Part 3

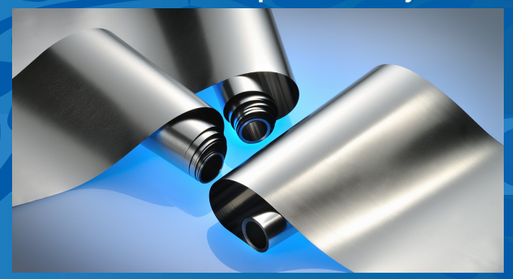
Technology and R&D

CONTENTS

Examples of Products That Help Realize a Sustainable Society

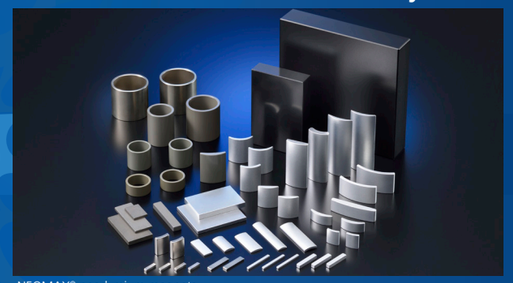
Our global environment faces many challenges, including rising sea levels and intensifying storms and floods resulting from climate change, as well as the depletion of resources and the loss of biodiversity. To address these challenges, we are pursuing environmental activities all over the world. The Hitachi Metals Group focuses on the development of key environmentally conscious products. At the same time, we contribute to realizing a sustainable society by providing key environmentally conscious products to customers in a wide range of fields, such as those for automobiles and electric power.

For the electric power industry



Metglas® amorphous alloy ribbon

For the automobile industry



NEOMAX® neodymium magnets

SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

In 2015, the United Nations adopted a set of 17 Sustainable Development Goals (SDGs) as part of a universal action plan aimed at ending poverty, protecting the planet, and ensuring peace and prosperity for all people by 2030.

■ Neodymium magnets: Contributing to popularization of xEVs

In 1982, our company (then called Sumitomo Special Metals) invented a neodymium magnet with a much stronger magnetic force than ordinary ferrite magnets. In general, a stronger magnetic force of the magnet means higher performance of the motor, which contributes to miniaturization and weight reduction. In light of technological advances in xEVs*1, neodymium magnets play a significant role, which are indispensable for making motors smaller and lighter, thus increasing efficiency and saving energy. Boasting the world's strongest magnetic force among permanent magnets, NEOMAX® magnets are used in various fields, including automobiles, IT, home appliances, industry, medical devices, and environment and energy. Currently, we are focusing on increasing our presence in the automotive market, which is undergoing transformation due to advances in connectivity, automated driving, and electrification. Supplying high-performance neodymium magnets for around 1.18 million vehicles*2 annually, we contribute to higher efficiency and downsizing of xEV drive motors and generators.

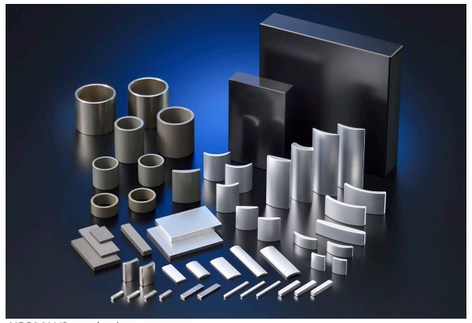
*1 xEV: A generic term for electric vehicles (EVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs).
*2 Based on the Fiscal Year 2021 Medium-Term Management Plan

Approx.
1.18
million vehicles*2
High-performance neodymium magnets supplied by the Group annually

■ Sustainable use of rare earth materials

Neodymium magnets are expected to find more widespread use as companies work to realize an energy-efficient society. These magnets consist mainly of neodymium, iron, and boron, a composition that is vulnerable to heat and whose magnetic properties deteriorate when the temperature exceeds around 80°C. Therefore, it is necessary to add dysprosium (Dy) and terbium (Tb), which are heavy rare earth elements.

Neodymium and heavy rare earth elements are indispensable materials for the evolution of magnets, but since they are derived from natural resources, there are risks in terms of procurement stability and costs. Because it is difficult to reduce the amount of neodymium, which is the basic composition of the magnets, the Group has been developing the NEOMAX®F Series since 2014, reducing the amount of heavy rare earth elements while maintaining heat resistance. By limiting the use of rare earth elements, we contribute to their sustainability.


NEOMAX® neodymium magnets

Rare earth magnet business

We produce neodymium rare earth magnets (neodymium magnets), which are indispensable for advances in miniaturization, weight reduction, and operational and energy efficiency. They are used in motors in such fields as automobiles, IT, home appliances, industry, medical devices, and environment and energy. In the automotive field, they are used in xEV drive motors and generators.

	Contribution to SDGs	Value created
Environmental value	7.3 11.6 13.1	We provide high-performance rare earth magnets for xEV applications in order to improve fuel efficiency, reduce vehicle exhaust emissions, and enhance operational efficiency and miniaturization of xEV drive motors and generators, stemming from replacement of internal combustion engines with xEV motors. (Approximately 1.18 million vehicles/year equivalent) [Customer value created] Note: Based on the amount used and shipment volume for xEV applications Developing magnets that require less heavy rare earth resources (less heavy rare earth magnets) will reduce the use of such resources. [In-house value created]

Potential risk of business on society/environment	Response
Environmental destruction due to rare earth mining; poor working conditions	Procure from companies that care for the environment and working conditions

■ Amorphous alloys: Contributing to energy efficiency of power transformers

Transmission energy gets lost as electricity travels from the power plant to factories and homes. High-voltage electricity sent from the power plant is converted to low-voltage electricity by transformers. However, transformers not only consume power during the conversion, but also when in standby mode.

To solve this problem, the Hitachi Metals Group developed an amorphous alloy called Metglas®. Transformers using Metglas® as the core material consume around one-third of the power of those using conventional materials, such as magnetic steel sheets. We have been supplying this alloy since 2003. Amorphous alloys have excellent soft magnetic properties due to their lack of crystal structure, which makes it possible to suppress power loss in standby mode. The Group has provided core materials for 480,000 amorphous transformers, contributing to a reduction in CO_2 emissions*3 of around 50,000 tons*2 per year compared with those of conventional transformers. In March 2020, meanwhile, we announced the development of MaDC-A™, a new amorphous material that contributes to even higher efficiency in transformers.

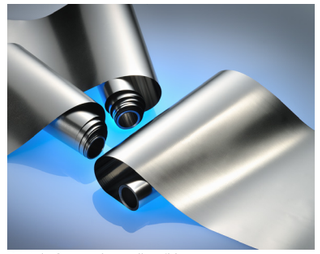
*3 Based on shipment volume and difference in transformer energy loss, according to Indian standards
For the CO_2 emission coefficient, we use IEA CO_2 emissions from fuel combustion (2017 world).

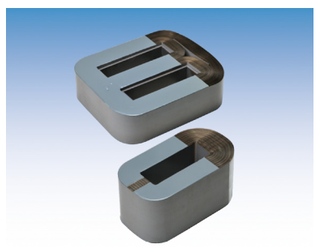
Approx.
50
thousand-ton*2 reduction
CO_2 emissions compared with conventional transformers

■ Targeting a global proliferation rate of 30% for high-efficiency amorphous transformers

Amorphous alloys are used in transformer cores to help save energy and reduce CO_2 emissions. However, the initial costs are higher than those for conventional transformers, and standards and regulations related to enhancing transformers' energy efficiency are inadequate. For these reasons, the global proliferation rate for amorphous core transformers is only 14%, according to our research. The Hitachi Metals Group is working to develop materials aimed at reducing the initial costs. Also, we are seeking to establish appropriate evaluation benchmarks through lobbying activities targeting governments, electric power providers, and electric transmission companies, while providing our expertise to amorphous transformer manufacturers. Our goal is to achieve a global proliferation rate of 30%, which will lead to reductions in CO_2 emissions of more than 4.6 million tons per year, equivalent to the emissions of 32 coal-fired power plants (each with a 1 million-kilowatt capacity).

Since amorphous alloys can also help enhance the energy efficiency of products other than transformers, we anticipate a significant emergence in demand. We will work to minimize environmental impacts in more domains by developing new production and processing procedures for amorphous alloys.


Metglas® amorphous alloy ribbon


High-frequency transformer core

Soft magnetic materials business

We produce soft magnetic materials used in energy-saving transformers and noise suppression components in industrial and electronic equipment.

	Contribution to SDGs	Value created
Environmental value	7.3 13.1	Compared with transformers using conventional materials, such as grain-oriented magnetic steel sheets, the no-load loss (standby power) of those using amorphous alloys is low, at around one-third. We provide high-efficiency amorphous transformer materials that can significantly reduce power conversion loss (used in around 480,000 transformers). This translates to an annual CO_2 emission reduction of around 50,000 tons compared with transformers using grain-oriented magnetic steel sheets. [Customer value created]

Potential risk of business on society/environment	Response
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Aiming to Be a “Genuinely Development-Driven Company”

In April 2017, the Hitachi Metals Group opened the Global Research & Innovative Technology center (GRIT), a reflection of its principle to “promote research, development, and innovation for the future, to become a genuinely development-driven company.” In April 2018, we opened a new facility within GRIT consisting of a research building and an experimental building. We will continue to invest in R&D on advanced materials that foster sustainable growth and contribute to society. At the same time, we will deploy AI, materials informatics, and other digital technologies to shorten product development periods.

Main R&D achievements in fiscal 2019

In fiscal 2019, the Group made investments in R&D totaling ¥15.9 billion and achieved the following results. We will contribute to advances in weight reduction and fuel and energy efficiency of products in fields related to industrial infrastructure, electronics, and automobiles, where electrification (xEV)*1 is making progress.

Specialty Steel Products

- The Group developed MVF-5X, a new Mo alloy with high corrosion resistance and the high adhesion properties needed for high-performance thin-film devices and the low stress and flex resistance needed for flexible substrates. This product is expected to be used as a foundation film for ensuring the adhesion of functional thin films and as a cap film to protect surfaces.
- The Group developed SLD®-f, a prehardened die steel*2 with a 60 HRC-level hardness (versatile hardness of cold press dies) to which the cutting process can be directly applied when dies are produced. This product has the characteristics needed for die steel and is expected to open up new possibilities in the production of dies.
- The Group developed Tribec®SC, a physical vapor deposition (PVD) coating with improved erosion resistance and corrosion resistance using thick-film coating and blocking layers. The application of Tribec®SC to die casting and injection molding dies can be expected to increase the useful lives of dies.

Functional Components and Equipment

- The Group developed electrically operated segment ball valves with a variable opening/closing speed function that enables high-speed openings and closings. By combining the torque characteristics of these valves with those of electric motors inside actuators, users can set a minimum time of one second or a maximum time of 16 seconds for openings or closings.

Magnetic Materials and Applications

- The Group developed MaDC-A™, a magnetic domain control Fe-base amorphous alloy that can contribute to size and weight reduction and higher efficiency of distribution transformers. This product features approximately 25% less core loss than the Group’s conventional products and is expected to reduce environmental impacts.
- The Group developed the MaDC-F™ series*3 of soft ferrite cores for high-frequency power supplies. The cores are made of Mn-Zn soft magnetic materials that enable the reduction of core losses (energy losses) even in high-frequency environments. Accordingly, they are expected to help prevent performance degradation of servers, adapters, and EV power supplies and power transformers.
- The Group developed a high-power-density technology for on-board chargers (OBCs)*4-5 for installation in EVs and plug-in hybrid electric vehicles (PHEVs). A prototype OBC incorporating this technology operated successfully at a high-output density of 3.8 kW/L (details on page at right).

Wires, Cables, and Related Products

- The Group developed EN wires with improved identifiability and thin-wall three-layer wires that incorporate multilayer simultaneous extrusion molding technology. Here, we used our original formulation technologies to lessen the diameter and weight compared to those in conventional EN wires, thus contributing to saving space and energy.

*1 A general term for electric vehicles (EVs), hybrid electric vehicles (HEVs), and plug-in hybrid electric vehicles (PHEVs)
*2 Moderately quenched steel materials for dies (featuring lower heat treatment costs, shorter delivery time, and no deformation from the quenching process, as no heat treatment is needed)
*3 Received the Environment-, Resource- and Energy-related Components Award at the “CHO” MONOZUKURI (“super” production) Innovative Parts and Components Award 2019
*4 AC/DC converter used to convert AC voltage to DC voltage and charge EV and PHEV batteries
*5 The OBC prototype uses the soft magnetic materials of Hitachi Metals and the circuit technology of the Fraunhofer Institute for Integrated Systems and Device Technology IISB of Germany to achieve both high output and miniaturization.

Open innovation for advances in output and compactness of in-vehicle chargers

The Hitachi Metals Group established the Global Research & Innovative Technology center (GRIT) to create a framework for promoting medium- to long-term research across the entire Group. By emphasizing cross-departmental projects and open innovation through collaboration between the research arm of our business headquarters and GRIT, we aim to create new levels of value. Below, we introduce examples of prototype development through open innovation aimed at increasing the output and miniaturization of in-vehicle chargers, including those of EVs.

■Addressing problems of on-board chargers

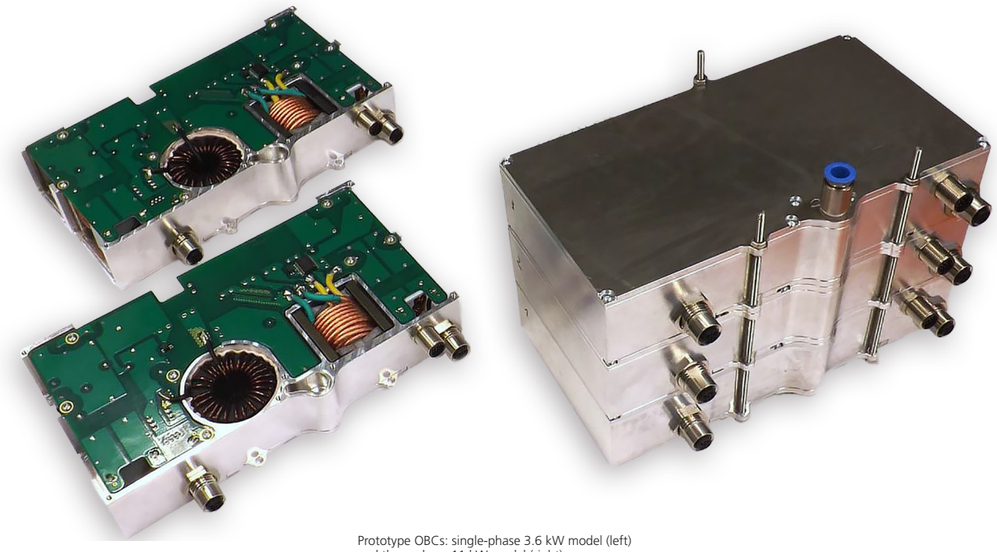
Charging batteries for such things as EVs requires conversion of alternating current (AC) to direct current (DC), and on-board chargers (OBCs), which serve as AC/DC converters, need to have high output to charge batteries in a short time. They also need to be compact to save space inside the vehicle. Since there is a trade-off between high output and the miniaturization of OBCs, achieving both has been a longstanding challenge. As a manufacturer of soft magnetic materials, the Hitachi Metals Group constantly looks for ways to help resolve problems. With the OBC issue in mind, we started working with the Fraunhofer Institute for Integrated Systems and Device Technology IISB (Fraunhofer IISB), the largest applied research institute in Europe.

■ World’s highest levels of output and miniaturization

Together with Fraunhofer IISB, we applied silicon carbide (SiC) to semiconductors and used a combination of our soft magnetic materials—which permit both miniaturization and high-frequency drive—and Fraunhofer IISB’s circuit technology to develop a high-output, compact OBC prototype. In April 2019, we announced our development of an OBC that can independently operate at 3.8 kW/L, which is the world’s highest output density. Moreover, up to six units can be connected in parallel to achieve outputs as high as 22 kW. This type of flexibility will lead to significant reductions in OBC design time and cost. By sharing the data obtained from such open innovation with our OBC-manufacturing customers, we will contribute to the practical application and widespread use of high-output, compact OBCs.

Soft magnetic materials used in OBC prototype

- Section of input/output noise filter
  Common-mode choke coils made with the FT-3K50T (Finemet®) nanocrystal alloy
- Rectifier/power factor correction circuits
  Choke coils made with the HLM50 series of amorphous powder cores
- AC/DC converter
  Isolation transformer (with integrated resonant inductor) made with ML29D low-loss soft ferrite core material



Prototype OBCs: single-phase 3.6 kW model (left) and three-phase 11 kW model (right)