltd.

https://www.proterial.com/e/

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

Proterial Europe GmbH

Immermannstrasse 14-16, 40210 Dusseldorf, Germany

motor@eu.proterial.com