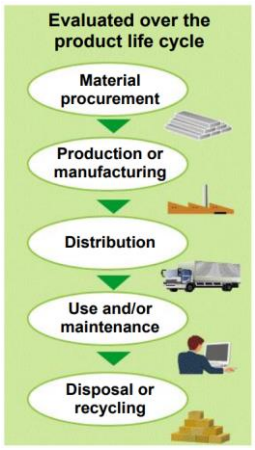
# Environmental Consideration in Products

The Proterial Group considers “Thinking about the next generation—An environment-friendly solution” an important managerial issue. We contribute to the realization of a sustainable society through the creation of new products and new technologies that meet such needs, as well as through the provision of advanced environmentally conscious products.

## (1) Environmental Consideration (Life Cycle Assessment [LCA]) in Products and Services




For the purpose of contributing to the realization of a sustainable society, the Proterial Group is focusing attention on the environmental and energy sectors when promoting the development of new products. Moreover, for the development and design of new products, we promote environmentally friendly product development based on our Eco-Design Activity Guidelines, taking product life cycles into account.

Eco-design that takes product life cycles into account has begun to be required by various international initiatives, including the revision of ISO 14001:2015 and the establishment of IEC 62430*1 as well as national regulations for energy-saving products. In order for evaluations to be made from the viewpoint of life cycles based on IEC 62430, the Proterial Group revised its environmentally conscious design assessment and LCA systems in fiscal 2016. Using these assessment tools, we promote product development and design in consideration of environmental impacts the product will have on the environment throughout its entire life cycle that ranges from procurement and manufacturing to use and disposal by the customer. The table below shows examples of the Group’s environmentally friendly products and technologies that are applied to the environment and energy-related fields.

*1 IEC 62430: The standards set by the International Electrotechnical Commission (IEC) for “Environmentally conscious design for electrical and electronic products”

**[Examples of the Proterial Group’s environmentally friendly products and technologies applied to the environment and energy-related fields]**

| Field of contribution | | Environmental value offered | Products and development technologies |
|---|---|---|---|
| Energy | Photovoltaic generation | Renewable energy | Amorphous cut core, dust choke coil, target materials for power conditioners |
| | Wind-power generation | | Amorphous metal materials, FINEMET® core, magnet wires |
| | Power generation facilities | Energy saving, higher efficiency | Super-heat-resistant metal materials, precision cast blades for turbine wheels |
| | Home appliances | | Magnets for water pump/fan motor/air conditioner/refrigerator compressors, high-efficiency amorphous motor components |
| | Transformers | Higher efficiency, longer life | Amorphous metal materials for low-loss transformers |
| | Batteries | | SOFC*1 fuel cell parts (interconnector materials, heat-resistant parts), cathode materials for lithium-ion batteries, clad metals |
| Mobility | Automobiles | Exhaust gas purification | Components that help clean exhaust gas (CERACAT, magnets for EGR*2) |
| | | Lighter weight | Lightweight undercarriage, magnets for EPS*3, magnets for auxiliary motor |
| | | Higher efficiency, longer life | Heat-resistant cast steel materials, CVT*4 belt materials, magnets for magnetic sensors |
| | | Electrification | Neodymium magnets, amorphous metals, amorphous metal motor, FINEMET® core, clad metals for secondary battery electrodes, high PDIV*5 enameled wire |
| | | | Members for fast charging, aluminum cast inverter cases, silicon nitride substrates for power modules, harnesses for EPB*6 |
| | Railway | Higher efficiency, lighter weight | Cables for rolling stock, contact wires |
| | Aviation | Longer life, higher efficiency | Nickel-based alloy large forged parts for aircraft engines, high-heat-resistance/high-corrosion-resistance alloys |

| Field of contribution | | Environmental value offered | Products and development technologies |
|---|---|---|---|
| All industries/ infrastructure | Industrial equipment, etc. | Longer life, lighter weight | Long-life die steel, carbide rolls, corrosion/heat-resistant fittings, metal additive manufacturing technology, ultra-fine copper-alloy wire, magnets for servomotors, magnets for VCM*7, linear stages, radiating fin components, heat sink components |
| | Water treatment | Seawater desalination | Ceramics adsorption filters for pretreatment of seawater desalination |
| | Electronics | Higher efficiency, downsizing, lighter weight | Additive manufacturing parts, silicon nitride substrate for power semiconductors, clad metals for heat resistance of smartphones, low thermal expansion alloys for precision equipment |

*1 SOFC: solid oxide fuel cell;
*2 EGR: exhaust gas recirculation;
*3 EPS: electric power steering;
*4 CVT: continuously variable transmission;
*5 PDIV: partial discharge inception voltage;
*6 EPB: electric parking brake;
*7 VCM: Voice Coil Motor

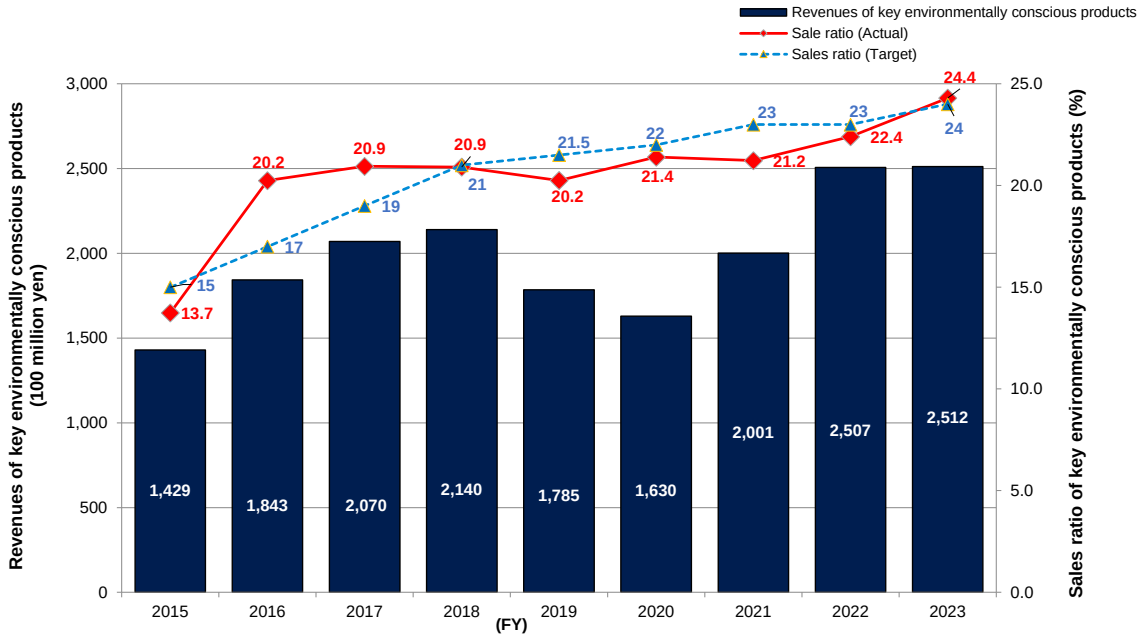
## (2)Expansion of Key Environmentally Conscious Products

The Proterial Group defines environmentally conscious products as those targeted for growth based on a management strategy and that make a significant contribution to resolving environmental issues such as climate change and resource recycling. The Group is promoting the increase of revenues from environmentally conscious products.

In fiscal 2023, revenues from sales of environmentally friendly priority products increased to 251.2 billion yen, up 0.5 billion yen year on year. The revenue ratio on a consolidated basis increased to 24.4%, up 2 percentage points year on year.

Going forward, we will expand the lineup of target products and promote sales, aiming to contribute to tackling environmental issues facing our society (climate change, resource recycling, etc.).

**[Revenues and Sales Ratio of Key Environmentally Conscious Products]**

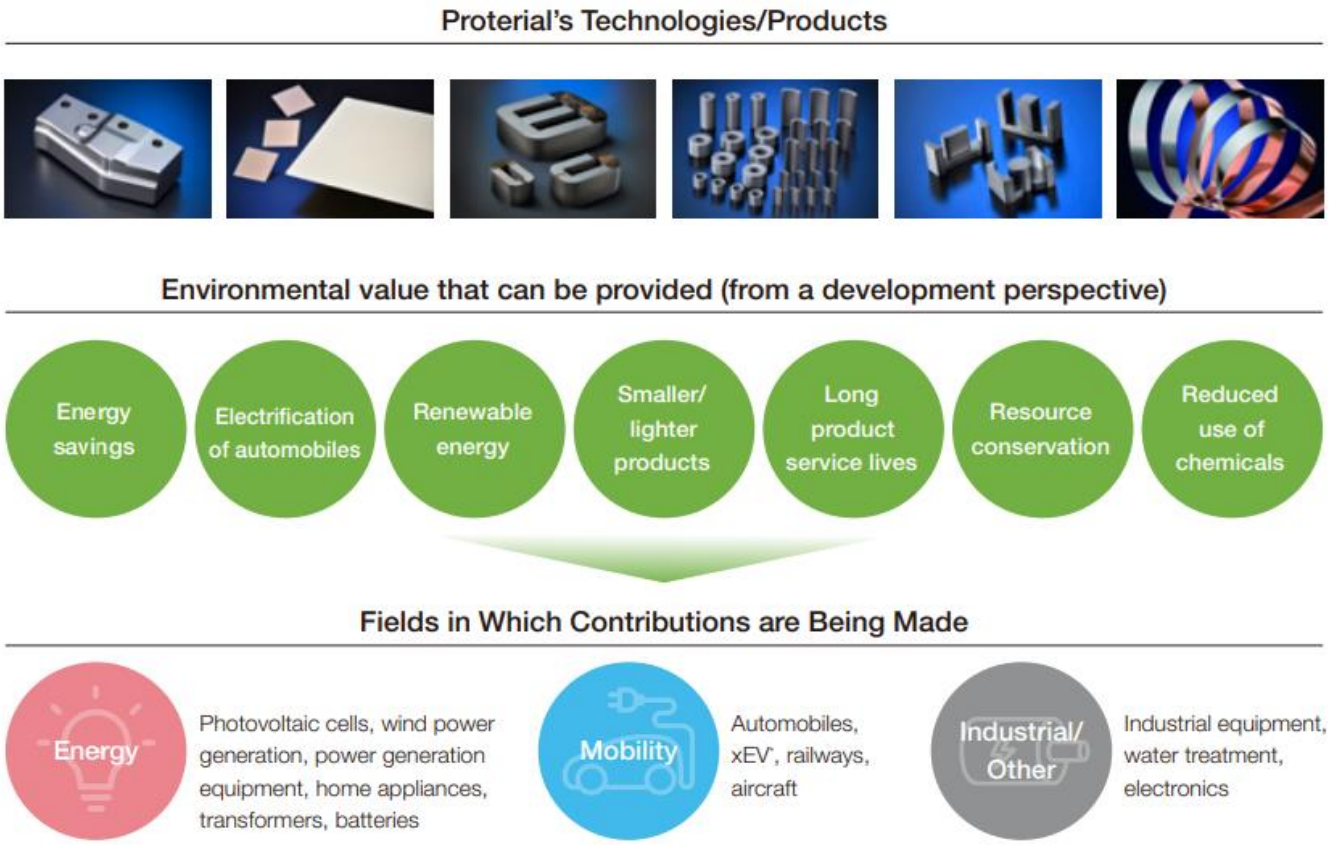



## (3) The Proterial Group's Environment- and Energy-related Products

The Proterial Group develops and delivers materials and products that contribute to the environment and energy conservation across wide-ranging areas of society, from electricity generation and transformation to use in factories, plants, offices, homes, and vehicles.

**[Introducing Environment- and Energy-related Products]**

## ■Proterial's Environment-related Products, Environmental Value That Can Be Provided, and Field of Contribution

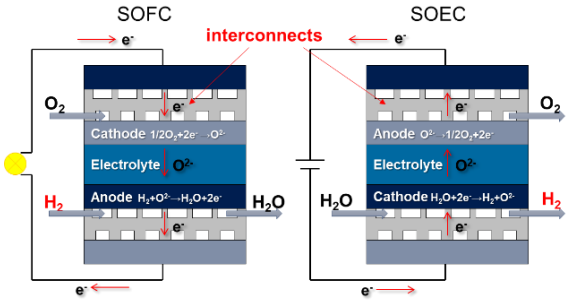



*1 xEV: generic term for electric vehicles (EVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs);

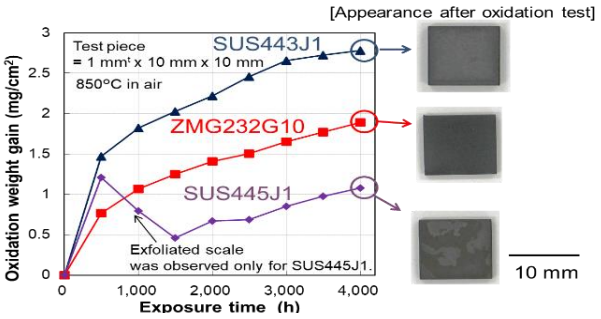
## ■ZMG®232G10 interconnector material for SOFC/SOEC

**Specialty Steel Business Unit**

A solid oxide fuel cell (SOFC), known as a clean device that can produce electricity from hydrogen while generating water as a by-product, and a solid oxide electrolysis cell (SOEC), a highly efficient hydrogen producer using high-temperature steam, are technologies expected to contribute to a hydrogen society in the near future. SOFCs and SOECs both are composed of ceramic cells, and the interconnect sits between individual cells to combine the electricity generated by each cell. Interconnector material ZMG®232G10 developed by Proterial is characterized by less oxidation weight gain than general stainless steel, thus less prone to oxide film detachment. This has been made possible by continuously improving the alloy composition to control the structure and composition of oxide film formed on the surface of Fe 22-24% Cr ferritic stainless steel at the operating temperature. Also, examination is underway to apply this material to the support portion of metal-supported cells adaptable to low-temperature operation.




Structural schematic of SOFC and SOEC cells




Oxidation resistance comparison between

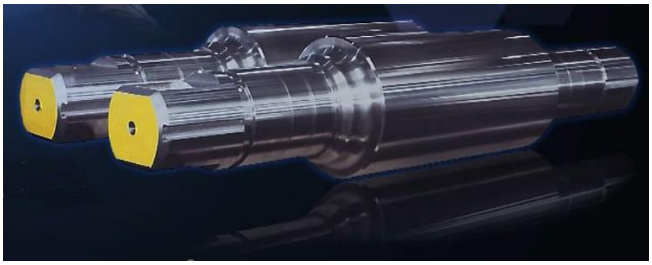
## ■TMAX Series high-performance indefinite chilled rolls for hot strip mills

**Rolls Business Unit**

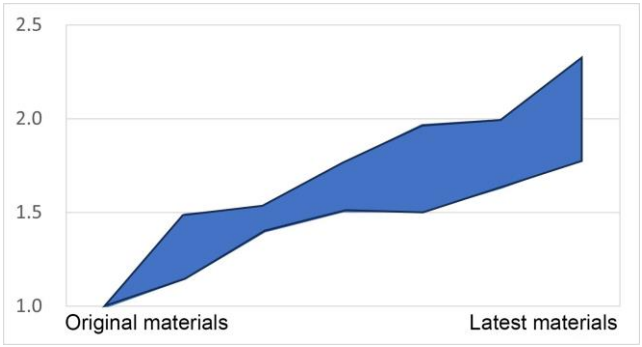
Development of rolled steel sheets is advancing in pursuit of higher-function products, such as high-tension steel and magnetic steel sheet, which are manufactured using hot strip mills. Indefinite chilled rolls used in this process are required to exhibit high performance, particularly in terms of abrasion resistance and wear damage resistance in case of an operational failure.

In the late 1990s, Proterial developed improved models of indefinite chilled rolls by increasing abrasion resistance by 120% from the previous models. Afterwards, improvement has been made continuously to achieve the latest model with a 180% improvement in performance compared with the improved model in the earliest phase of development, bringing about a longer service live accordingly. This advancement has helped raise steel sheet rolling efficiency, and a longer roll life means an overall reduction in environmental impact despite the amount of energy used for roll manufacturing being almost unchanged.

An extended product life directly effects a reduction in $CO_2$ emissions, thereby contributing to a sustainable manufacturing process. Adoption of improved-model indefinite chilled rolls and development of their higher-performance contribute to more environmentally friendly steel sheet rolling process, thus supporting steelmakers' efforts to reduce environmental impact. In this sense, evolution of improved-model indefinite chilled rolls can be considered as an important technological upgrade that pursues environmental protection and manufacturing efficiency at once.



**Improved-model indefinite chilled rolls (external appearance of rolls for hot strip mills)**




**Improving performance of improved-model indefinite chilled rolls**

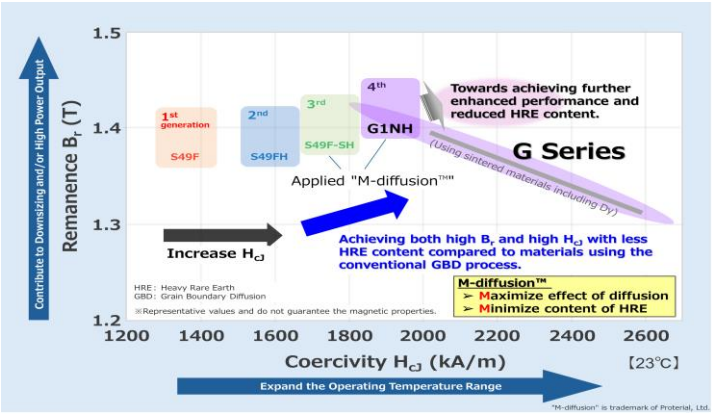
## ■NMX®-G1NH series high-performance neodymium magnets with heavy rare earth requirement reduced

**Magnetic Materials Business Unit**

Neodymium magnets (Nd-Fe-B magnets) are commercially available magnetic materials with the highest magnetic properties. Proterial, one of the world's pioneers in developing neodymium magnets, provides the material under the name of NEOMAX® " which contributes to the miniaturization and higher output and efficiency of motor and other products. Demand for neodymium magnets is expected to grow in the future, given the electrification of mobility being promoted as an approach to control global warming. One major issue with this material is related to heavy rare earths, such as dysprosium (Dy) and terbium (Tb), being used in order to ensure magnetic performance at high temperatures. These elements are unevenly distributed scarce resources.

The major previous way of addressing this issues was the grain boundary diffusion process to achieve necessary heat resistance and high magnetism with small amounts of heavy rare earths. Against this background, we have developed NMX®-G1NH, which exhibits high magnetic properties while significantly reducing usage of heavy rare earths compared to the previous grain boundary diffusion process by employing our proprietary M-Diffusion™ technology. We have begun to introduce the new product to our customers.

Going forward, we will promote efforts directed at higher performance and reduced usage of heavy rare earths, with the aim of achieving effective use of resources and a decarbonized society at the same time.

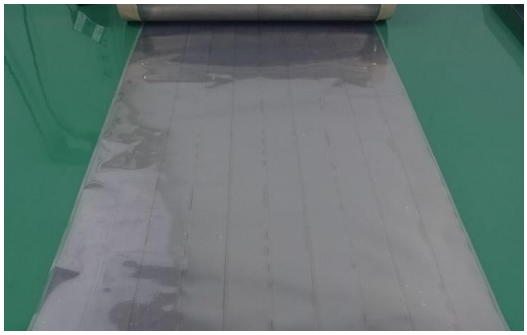



**Magnetic properties of NMX®-G1NH**

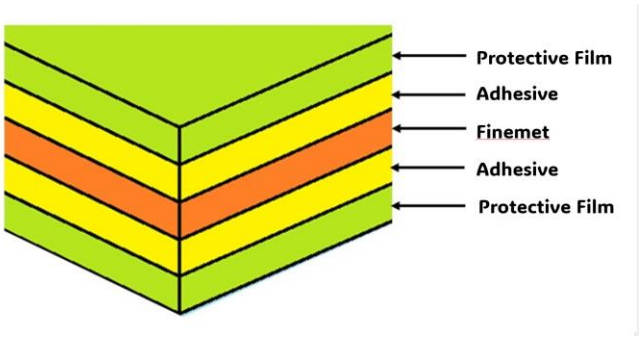
## ■MS-FH, highly heat-resistant magnetic shielding sheet

**Power Electronics Materials Business Unit**

Our MS-F magnetic shielding sheet made of nanocrystalline soft magnetic material FINEMET® ("FINEMET") boasts excellent magnetic properties, offering flexible handling and good workability. As such, it has been used for noise suppression in a wide range of applications, specifically in electronic devices such as mobile phones and cameras, medical equipment including X-ray diagnostic devices, and shielded rooms designed to reduce geomagnetism and other external magnetic fields. In recent years, MS-F has increasingly been used in noise suppression for in-vehicle electronics on xEVs. However, the scope of its adoption was limited due to its usable temperature being 80°C or lower, which meant that high temperature conditions would cause protective film and adhesive to deteriorate, and also affect its magnetic properties. To address this limitation, Proterial has developed MS-FH, a new magnetic shielding sheet with a heat resistance enhanced to 130°C while possessing the excellent properties equivalent to previous products. In addition to its increased usability in high temperature environments, the new material has achieved a thinner profile to improve adaptability, thus broadening the range of applications. Especially, the product will contribute to the miniaturization and weight reduction of an array of electronic devices used in xEVs, a rapidly growing field, thus helping realize a decarbonized society through supporting the spread of xEVs.



**External appearance of MS-FH (photo)**



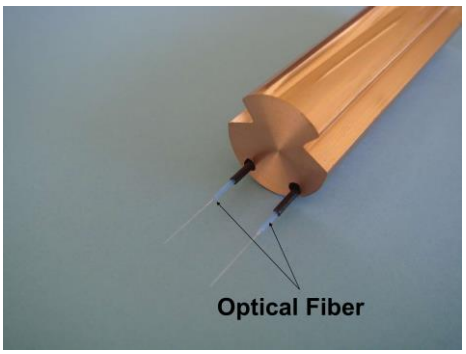

**Cross-sectional schematic of S-FH**

## ■Fiber-optic warning system for contact wire

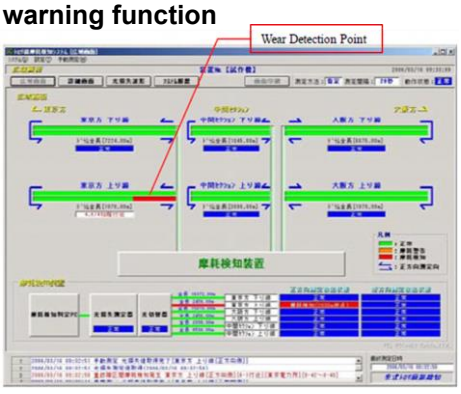
**Cable Business Unit**

Shinkansen bullet trains and other rolling stock run by receiving power from contact wires above the track through pantograph units fitted to their rooftops. Due to the structure where pantographs and contact wire are in contact, the contact wires can break due to the effects of friction, resulting in trains stopping on tracks, in the worst case. To prevent this, conventional warning systems place a metal detection line inside the contact wire and monitor friction based on the presence or absence of a flowing current. With this approach, however, detection can only be performed at night when no noise is produced by running trains. To address this issue, Central Japan Railway Company and Proterial, Ltd. jointly developed the fiber-optic warning system for contact wire in 2021. The new system uses optical fiber detection wires to enable the 24-hour constant real-time monitoring of the status of wear. This system also allows for central monitoring from the shinkansen system's general control center, compared with the previous wear detection functionality limited to on-site work, thus significantly reducing maintenance and management man-hours.

The system won the Masuda Award at the Grand Prize of the Best 10 New Products, organized by Nikkan Kogyo Shimbun in January 2023, and the Ichimura Prize in Industry for Distinguished Achievement, organized by the Ichimura Foundation for New Technology in April 2024.




**Contact wire with fiber-optic warning function**




**Contact wire monitoring system display (example)**