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NIPPON STEEL CORPORATION

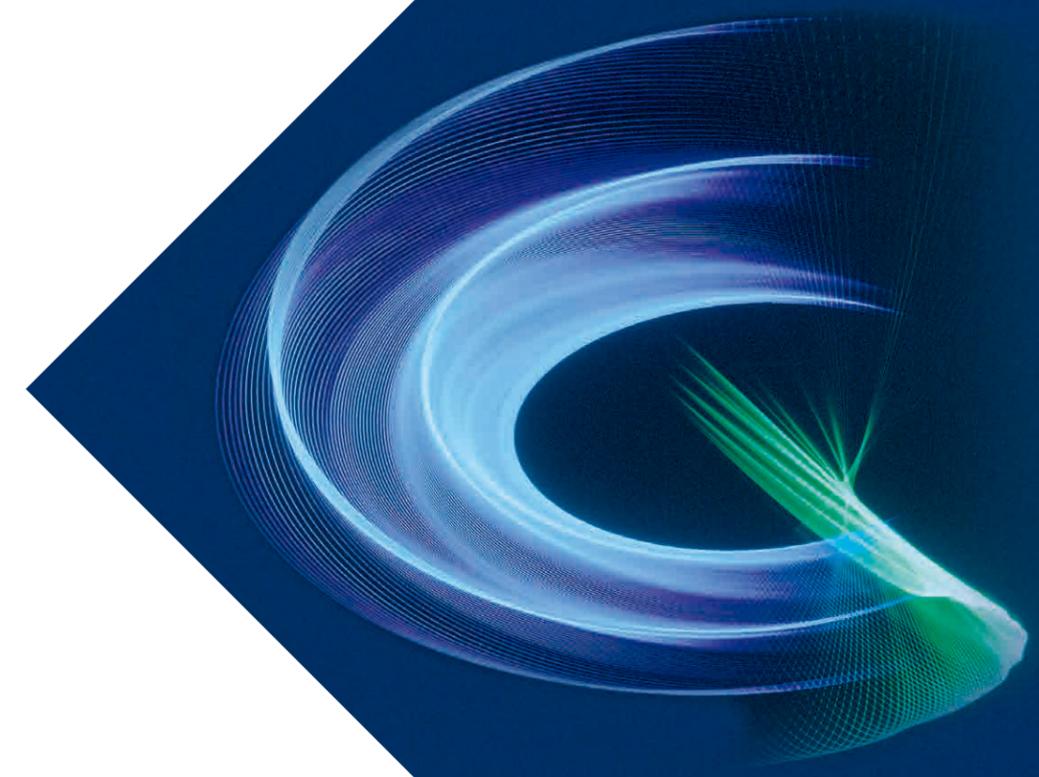
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SUPERNICKEL™

Nickel Coated Steel Sheets

Steel Sheet



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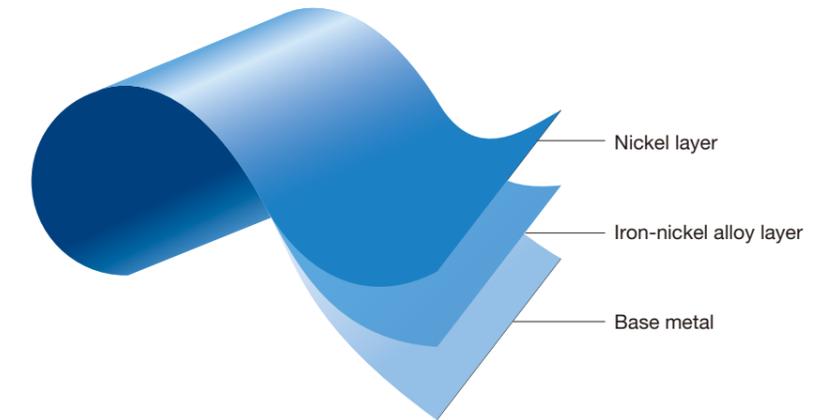
SUPERNICKEL™ Nickel Coated Steel Sheets
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Features

- 1 You can choose the material that best fits your specific applications and the degree of fabrication.**
 - Since our SUPERNICKEL™ steel sheets products are subjected to stringent internal defect management, such as removal of non-ferrous metal inclusions, in the integrated manufacturing process, they can accommodate any complex metalworking jobs, including deep drawing.
- 2 You can select any type of surface finish, ranging from extremely attractive mirror finish to dull finish.**
 - Even differentially finished steel sheets having different glossiness between obverse and reverse surfaces are available.
- 3 You can select any desired coating weight, from lighter-coated sheets to heavier-coated ones.**
 - Differentially coated sheets having different coating weights on the obverse and reverse surfaces are also available.
- 4 Excellent corrosion resistance and coating-film adhesion**
 - Formation of an Fe-Ni alloy layer by heat treatment after Ni coating gives the steel sheet excellent post-fabrication corrosion resistance.
- 5 Heat resistance comparable to stainless steel**
 - The glossiness, color tone and infrared-ray reflection of SUPERNICKEL steel sheets in a high-temperature (~ 300°C) atmosphere are comparable to those of stainless steel sheets.

NIPPON STEEL's SUPERNICKEL steel sheets

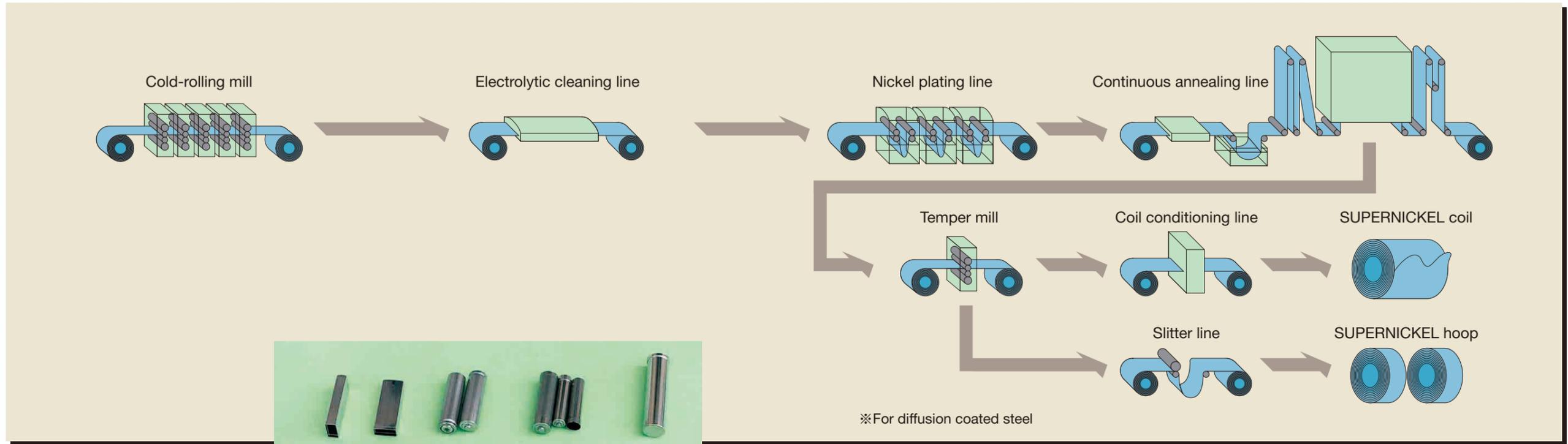


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Manufacturing Process



Applications



Classification

Standard

SUPERNICKEL is classified as "NTSN" according to NIPPON STEEL Standards for Steels for Sale.
 ※The dimensions, shape, external appearance, etc., of SUPERNICKEL are as specified in JIS 3303 (Tinplate and Blackplate).

Temper Grade

| Temper designation | Aimed hardness (HR-30T) | Application |
|--------------------|-------------------------|---|
| T-1 | 49 | Deep drawing applications of a severe degree requiring exceptionally good ductility |
| T-2 | 53 | Deep drawing applications of a normal degree requiring good ductility |
| T-2.5 | 55 | Applications requiring a moderate degree of ductility |
| T-3 | 57 | Applications requiring a moderate degree of hardness |
| T-4 | 61 | Applications requiring relatively high toughness |
| T-5 | 65 | Applications requiring excellent buckling resistance |

Classification by Coating Weight

(1) Coating Weight Target Value Display: (Nominal Display)

It is the specification of production aiming at the displayed coating layer.

| Type of coating | Designation of coating | Coating thickness [aiming](μm) | Coating weight [aiming](g/m^2) |
|-----------------------|------------------------|---|--|
| Equally coated | 1.0 / 1.0 | 1.0 / 1.0 | 8.9 / 8.9 |
| | 2.0 / 2.0 | 2.0 / 2.0 | 17.8 / 17.8 |
| | 3.0 / 3.0 | 3.0 / 3.0 | 26.7 / 26.7 |
| | 4.0 / 4.0 | 4.0 / 4.0 | 35.6 / 35.6 |
| Differentially coated | * / 1.0 | * / 1.0 | * / 8.9 |
| | * / 2.0 | * / 2.0 | * / 17.8 |
| | * / 3.0 | * / 3.0 | * / 26.7 |
| | * / 4.0 | * / 4.0 | * / 35.6 |

(2) Coating Weight Minimum Value Display: (Minimum Display)

It is the specification to guarantee the minimum thickness of the displayed coating layer.

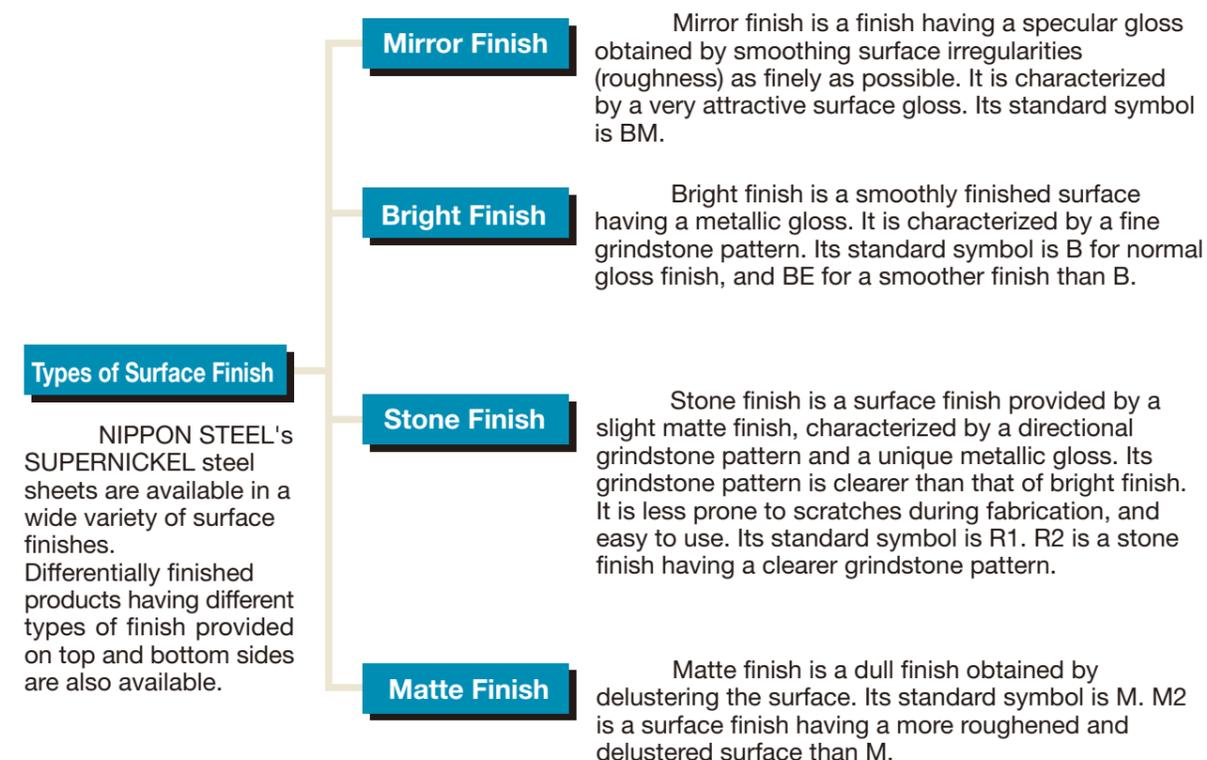
| Type of coating | Designation of coating | Min. coating thickness (μm) | Min. coating weight (g/m^2) |
|-----------------------|------------------------|--|---|
| Equally coated | Min1.0 / 1.0 | 1.0 / 1.0 | 8.9 / 8.9 |
| | Min2.0 / 2.0 | 2.0 / 2.0 | 17.8 / 17.8 |
| | Min3.0 / 3.0 | 3.0 / 3.0 | 26.7 / 26.7 |
| | Min4.0 / 4.0 | 4.0 / 4.0 | 35.6 / 35.6 |
| Differentially coated | Min * / 1.0 | * / 1.0 | * / 8.9 |
| | Min * / 2.0 | * / 2.0 | * / 17.8 |
| | Min * / 3.0 | * / 3.0 | * / 26.7 |
| | Min * / 4.0 | * / 4.0 | * / 35.6 |

- ※ Notation: Front/Back
- ※ Please ask us for the quantity not described above.
- ※ "*" of differential coating means that the coating quantity is different from the opposite side. For front/back combination of the differential coating, please ask us.
- ※ Nickel coating weight means the nickel coating weight (total of pure nickel layer and nickel quantity in the iron/nickel alloy layer) per one side of steel sheet.
- ※ Nickel coating quantity is measured by the fluorescent X-ray and it is indicated by the arithmetic average of 3-point measurements in the width direction.
- ※ The fluorescent X-ray unit uses a nickel coated steel sheet with iron/nickel alloy layer as the standard plate similar to a product, and it is calibrated. (If a nickel coated steel sheet without iron/nickel alloy layer is calibrated as the standard sample, note that the measurement quantity is lower than the actual nickel coating weight.)
- ※ The coating layer thickness is calculated by converting the nickel coating weight measurement value ($1\mu\text{m}$ for $8.9\text{g}/\text{m}^2$).

Surface Finish

| | Symbol | Type of finish | Aimed roughness range | Features |
|-------------------------|--------|-------------------------------|--------------------------------|---|
| Equally finished | BM | Mirror finish | $\sim 0.10 \mu\text{mRa}$ | An extremely attractive surface finish having a specular gloss |
| | BE | Extra bright finish | $\sim 0.18 \mu\text{mRa}$ | Glossier finish than bright |
| | B | Bright finish | $\sim 0.33 \mu\text{mRa}$ | A finish having a smooth gloss |
| | R | Stone finish | $0.2 \sim 0.72 \mu\text{mRa}$ | A finish provided by a fine grit lines. It is less prone to scratches. |
| | M | Matte finish | $0.77 \sim 3.43 \mu\text{mRa}$ | A dull finish provided by delustering |
| Differentially finished | D | Mirror or bright/matte finish | (See above) | Having different finishes on top and bottom sides; a can with an attractive mirror- or bright-finished outside and matte-finished inside, for example, can be obtained. |

- ※ For surface finishes other than specified above, consult us.
- ※ For types of surface finishes, see below.



◆Types of differentially finished sheets
 BE/M (Symbol: D2) are available as standard items.
 For other combinations, consult us.

Available Sizes

Classification by Specified Sheet Thickness

| Specified sheet thickness | Symbol | Description |
|---------------------------|--------|---|
| After coating | Y | Ordered sheet thickness indicates the product thickness including nickel coating. |
| Before coating | — | Ordered sheet thickness indicates the raw sheet thickness before nickel coating. |

Others

Classification by oil application

SUPERNICKEL is basically provided with no oil application.

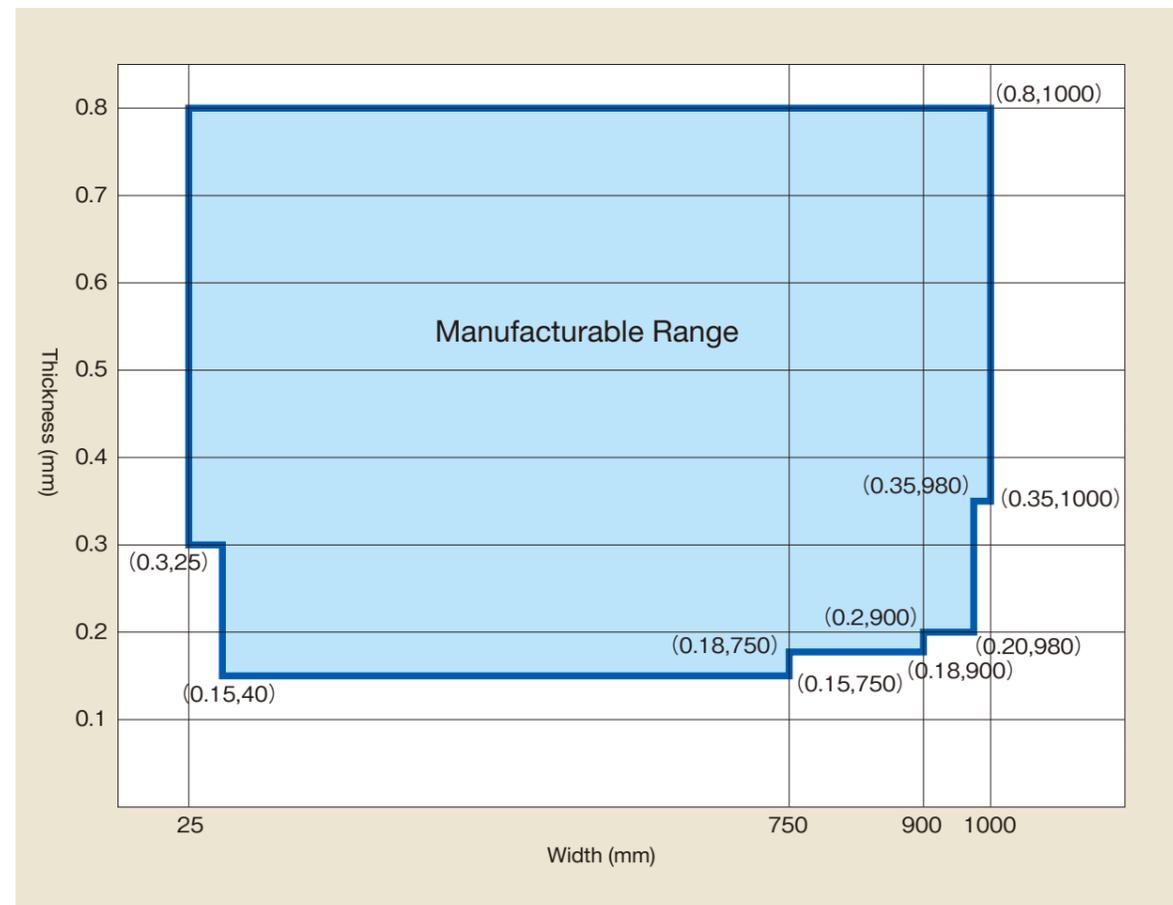
※Consult us if you request for oil application.

Trade weight

SUPERNICKEL is basically traded on the basis of actual weighed volume.

※Consult us if you request for trade on the basis of calculated weight.

Size



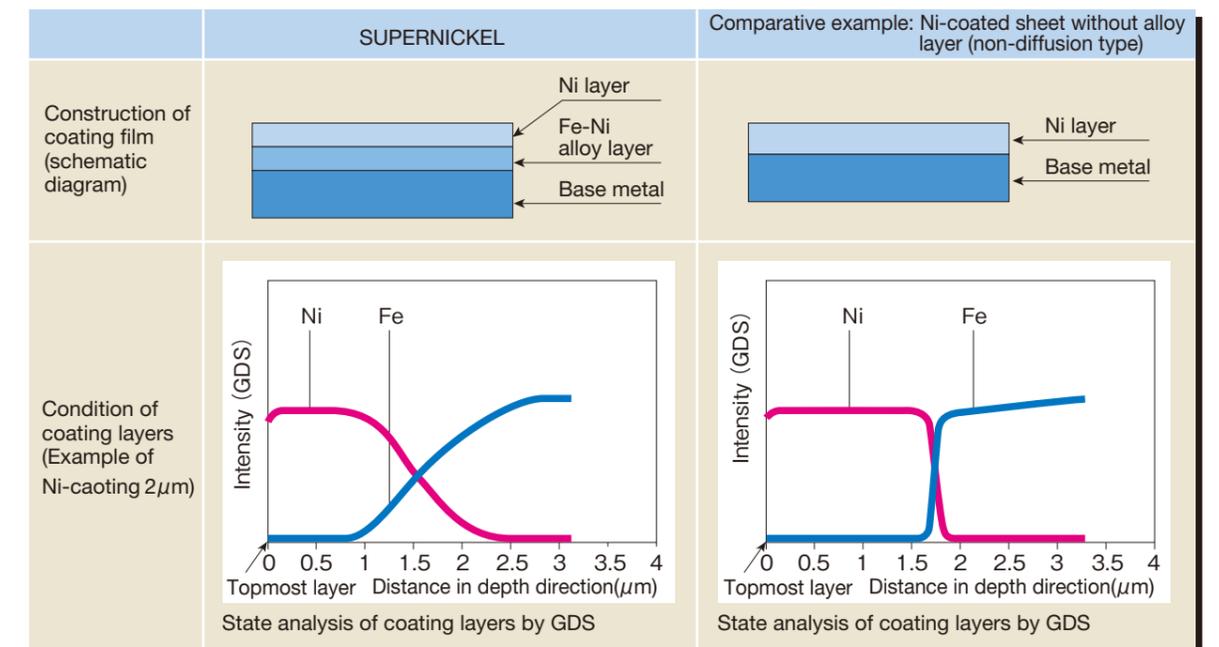
* Since manufacturing methods vary according to specifications, consult us if you wish to have sheets of less than 0.25 mm in thickness.

Characteristics

NIPPON STEEL's SUPERNICKEL Ni-coated Steel Sheets

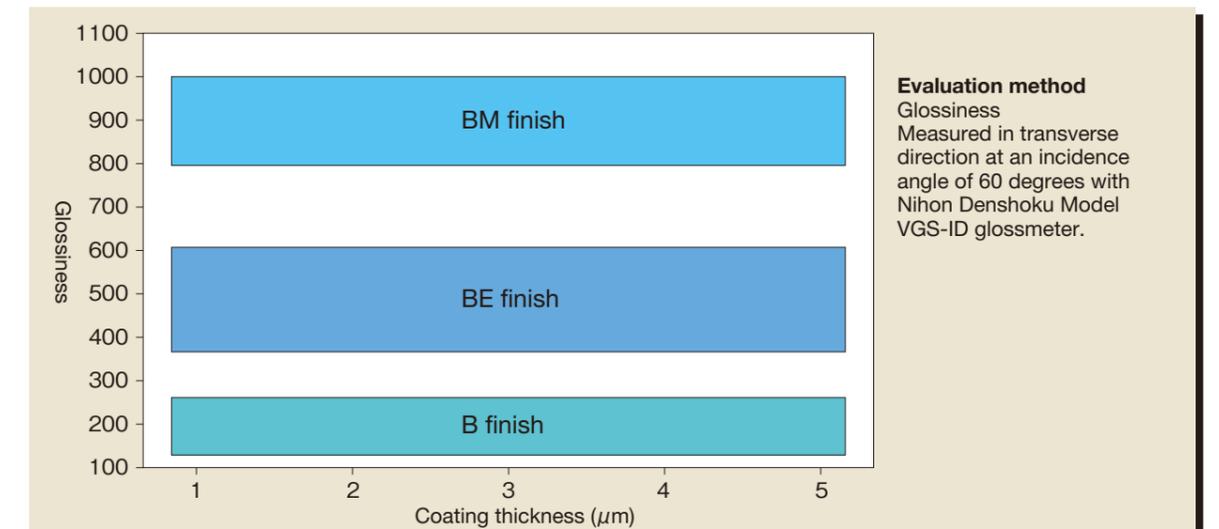
NIPPON STEEL's SUPERNICKEL Ni-coated steel sheets have an attractive gloss finish, and an Fe-Ni alloy layer on their surface imparts excellent coating adhesion and corrosion resistance to them. In addition, selection of the Ni coating thickness and surface finish give better heat resistance.

Construction of coating film



1 Surface Gloss

Glossiness of surface finish



Characteristics

2 Coating Adhesion (workability)

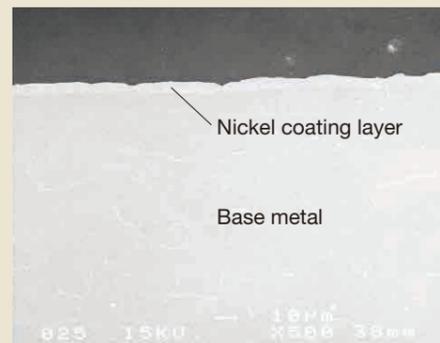
An example of evaluation of coating adhesion (workability)

| | | SUPERNICKEL | Comparative example: Ni-coated sheet without alloy layer (non-diffusion type) |
|------------------------------------|---------------|---|---|
| Coating adhesion (tape peeling) | Bending test | ◎(No peeling found) | △ (Peeling found) |
| | Erichsen test | ◎(No peeling found) | ◎(No peeling found) |
| | Cupping test | ◎(No peeling found) | △(Peeling found) |
| Work follow (SEM observation) | Bending test | ○ (Virtually no cracks found) | ×(Many cracks found) |
| | Erichsen test | ○(Virtually no cracks found) | ×(Many cracks found) |
| Test Methods | Bending test | A cellophane tape on the coating is peeled after 0T bend. | |
| | Erichsen test | A cellophane tape on the coating is peeled after a 7mm-deep cup is formed. | |
| | Cupping test | Cellophane tapes on the inside and outside are peeled after a 30mm-deep cup is drawn. | |

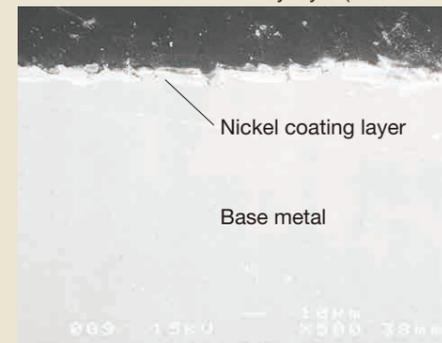
State of coating layer after cupping (coating thickness: 2μm)

1) State of coating layer as seen from the cross sectional micrograph (can body surface)

SUPERNICKEL

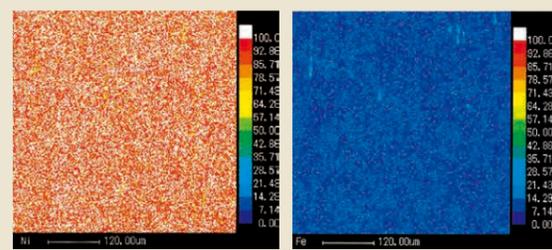


Comparative example:
Ni-coated sheet without alloy layer (non-diffusion type)

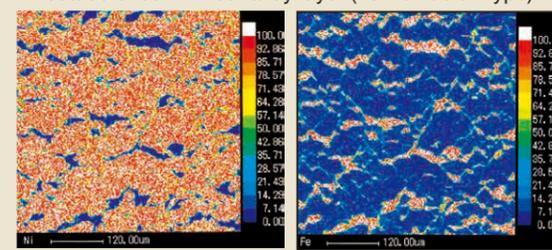


2) State of coating layer after fabrication - EPMA analysis results of Fe, Ni distribution -

SUPERNICKEL



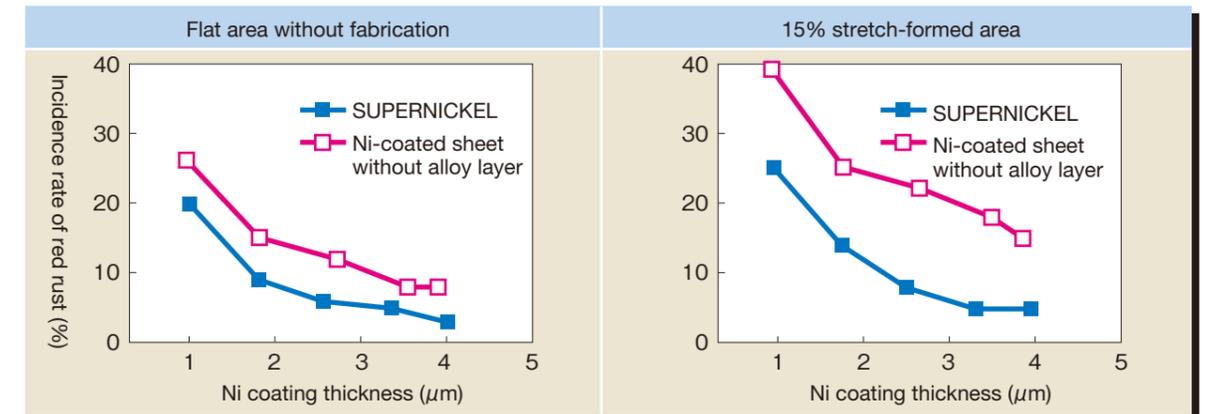
Comparative example:
Ni-coated sheet without alloy layer (non-diffusion type)



3 Corrosion Resistance of As-coated Flat Sheet Without Fabrication

Result of SST (salt spray test) (Incidence rate of red rust in SST6H)

※SST: Pursuant to JIS Z 2371



SUPERNICKEL steel sheet shows better corrosion resistance than Ni-coated steel sheet without alloy layer on both unfabricated and fabricated parts due to ① reduced pinholes on the coating layer, ② formation of an Fe-Ni alloy layer having good adhesion, and ③ improved ductility due to recrystallization and softening of the Ni coating layer.

4 Post-fabrication Corrosion Resistance

External appearances of the top and body parts of size C and AA batteries made of SUPERNICKEL steel sheets and Ni-coated sheets without alloy layer, after subjected to 60 minutes of salt spray tests are shown below. In both cases, batteries made of SUPERNICKEL steel sheet shows better post-fabrication corrosion resistance.

External appearances after SST (coating thickness: 2μm)

※SST: Pursuant to JIS Z 2371

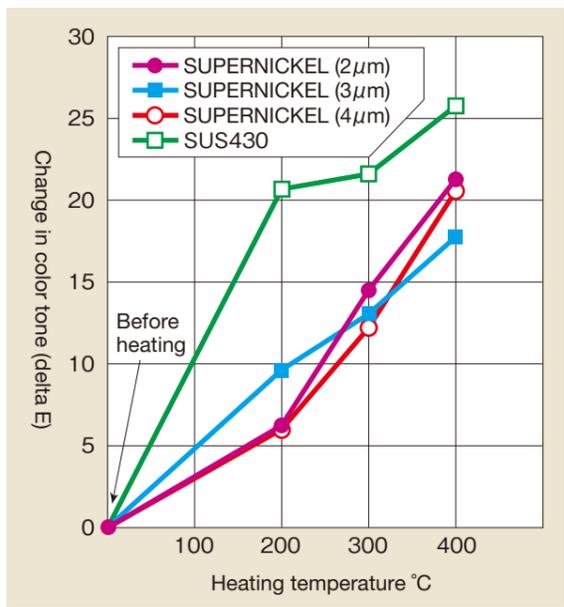
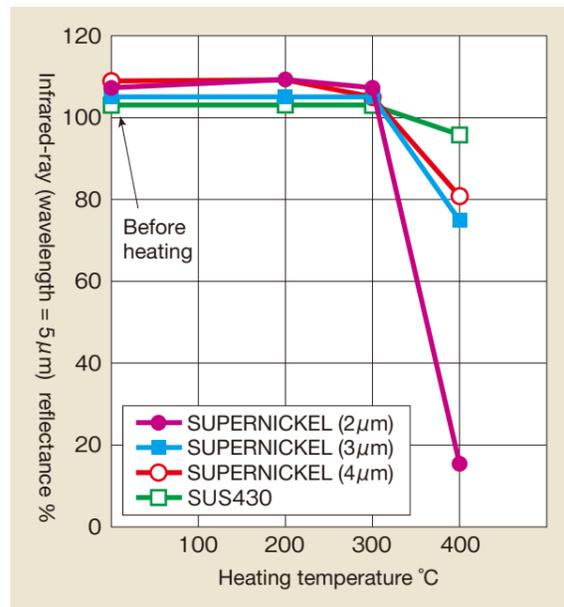
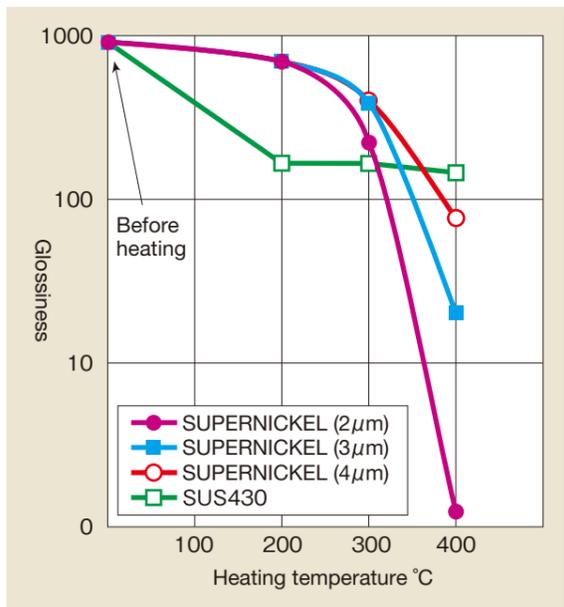
| | | Top | Body |
|--------------------------------------|-------------------------------------|-----|------|
| Fabricated into size C batteries | SUPERNICKEL | | |
| | Ni-coated sheet without alloy layer | | |
| Fabricated into size AA batteries | SUPERNICKEL | | |
| | Ni-coated sheet without alloy layer | | |

Characteristic

5 Heat Resistance

SUPERNICKEL steel sheet has heat resistance comparable to stainless steel (SUS) that is normally used as a heat-resistant material (heating temperature ~300°C). As typical evaluation results of heat resistance, changes in glossiness, changes in infrared-ray reflectance and changes in color tone on heating are shown below.

Typical evaluation results of heat resistance of SUPERNICKEL



(Evaluation method)

Test specimens:
 SUPERNICKEL Surface finish; BM, Ni coating thickness (2,3,4 μm)
 Stainless steel SUS430 (commercially available 18Cr stainless steel), mirror finished

Heating method:
 Heated for 24 hours at each temperature in electric furnace.

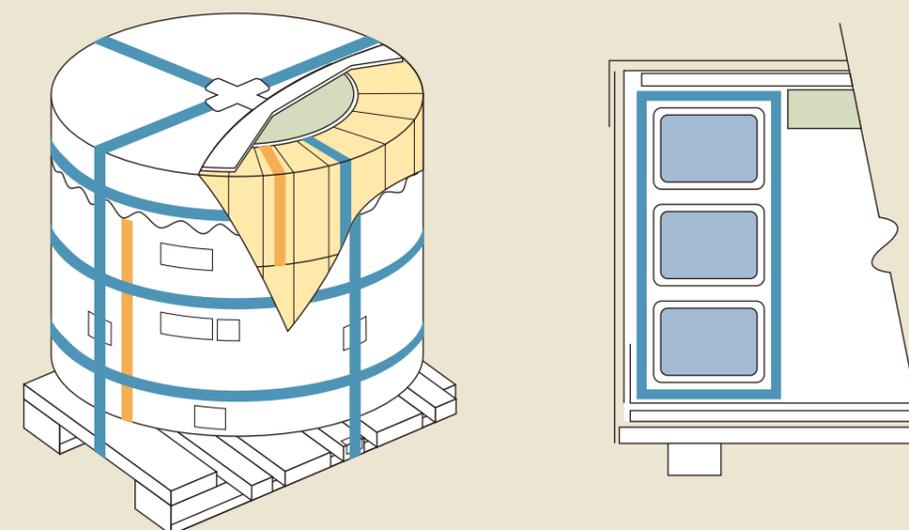
Evaluation method:
 Glossiness Measured at an incidence angle of 60° in transverse direction with Nihon Denshoku Model VGS-ID glossmeter.
 Infrared-ray reflectance Measured using FT-IR instrument (Perkin Elmer Auto Image Spectrum-2000) with the regular reflection method (incidence angle: 16°) in transverse direction. Relative value with the background TiN surface (mirror finish) as 100%
 Changes in color tone Color difference (delta E) before and after heating was measured with Minolta CR-3000 color difference meter.

Packing and Marking

Packing

Each coil is covered with several kinds of packing paper to prevent scuffing and water infiltration, the outside surfaces protected with steel sheets, placed on wooden skid, and bundled with hoops, with special attention paid in preventing dent and rusting.

[Typical Coil Packing (Hoop products)]



Marking

A label clearly stating the manufacturing history of the product is affixed to the outside surface of each package. A package card stating same items is also placed inside the package.

Display Items on Label and Package card

- Classification and steel type symbol
- Dimensions (thickness and width)
- Surface finish
- Weight
- Date of manufacture
- Nickel coating weight (thickness)
- Temper grade
- Inspection number

Precautions for Use

We are confident that excellent properties of SUPERNICKEL steel sheet meet customers' needs, but when you use SUPERNICKEL, you are requested to observe the following precautions to make full use of its advantages.

Storage and Cargo Handling

Wetting during handling and storage may cause rusting. Use care to avoid dew condensation and handling in the rain. Storage in a dry, clean indoor space is recommended. Use special care to prevent dew condensation during storage after unpacking. It is recommended that uncoiled products be stored with extreme care and used as soon as possible.

Handling

Handle with care not to cause damage to the coating. Keep the surface clean since perspiration, fingerprints and other contamination may cause rusting or painting defects.

Fabrication

Select a proper material (temper grade) according to the method and degree of fabrication. For severe fabrication, such as spinning, use of a material (temper grade) best suited to your fabricating need is recommended. Fabricating under proper conditions for a specific thickness leads to satisfactory results.

Welding

In resistance welding, a prolonged use of welding electrodes may contaminate them due to buildup of coating metal. Appropriate conditioning or replacement of the electrodes is needed.

Degreasing

For degreasing, weak alkaline type detergent, neutral detergent, organic-solvent degreasing agent, etc., can be used.

Painting

Roller, spray, immersion and various other coating methods can be used.

Ordering Information

When placing an order, let us know your requirements as listed below.

(1) Specifications of steel sheet: Thickness, width, temper grade, coating weight, surface finish, oiling, etc.

(2) Applications and conditions -

applications

Service conditions (such as a heat-resistant application)

Fabricating conditions (such as the method and degree of fabrication)

Coil (hoop) or sheet

Other special requirement

(3) Quantity

(4) Delivery

● When ordering SUPERNICKEL, or for further technical information, contact our sales personnel, who are ready to respond to customers' inquiries.