Feature Story

“A Pilgrimage Colored Fibers Encounter Iron”
(A series of works by Kei Tsuji)
— Contribution for October 2004 —
(Works of art focused on “an alliance of iron—closely bound to both earth and man—with the arts of dyeing and weaving”) 

Born in Tokyo 1953, Kei Tsuji displays her installations, centered on dyeing and weaving, in deserts, woodlands and waterfronts the world over. Produced through a fieldwork approach, her installations represent a continuous pursuit of the connection between herself (dyed and woven cloth) and the realm of time and space (principles of the natural world).

In this issue

Operating Roundup

Long-term Coke Transaction Agreement with Mitsui Mining
Nippon Steel and Mitsui Mining Co., Ltd. have signed a long-term agreement under which Mitsui Mining will manufacture and supply metallurgical coke for Nippon Steel for a period of ten years.

WISCO Awards Contract for CDQ Plant
Nippon Steel has been awarded a contract for coke dry quenching (CDQ) plant by Wuhan Iron & Steel (Group) Corporation (WISCO), one of China’s leading steel producers.

Forecast for Consolidated Operating Performance in 1st Half of FY 2004
The forecast for consolidated operating performance for the first half of fiscal 2004 (April 1, 2004 to September 30, 2004) and interim dividends, and full-year forecast are outlined.
**Feature Story**

**Electrical Steel Sheet of Nippon Steel (Two-part Series: 1)**

—High-performance Products Support Energy Savings Worldwide—

The need is rising for enhanced energy savings with regard to both global environmental problems and stable energy supplies. Particularly in the consumer product and transport sectors where there is considerable growth in energy consumption, it is becoming a difficult task to attain the desired energy savings. Electrical steel sheets are indispensable for the equipment and devices used by these two sectors to save energy.

Electrical steel sheets supplied by Nippon Steel support energy savings worldwide by providing advanced development capabilities, production technologies and diverse application solutions. This issue and the next highlight electrical steel sheets manufactured by Nippon Steel:

No. 321: Electrical Steel Sheets: Highly Conducive to Energy Savings

No. 322: Functional Advances Supported by Advanced R&D System
Electrical Steel Sheets: Highly Conducive to Energy Savings
Completing Tasks to Realize an Energy-saving Society

According to the Advisory Committee for Natural Resources and Energy of the Agency for Natural Resources and Energy, energy-related CO₂ emissions in Japan in 2010 will be about 16 million tons more in terms of carbon equivalent than in 1990. While energy savings are steadily being achieved in the industrial sector that is led by self-imposed action programs for energy conservation, it has been pointed out that additional measures for saving energy are necessary in the consumer product and transport sectors where energy consumption is still growing at a high rate.

In contrast to the industrial sector, it is difficult to adopt action plan-based or semi-compulsory approaches to energy savings in the consumer product and transport sectors where users demand for more comfort and convenience, along with enhanced lifestyle options. An alternative means, then, “introduction and expanded application of the Top Runner Program”—a program that assures promising energy savings without changing users’ comfort and convenience—is expected in the consumer product and transport sectors. The “Top Runner Program” came into effect with the enforcement in 1998 of the revised Energy Savings Law. Since the introduction of the Top Runner Program, 18 types of equipment and appliances (including automobiles) have been specified, and raising the energy efficiency standards and expanding targeted products are planned.

According to recalculated results released by the Advisory Committee, improvements in energy efficiency brought about by the Top Runner Program and the effect of expanding the program will be considerable, producing energy savings of 5.8 million kl of crude oil in the consumer product sector. In the transport sector, savings of 10.1 million kl of crude oil will be realized when the effect of vigorously introducing clean-energy, hybrid automobiles and idling-strop cars is added to the effectiveness of the Top Runner Program. Because of this, expectations are high for even wider use of the Top Runner Program and an expansion of targeted products.

In comparison to energy savings targeted at the equivalent of 21.1 million kl of crude oil in various action programs of the industrial sector, it is clear how great the energy savings in the consumer product and transport sectors can be. Group Manager Toru Ono, Technical Administration & Planning Div. comments as follows:

“In such situation, a number of applications of electrical steel sheets are expected to grow in such fields as small- to medium-sized transformers and electric home appliances in the consumer product sector and hybrid automobile motors in the transport sector. Moreover, from a medium- to long-term perspective and in conjunction with the arrival of a hydrogen-based society, the electrical steel market is expected to expand further.”
Feature Story

Electrical Steel Sheets Improve the Performance of Motors and Transformers

Electrical steel is an indispensable magnetic material that supports every stage of electricity usage—power plant generators, transformers for power transmission and motors to convert electricity to a power source. Electrical equipment and appliances operate by converting electrical energy to magnetic energy, and back again. Electrical steel is a key material for power apparatus in electric home appliances, industrial machinery and transport equipment.

Electrical steel sheets are used for the cores in transformers, generators and motors, efficiently converting magnetic energy and electricity. Magnetic flux, when passing through the core of an electrical device, causes a loss of electricity, or core loss, by the core’s Joule heat. The demanding task Nippon Steel faces in the development of electrical steel sheets is a continuous challenge of reducing core loss.

Electrical steel sheets are classified into two types. One is grain-oriented sheets whose grains are aligned in the rolling direction so as to impart excellent unidirectional magnetic properties. The other type is non-oriented electrical sheets with random textures that evenly impart magnetic properties in all directions. Grain-oriented electrical sheets are used mainly for transformers, and non-oriented sheets for generators, motors and other rotating devices. During the approximately 100 years since their development, electrical sheets have pursued better and better performance, thereby meeting the need for energy savings, the pressing issue of our time.
Grain-oriented and Non-oriented Electrical Steel Sheets

In the development of grain-oriented electrical steel sheets at Nippon Steel, ORIENTCORE•HI-B•LS was first marketed in 1984 with an effective reduction in core loss of about 10% over conventional products. Then in 1989 ORIENTCORE•HI-B•PM was put on the market and greatly contributed to energy savings in transformers (Fig. 1). In terms of market share for grain-oriented electrical steel sheets, Nippon Steel ranks among the top makers in the world. In this regard, Manager Haruo Yoneda of Electrical Sheet Div., explains:

“Nippon Steel is the world’s top ranked producer of grain-oriented electrical sheets in terms of market share. We have also granted our original ORIENTCORE•HI-B production technology to makers all over the world. When HI-B, the electrical steel sheet produced using high standard technology, is taken into account, Nippon Steel has an overwhelming share in this field, which proves that Nippon Steel’s technology and products are highly valued throughout the world.”
Supported by such technical predominance, Nippon Steel’s electrical steel sheets are exported not only to neighboring Asia but also to the EU, North and South America and Oceania (Fig. 3).

In the field of non-oriented electrical steel sheets, a succession of new products has been marketed to meet the growing diversification and development of electrical equipment and electric home appliances. The products, which use non-oriented electrical steel sheets, range from power generators and other large-capacity rotating machines to motors for air-conditioners and refrigerators, drivers for portable stereo cassette tape players and other compact electric appliances, hard-disc drives for personal computers, and motors for energy-saving hybrid cars (Fig. 2). Nippon Steel’s non-oriented electrical sheets also account for a large market share.
At present, Nippon Steel has structured an ideal supply system for electrical steel sheets in the major overseas markets. It is based on user locations and the use of coil centers and other fabricating plants operated by Japan’s trading companies. Exports show steady gains mainly to China where demand is rapidly growing and to other Asian nations as well.

Fig. 3 Export Destinations of Electrical Steel Sheets in Japan

Source: Japan Trade Statistics for 2003
Energy Savings through Application Technologies

In the Top Runner Program, transformers are one of the targeted types of electrical equipment. In order to meet emerging needs from society, Nippon Steel not only carries out R&D on the properties of electrical steel sheets but also promotes high value-added technological development projects involving application technologies that take into account the performance characteristics of the electrical equipment. Manager Yoshio Nakamura of Electrical Sheet Div. offers some examples.

“Nippon Steel conducts R&D not only to reduce transformer core loss but also to mitigate noise generated during operation. At the R&E Center in Futtsu, core loss is analyzed by building model transformers in anechoic chambers. At the same time, vibration and noise are measured in order to analyze how various elements such as materials and transformer structure relate to noise generation. One of the more important aspects of our technical support is that we suggest to our customers better ways to use electrical steel sheets.”

Demonstrative of its world-class market share, Nippon Steel has prepared a rich line-up of grain-oriented and non-oriented electrical steel sheets that will meet any specific user need in terms of product properties and grade. Meanwhile, the company has also established an ISO9001-certified quality control system—the world’s first in the field of electrical steel sheets—and an up-to-date, efficient production system.

Accommodating the Expanding Chinese Market

Among electrical steel markets, growth in China is attracting attention. Along with a rapid increase in electricity demand that has been followed by rapid industrial development, China is becoming a huge production center for electric home appliances, replacing Japan and the EU nations. In this huge market, the demand for electrical steel sheets is growing remarkably (Fig. 4). Yoneda comments that the 2008 Beijing Olympics and the 2010 Shanghai Exposition are conspicuously important in forecasting future market trends for electrical sheets in China.

“Just as the Tokyo Olympics and Osaka Exposition spurred economic growth in Japan, these two great events in China are accelerating rapid and large-scale development and improvement of the country’s infrastructure, and this is influencing the large demand for electrical steel sheets.”

However, the forecast for China’s electrical steel market indicates some difficulties. At the major steel mills in China, production of non-oriented electrical steel has almost completely shifted to cold rolling. However, many local mills still produce hot-rolled electrical steel with high core loss.
at a volume comparable to that of the cold-rolled electrical steel produced by the major mills as of 2003.

The policy of the Chinese government from an environmental perspective is to increase the manufacture of cold-rolled electrical steel sheets. However, because the priority is to handle the production of domestic demand, which is rapidly growing, the shift to cold-rolling production shows no substantial progress. Yoneda adds:

“The major mills in China are planning to expand the production of non-oriented electrical steel sheets and are forecasting a considerable increase in output several years hence. Nevertheless, this increased output will fail to meet the rapidly growing demand in that country, where not only production of electrical device which uses cold-rolled electrical steel will expand but also cold-rolled electrical steel is expected to replace hot-rolled electrical steel, which is still used in the cores of electrical device produced in China. We at Nippon Steel intend to meet such growing market needs in China by providing a stable supply of our high-grade non-oriented electrical steel sheets which will hopefully contribute to energy savings and environmental preservation in China.”

Nippon Steel is fulfilling its role as a top runner in the field of electrical steel sheets by making the most of the world’s premier technological development capabilities and a worldwide sales network.
Continuous Challenges to Reduce Core Loss

HILITECORE (H9), which was developed in 1967 as a cold-rolled non-oriented electrical steel, replaced the highest grade of conventional hot-rolled electrical steel. This product achieved a dramatic reduction in core loss at that time and acquired global market acceptance as the world’s highest grade of electrical steel. Manager Yoshio Nakamura remarks:

“The development of HILITECORE (H9) greatly contributed to higher efficiency in industrial motors and large-capacity power generators. In order to shift to cold-rolled electrical steel, all grades of electrical machines that use hot-rolled electrical steel must shift to the use of cold-rolled electrical steel. Under these circumstances and after the development of H9, Nippon Steel confirmed the stable application of cold-rolled electrical steel in the electric machine industry and in 1967 ended 43 years of hot-rolled electrical steel production. Cold-rolled electrical steel possess high dimensional accuracy, and allow high-speed, highly efficient continuous stamping of cores.”

Since then Nippon Steel has met the challenge to further reduce core loss. In the mid-1980s, Nippon Steel sold electrical steel sheets for heavy electrical machinery. The products had least energy loss in the world in those days, which was a little over 2 watts per kilogram at 1.5 tesla. The core loss in this grade has been reduced to about 1/3 that of the hot-rolled electrical steel produced at the Yawata Works in 1924. Further, after two oil crises, even higher efficiency was required in electric home appliances, which are more sensitive to cost than in heavy electric machineries. To meet the demand, Nippon Steel has developed and supplied many electrical steel sheets that have less core loss.