Environment-friendly Steel Products

JFE Holdings				
JFE Steel	JFE Engineering	Kawasaki Microelectronics	JFE Urban Development	JFE R&D

Contributing to Auto Weight Reduction
High Tensile Strength Automotive Steel Sheets (HITEN)

Auto weight reduction is an effective means of preventing global warming because it improves fuel economy, thereby reducing exhaust gas emissions. In particular, further reduction in the weight of automotive steel sheets is needed, as these account for the largest percentage by mass of auto structural materials. At the same time, improved crashworthiness is also required to ensure passenger safety during collisions.

High tensile strength steel sheets (HITEN) are extremely effective for both weight reduction and crashworthiness because the same strength can be secured with thinner material. However, press formability, weldability, and fatigue characteristics, all tend to deteriorate in high strength steel sheets, limited their applicability.

JFE Steel was among the first steel makers to take up this problem, and has developed a wide range of innovative high strength steel sheets using the company's own technologies.

For example, "SFG HITEN," which offers extremely high formability and attractive surface appearance, was the first 390 MPa[*1] and 440 MPa grade steel sheet in the world used in auto side panels, enabling a 10 kg weight reduction, while 980 MPa HITEN sheets manufactured with JFE Steel's proprietary continuous annealing process are used in the seat frame and various reinforcing members, reducing weight by 15-20 kg. JFE Steel has also developed and commercialized many other high quality, high strength steel sheets for a wide range of applications, including "NANO HITEN" (p. 51) and "BHT steel sheets."[*2]

***1) MPa**
Unit of tensile strength. 390 MPa grade steel sheets can withstand a load of 40 kg/mm^2. Similarly, 440 MPa and 980 MPa can withstand loads of 45 kg/mm^2 and 100 kg/mm^2, respectively.

***2) BHT steel sheet**
High strength hot rolled steel sheet utilizing strain aging hardening. Products display high formability during press forming and a large increase in strength after paint baking.

High tensile strength automotive steel sheets (HITEN)
*Door panel test produced with 1200t press at JFE

Ferritic Stainless Steel with High Corrosion Resistance and Ultra-deep Drawing Property
JFE-SX1

With automotive fuel tanks, it is important to maximize capacity in the limited space available, which requires forming in extremely complex shapes. The material must have excellent formability, combined with high corrosion resistance to prevent dangerous fuel leaks.

Conventionally, lead-tin plated steel sheets were used in fuel tanks, but in recent years, lead substitutes have been demanded in response to stricter environmental regulations such as the ELV Directive[*1] in the EU and California's CARB regulations[*2] in the U.S. The Strategic Alliance for Steel Fuel Tanks (SASFT) of the American Iron and Steel Institute (AISI) conducted evaluation tests of various fuel tank materials supplied by steelmakers to meet extended product warranties of 15 years-150,000 miles, as required under the California regulations, with the aim of establishing the superiority of steel fuel tanks in terms of both durability and environmental performance.

JFE Steel is a leader in R&D on ferritic stainless steels for fuel tanks, where this material offers excellent corrosion resistance and recyclability, and developed "JFE-SX1" with high formability and corrosion resistance. The performance of this product has also been confirmed in the common corrosion resistance test for North America by the SASFT. JFE-SX1 also possesses sufficient corrosion resistance for high concentration biomass alcohol fuels. Because heavy painting for corrosion resistance is not necessary, it also contributes to reducing environmental loads and improving the working environment in the tank manufacturing process.

Where formability is concerned, JFE-SX1 is the world's first ferritic stainless steel to achieve an extremely high Lankford value (r-value)[*3] of 2.6 and has demonstrated satisfactory ultra-deep drawability.

***1) ELV(end-of-life vehicle) Directive (EU)**
EU Directive on scrapped automobile recycling/disposal. Effective July 2003, it banned the use of four substances, lead, mercury, cadmium, and hexavalent chromium.

***2) California's CARB regulations (US)**
Strict exhaust regulations imposed by the California Air Resources Board (CARB), centering on ZEV (Zero Emission Vehicle) regulations.

***3) Lankford value (r-value)**
Index of the deep drawing property of steel.

Test-manufactured fuel tank using stainless steel

Environment-friendly Steel Products

JFE Holdings				
JFE Steel	JFE Engineering	Kawasaki Microelectronics	JFE Urban Development	JFE R&D

Eliminating Use/Discharge of Harmful Chemical Substances

Chromate-free Coated Steel Sheets (2002 Japan Coating Technology Association Technology Award)

The EU has set a deadline of July 2006 for replacing hexavalent chromiun, lead, mercury, and cadmium with substitutes, in accordance with RoHS Directive*1 effective from February 2003. In Japan, the manufacturing industry is reducing the use of harmful substance amount to their products along with the introduction of "Green Procurement Programs." In the view of reduction of environmental load and consideration of workers' health, to replace chromate coated steel sheets, JFE Steel developed a coated steel sheet which contains no chrome (VI) but still offers excellent corrosion resistance, electrical conductivity, paint adhesion, anti-fingerprint property, and lubricity. In particular, because simply substituting other heavy metals for chrome (VI) reduces corrosion resistance, the same performance as in conventional products is secured by a composite film with a unique design consisting of a special organic resin and inorganic substance.

In order to secure high long-term use reliability in electric appliances made from Chromate-Free Coated Steel Sheets, a test method for accurately evaluating corrosion resistance in actual service environments is indispensable. JFE Steel therefore began development in 2001 and established an independent Accelerated Corrosion Test for Electric Appliances (ACTE*2) in November 2003. This test method accurately reproduces corrosion phenomena in coated steel sheets in actual service environments, which had been difficult with the conventional salt spray test, and is useful in appropriate development and selection of coated sheets.

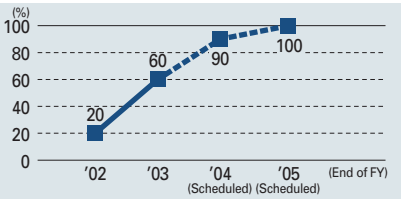
This product is now used in internal panels of appliances and vending machines, internal components of OA equipment and copiers, chassis of televisions, VTRs, and audio equipment, and other parts, and an expanded range of applications is expected.

The chromate-free ratio of steel sheets at JFE Steel was 60% as of April 2004, and a complete changeover is scheduled by the end of FY2005.

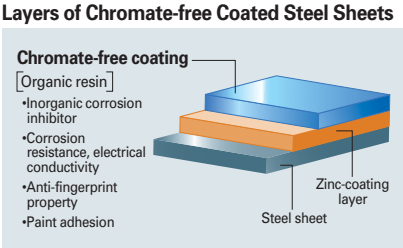
***1) RoHS Directive**
EU Directive placing restrictions on the use of designated chemical substances in electrical/electronic equipment. Abbreviation for Restriction on the use of certain Hazardous Substances in electrical and electronic equipment.

***2) ACTE**
Abbreviation for Accelerated Corrosion Test for Electric Appliances.

Transition of chromate-free products



Layers of Chromate-free Coated Steel Sheets



Large Reduction in Solvent/CO_2 Emissions

Laminated Steel Sheet for Food Cans (Universal Brite)

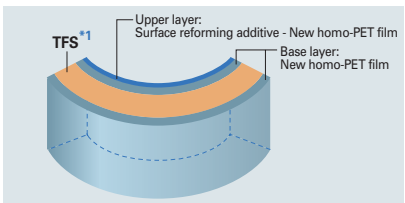
As conventional painting/baking process in canmaking generates harmful chemical substances (waste solvents/paint) and flue gas, there have been increasing demands for eliminating the painting process.

JFE Steel produces approximately 800,000 tons/year of coated steel sheets for cans. Replacing this entire amount with laminated sheets would greatly reduce environmental loads in the canmaking process, reducing releases of solvents from approximately 4,000 tons to 0 and CO_2 emissions from 600,000 tons to 200,000 tons. JFE Steel is therefore developing new laminated steel sheets to realize a 100% laminated canmaking product line.

"Universal Brite" is an epoch-making laminated steel sheet for food cans which was developed based on proprietary JFE Steel technologies. Using a base homo-PET film with a unique molecular structure, a special additive which improves the meat release property (easy removal of the contents) is added to the film surface layer, making it possible to omit the painting/baking processes while securing excellent formability, adhesion, corrosion resistance, and a meat release property equal to or better than those of existing paints.

Example of canmaking (half-pound food can)

Cross-sectional structure of Universal Brite



***1) TFS** Abbreviation for Tin Free Steel.

Universal Brite has been ordered in large quantities by major canmakers in North America and has a steadily increasing record of use around the world. It is expected to contribute to expansion of the market as the standard coated steel sheet product for food cans.

Comparison of environmental loads in canmaking (annual) (unit: 1000 tons)

	Solvent releases	CO_2 emissions
Painted can	4 approx.	600 approx.
Laminated can	0	200 approx.

Assuming 800,000 tons of product (JFE Steel's total annual production of steel sheets for cans)

Ecological Steel Products

JFE Holdings				
JFE Steel	JFE Engineering	Kawasaki Microelectronics	JFE Urban Development	JFE R&D

Reducing Environmental Loads and the Life Cycle Cost of Steel Structures

Weathering Steel/Rust Stabilization Treatment

Rustproof paint is generally used to prevent corrosion in steel structures such as bridges, but paint deteriorates and loses its corrosion resistance after 10-20 years, requiring expensive repainting. The work load is heavy, and chemical substances in the paint may affect the environment.

JFE Steel therefore developed "Weathering Steels," using the steel material itself to suppress corrosion. A fine, dense layer of strongly protective rust forms on the steel, effectively preventing further corrosion without painting and contributing to a long life of 50-100 years. Because the protective rust (iron oxide) has the same composition as natural iron ore, it does not cause environmental pollution.

JFE Steel has also developed and introduced nickel-added high atmospheric corrosion resistant steels for use in environments with high airborne salt concentrations, which was impossible with conventional products. Conventional JIS weathering steel is susceptible to lamellar exfoliation of the rust layer in airborne salt environments, and therefore cannot be used in coastal areas. In contrast, the new JFE products prevent this problem, even in environments with high concentrations of airborne salt. At present, these products are used mainly in bridges.

In cities and other areas where appearance is important, rust outflows and uneven rusting in the early period are problems which sometimes limit the applicability of weathering steels. JFE Steel solved this problem by developing new rust stabilization treatments. These treatments are applied only once, at the start of use. Thereafter, the dense layer of protective rust which is the essential feature of weathering steels forms on the steel surface over time, eliminating the need for periodical paint repair, while preventing rust outflow and uneven rusting, and maintaining satisfactory scenic appearance.

JFE Steel developed and introduced two types of new rust stabilizer, "CUPTEN COAT M", aging as protective rust, and "e-RUS", quickly growing as protective rust. They are 100% free of chrome, lead, and other heavy metals and meet a variety of requirements for formation of a dense protective rust layer.

Bridge constructed using weathering steel

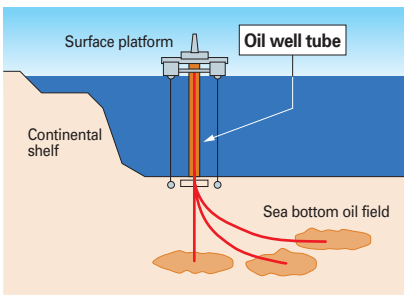
Supporting Stable Energy Supply

Martensitic Stainless Steel Tubes/Threaded Joints

To meet increasing demand for natural gas as a form of clean energy, deep oil and gas fields have been developed in recent years. Oil well tubes, or OCTG (oil country tubular goods), must have the strength to withstand high temperature/pressure and possess corrosion resistance against CO_2 in natural gas, while threaded joints must provide airtightness under the high compound loads associated with inclined/horizontal drilling.

With conventional OCTG, damage to the oil or gas well due to corrosion was a concern. Chemical inhibitors were used to prevent corrosion but caused environmental loads. JFE Steel therefore developed and supplies "Martensitic Stainless Steel Tubes," such as "13%Cr Steel Tubes," and threaded joints with excellent airtightness for use with these tubes. These products satisfy strength and corrosion requirements and reduce inhibitor use, and are widely employed as OCTG for natural gas development. By reducing environmental loads through extension of the life of oil and gas wells, they are contributing to a stable supply of natural gas.

Structure of sea bottom oil well

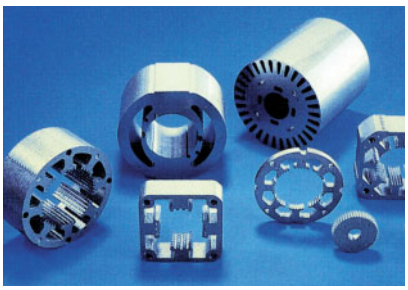


Surface platform

Reducing Power Loss in Electrical Appliances and Heavy Electrical Machinery

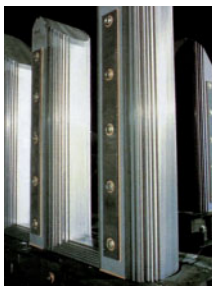
Non-oriented Electrical Steel Sheets for High Efficiency Motors/ Grain-oriented Electrical Steel Sheets for High Efficiency Transformers

Motors are used in a diverse range of products and currently account for more than half of Japan's total power consumption. A trial calculation showed that an improvement of only 1% in motor efficiency would result in energy savings equal to the output of one medium size (550 MW) nuclear power plant.[*1] Under the Revised Energy Conservation Law, which took effect in April 1999, the "energy saving top-runner system[*2]" was introduced to promote higher motor efficiency in designated equipment. However, improvement by methods such as inverter control has now basically completed one full cycle. To achieve higher efficiency, improved performance must be achieved in motor materials as such.



Non-oriented electrical steel sheets for high efficiency motors

JFE Steel has developed and is producing "Non-oriented Electrical Steel Sheets for High Efficiency Motors," which were developed to achieve low iron loss[*3] in motors, and thereby reduce power loss, particularly by reducing high frequency iron loss.



Grain-oriented electrical steel sheets for high efficiency transformers

In FY2003, transformers for the social sector were newly included in the designated equipment under the top-runner system. Because transformers have a long life of around 30 years, a large energy saving effect over an extended period can be achieved by using high efficiency cores with low iron loss, while also solving the characteristic problem of transformer noise during excitation.

Using its own proprietary technologies, JFE Steel developed and is producing "Grain-oriented Electrical Steel Sheets for High Efficiency Transformers." With excellent magnetic properties, these products achieve energy savings while reducing transformer noise by increasing magnetic flux density and suppressing the magnetostriction.

***1) Source**
Toshiro Higaki, '99 Motor Technology Symposium GS, Japan Management Association (JMA)

***2) Energy saving top-runner system**
Energy saving standard introduced under the Revised Energy Conservation Law. For designated equipment, the product with the highest energy efficiency among current commercial products is considered the "energy saving top-runner," and a higher target value and time frame for achievement are set.

***3) Iron loss**
Energy loss by power consumption as heat due to magnetic hysteresis and eddy current in the cores of motors and transformers.

Energy Saving Through Omission of Heat Treatment Processes

Alloy Steel Powder for Sinter-hardening

Sintered parts can be manufactured in complex shapes at comparatively low cost. Taking advantage of this feature, applications have expanded to include automotive and electrical machinery parts.

Carburizing heat treatment[*1] is performed after sintering to increase the strength of high strength sintered parts for gears and clutches. This requires reheating to around 900°C, but reheating generates environmental loads (fossil fuel consumption, CO_2 emissions, etc.) equivalent to about 20% of the total environmental load in the sintering process.[*2]

To eliminate the need for reheating, JFE Steel developed "Alloy Steel Powder for Sinter-hardening", which realizes high strength without carburizing. Because the microstructure is strengthened in the cooling process after sintering, tensile strength exceeding 900 MPa and surface hardness exceeding 30 HRC[*3] can be obtained. These mechanical properties are superior to those of conventional alloy steel powders with carburizing. The product has been adopted in power tools gears and similar applications.

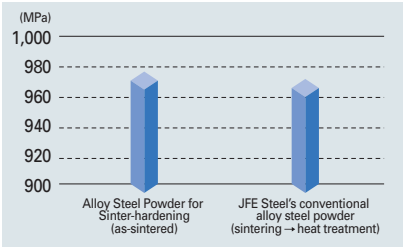
Power tool part

***1) Carburizing heat treatment**
Hardening process used to increase surface hardness by increasing the carbon content in the surface layer.

***2) Source**
Kohmei Harada, Materia Japan, Vol. 37 (1998) p. 42

***3) HRC**
Unit of hardness. Converted to tensile strength, 30 HRC is equivalent to 950 MPa.

Comparison of tensile strength of as-sintered 21SX and Sigmalloy 415 with carburizing



Development and Popularization of New Energy

Solar Cell Material Business

Although the manufacturing process for solar cells is energy-intensive, power generation is CO_2-free. Thus, life-cycle CO_2*1 emissions are low, at 1/14 to 1/18 the levels in thermal power generation. Solar cells have therefore drawn attention as a means of preventing global warming and depletion of fossil fuels. In addition to heightened environmental awareness in recent years, many nations have adopted preferential policies to encourage the use of solar power, resulting in large worldwide growth in the demand for solar cells, and in turn, rising demand for silicon wafer/ingot materials.

In 1997, JFE Steel began R&D on a new manufacturing technology using a metallurgical refining process for solar-grade (SOG) silicon ingots. By applying steel refining techniques, in 2001, the company established the metallurgical foundations for phosphorus and boron removing processes for SOG silicon for the first time in the world. With this process, production can be adjusted flexibly as required by demand for silicon ingots/wafers for solar cells.

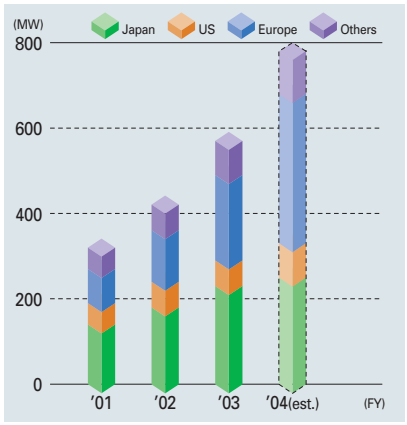
In the same year, JFE Steel also began commercial production of silicon blocks for solar cell substrates at 200 tons/year using purchased polysilicon material. In August 2004, production was scaled up to 800 tons to meet increasing demand.

Purity exceeding 99.9999% is secured in JFE Steel silicon ingots/wafers by applying contamination prevention technology, and thanks to the homogeneous solidification structure realized with casting technology, solar cells made from JFE's SOG silicon established a world's highest level of conversion efficiency*2 of 16% in multicrystalline silicon.

***1) Life cycle CO_2**
Total CO_2 emissions generated in all processes from extraction of resources to manufacture of generating equipment and fuel transmission, as well as in the combustion of fuel for power generation.

***2) Conversion efficiency**
Ratio (%) expressing conversion of light energy to electrical energy by solar cells. For example, if 1 kW/m^2 of light (energy of sun in clear weather) on a 1 m^2 solar cell area produces 100 W of electrical power, conversion efficiency = 10%.

Transition of solar cell demand worldwide



Silicon ingot manufacturing plant

Responding to Customers' Green Procurement Programs

In addition to eco-product R&D, JFE Steel has strengthened its marketing and created a marketing system for eco-products. It is also actively responding to the entire range of customer needs related to eco-products, which include implementation of EMS, reduction of toxic substances, submission of environmental load data, development of judgment criteria for green procurement materials, and proposal systems.

Green Procurement Network was created to enable company-wide sharing of information on customers' green procurement programs and studies regulatory and social trends to better serve customers with product information and direct contact. As an ultimate goal, JFE is working to establish a quantitative evaluation method based on Life Cycle Assessment (LCA).

JFE effort toward comprehensive products life cycle of automobiles