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ALSHEET™

Hot-dip aluminum-coated steel sheets

Steel
Sheet



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ALSHEET™
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NIPPON STEEL CORPORATION

Introduction

ALSHEET™ is a cold-rolled steel that has been hot-dipped in an aluminum/silicon alloy. It offers the attractive surface of processed steel sheet that simultaneously affords some of the features of aluminum, such as resistance to corrosion, attractive appearance, coupled with superior heat resistance and heat reflection, cold-rolled steel's mechanical attributes and other physical characteristics.

We have been manufacturing hot-dip aluminum-coated steel sheets under the name “ALSHEET™” since July 1961, and it has been widely adopted thanks to its superior features, such as for vehicle mufflers (silencers), toasters, and gas cookers.

In recent years, there have been calls for the development of materials to succeed stainless steel sheets to cope with exhaust gas restrictions, and inexpensive materials in order to cut costs, and accordingly the demand for ALSHEET™ with improved heat resistance performance has grown in these fields as well.

We have recently developed further improvements to our products in terms of heat resistance, strength at high temperature, colorfastness, and corrosion resistance, and have extended our product lineup to meet the ever-diversifying needs of today's market.

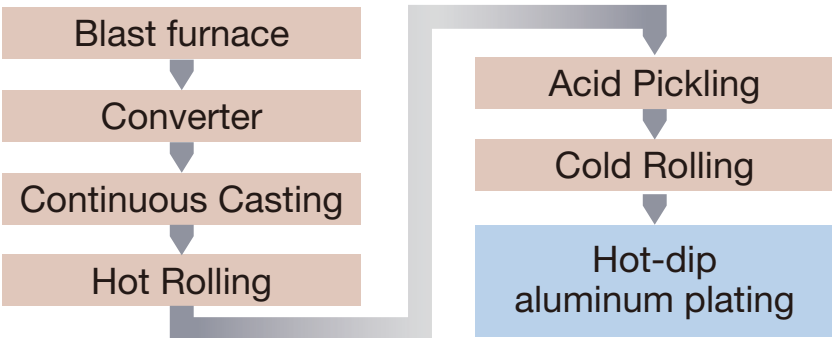
Contents

| | |
|---------------------------------------|----|
| Manufacturing Process | 1 |
| Product Usage Examples | 2 |
| List of Manufacturing Standards | 4 |
| Quality Attributes | 6 |
| Size Availability | 13 |
| ALSHEET Pipe | 15 |
| Cautions for Use | 18 |
| Order Guidelines | 19 |
| Packaging and Labeling | 20 |
| Unit Mass Table for Sheets | 21 |

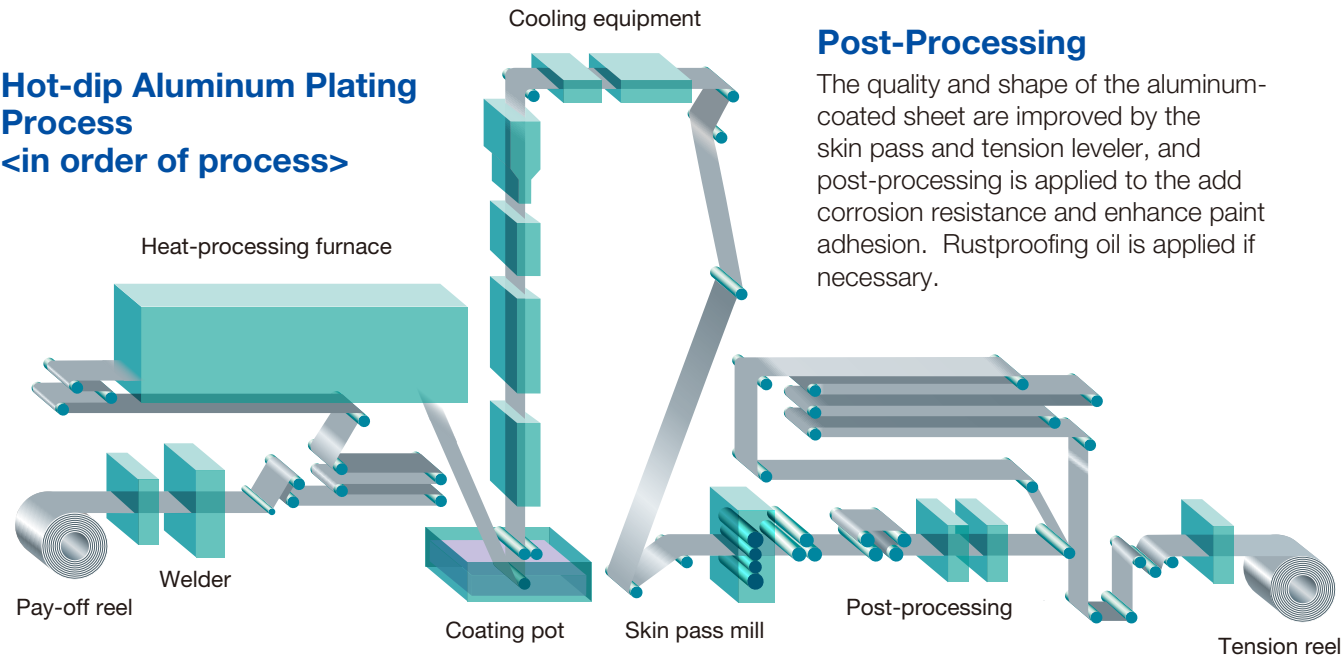
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Manufacturing Process

Overall manufacturing process



Hot-dip Aluminum Plating Process <in order of process>



Post-Processing

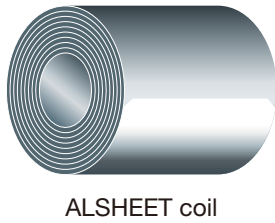
The quality and shape of the aluminum-coated sheet are improved by the skin pass and tension leveler, and post-processing is applied to the add corrosion resistance and enhance paint adhesion. Rustproofing oil is applied if necessary.

Heat Processing

In the heat-processing furnace, coils used for the base metal are subjected to surface treatments such as the cleansing of rolling oil and other deposits and the removal of oxides. Then, after being fully reheated, the coils undergo material property adjustments such as recrystallization.

Coating

After the surfaces of the base metal are cleaned, the coils are immersed in an aluminum galvanizing tank whose main component is aluminum to provide the coating. The coating mass is adjusted by means of gas wiping to ensure an even coating mass and beautiful appearance.



ALSHEET™ types and heat-resistance characteristics

| Type | Heat resistant | High strength | Colorfastness at high temperature | Colorfastness at high temperature II |
|---------------------------------|----------------|---------------|-----------------------------------|--------------------------------------|
| Heat resistance | | | | |
| Heat resistant (°C) | 500~600 | 500~600 | 550 | 500 |
| Changing color temperature (°C) | 300~350 | 300~350 | 550 | 500 |

Product Usage Examples



Standards

1. Types

• JIS G 3314-2018 (abstract) Hot-dip aluminum-coated steel sheets and bands

| Type | Application | |
|------|--------------------------------------|------------------------------|
| | Main use | Aluminum coating designation |
| SA1C | Heat resistance (commercial) | 40, 60, 80, 100, 120 |
| SA1D | Heat resistance (drawing) | |
| SA1E | Heat resistance (deep drawing) | |
| SA1F | Heat resistance (ultra-deep drawing) | |

• NIPPON STEEL Product Standards

| Type | Application | |
|------------|--------------------------------------|------------------------------|
| | Main use | Aluminum coating designation |
| NSA1C | Heat resistance (commercial) | 040, 060, 080, 100, 120 |
| NSA1D | Heat resistance (drawing) | |
| NSA1E | Heat resistance (deep drawing) | |
| NSA1F | Heat resistance (ultra-deep drawing) | |
| NSA1D-P | Colorfastness at high temperature | |
| NSA1D-PQ | Colorfastness at high temperature II | |
| NSA440R | High strength (TS=440 class) | |
| NSA590 | High strength (TS=590 class) | |
| NSSQAS1500 | Hot stamp | 80, 160, etc. |

2. Aluminum coating mass (NIPPON STEEL Product Standards)

| Aluminum coating designation | 040 | 060 | 080 | 100 | 120 | 160 |
|--|-----|-----|-----|-----|-----|-----|
| Minimum coating mass (both sides, triple-spot method) g/m ² | 40 | 60 | 80 | 100 | 120 | 160 |
| Minimum coating mass (both sides, Single-spot method) g/m ² | 30 | 45 | 60 | 75 | 90 | — |

3. Surface treatment (NIPPON STEEL Product Standards)

| Type | Main uses | Code | Remarks |
|-------------------------|------------------------------|------|---|
| Untreated | | M | — |
| Chromate-free treatment | Corrosion resistant | QM | Mainly domestic electrical appliances. Color remains stable after heating. Recommended by FDA |
| | Enhance corrosion resistance | QN | Mainly automobiles |

5. Dimensional tolerance (NIPPON STEEL Product Standards)

Thickness tolerance

| Width | | <1,000 | 1,000≤t≤1,250 |
|-------------|--|--------|---------------|
| Thickness | | | |
| <0.40 | | ±0.06 | ±0.06 |
| 0.40≤t<0.60 | | ±0.07 | ±0.07 |
| 0.60≤t<0.80 | | ±0.09 | ±0.09 |
| 0.80≤t<1.00 | | ±0.10 | ±0.11 |
| 1.00≤t<1.20 | | ±0.11 | ±0.12 |
| 1.20≤t<1.60 | | ±0.13 | ±0.14 |
| 1.60≤t<2.00 | | ±0.15 | ±0.16 |
| 2.00≤t<2.30 | | ±0.17 | ±0.18 |
| 2.30≤ | | ±0.20 | ±0.21 |

4. Oil coating

| Code | Type |
|------|--------------------|
| H | High oil coating |
| N | Normal oil coating |
| L | Low oil coating |
| X | No oil coating |

Width Tolerance

(units: mm)

| Classification | Tolerance |
|----------------|-----------|
| Width | -0, +7 |

Notes:

- 1. Nominal thickness refers to the thickness after coating
- 2. Thickness shall be measured from an optimal spot at least 50 mm inside the edge.

6. Mechanical Properties

• JIS G 3314-2018 (abstract) Hot-dip aluminum-coated steel sheets and bands

| Code | Tensile strength (N/mm ²) | Tensile test | | | |
|------|---------------------------------------|------------------------|-------------|-------------|-------|
| | | Elongation (%) | | | |
| | | Nominal thickness (mm) | | | |
| | | 0.30≤t<0.40 | 0.40≤t<0.60 | 0.60≤t<1.00 | 1.00≤ |
| SA1C | (270≤) | — | — | — | — |
| SA1D | 270≤ | (28≤) ① | 30≤ ② | 32≤ | 34≤ |
| SA1E | 270≤ | — | 34≤ ② | 36≤ | 38≤ |
| SA1F | 270≤ | — | 35≤ ② | 37≤ | 39≤ |

Note: Tensile test samples must conform to JIS 5.

| Code | Bending angle | Bending properties | |
|------|---------------|---|---|
| | | Internal spacing of bends | |
| | | Nominal thickness (mm) | |
| | | <1.60 | 1.60≤ |
| SA1C | 180° | Double-sheet product with nominal thickness | Double-sheet product with nominal thickness |
| SA1D | 180° | Single-sheet nominal thickness | Double-sheet product with nominal thickness ③ |
| SA1E | 180° | Single-sheet nominal thickness | Double-sheet product with nominal thickness ③ |
| SA1F | 180° | Single-sheet nominal thickness | Double-sheet product with nominal thickness ③ |

• NIPPON STEEL Product Standards

| Code | Tensile strength (N/mm ²) | Tensile test | | | |
|------------|---------------------------------------|------------------------|-------------|-------------|-------|
| | | Elongation (%) | | | |
| | | Nominal thickness (mm) | | | |
| | | 0.30≤t<0.40 | 0.40≤t<0.60 | 0.60≤t<1.00 | 1.00≤ |
| NSA1C | (270≤) | — | — | — | — |
| NSA1D | (270≤) | (28≤) ① | 30≤ ④ | 32≤ | 34≤ |
| NSA1E | 270≤ | — | 34≤ ④ | 36≤ | 38≤ |
| NSA1F | 270≤ | — | 35≤ ④ | 37≤ | 39≤ |
| NSA1D-P | 270≤ | — | 30≤ | 32v | 34≤ |
| NSA1D-PQ | 270≤ | — | 30≤ | 32≤ | 34≤ |
| NSA440R | 440≤ | — | 25≤ | 27≤ | 28≤ |
| NSA590 | 590≤ | — | — | — | 18≤ |
| NSSQAS1500 | — | — | — | — | — |

Note: Tensile test samples must conform to JIS 5.

| Code | Bending angle | Bending properties | |
|-------|---------------|---|---|
| | | Internal spacing of bends | |
| | | Nominal thickness (mm) | |
| | | <1.60 | 1.60≤ |
| NSA1C | 180° | Double-sheet product with nominal thickness | Double-sheet product with nominal thickness |
| NSA1D | 180° | Single-sheet nominal thickness | Double-sheet product with nominal thickness ⑤ |
| NSA1E | 180° | Single-sheet nominal thickness | Double-sheet product with nominal thickness ⑤ |
| NSA1F | 180° | Single-sheet nominal thickness | Double-sheet product with nominal thickness ⑤ |

①In cases where the coating designation is 120≤, the nominal thickness may be 26≤, if an agreement is reached between the delivering and accepting parties.

②In cases where the coating designation is 120≤, the nominal thickness may be 28≤ for SA1D, 32≤ for SA1E, and 33≤ for SA1F, if an agreement is reached between the delivering and accepting parties.

③In the case of SA1D, SA1E and SA1F, the internal spacing of bends may be single-sheet product of nominal thickness, if an agreement is reached between the delivering and accepting parties.

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⑤In the case of NSA1D, NSA1E and NSA1F, the internal spacing of bends may be single-sheet product of nominal thickness, if an agreement is reached between the delivering and accepting parties.

Quality Attributes

1.External appearance

The coating mass on our ALSHEET products is controlled using the wiping method, resulting in an even surface with a beautiful finish.

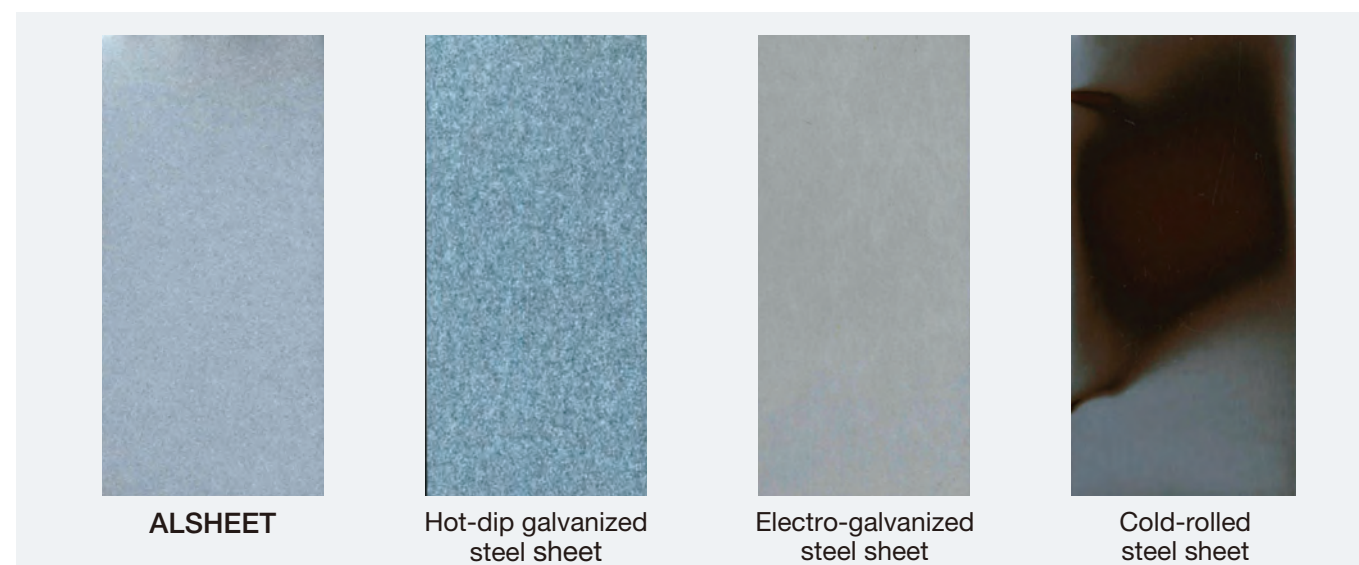
2.Heat resistance

The external appearance of ALSHEET at high temperature is much better than hot-dip galvanized steel sheet and cold-rolled steel sheet, and the surface does not discolor up to 300~350°C.

At higher temperature, the surface forms an Al-Fe alloy, of a different color, but this prevents the base metal from oxidizing, so its heat resistance is retained.

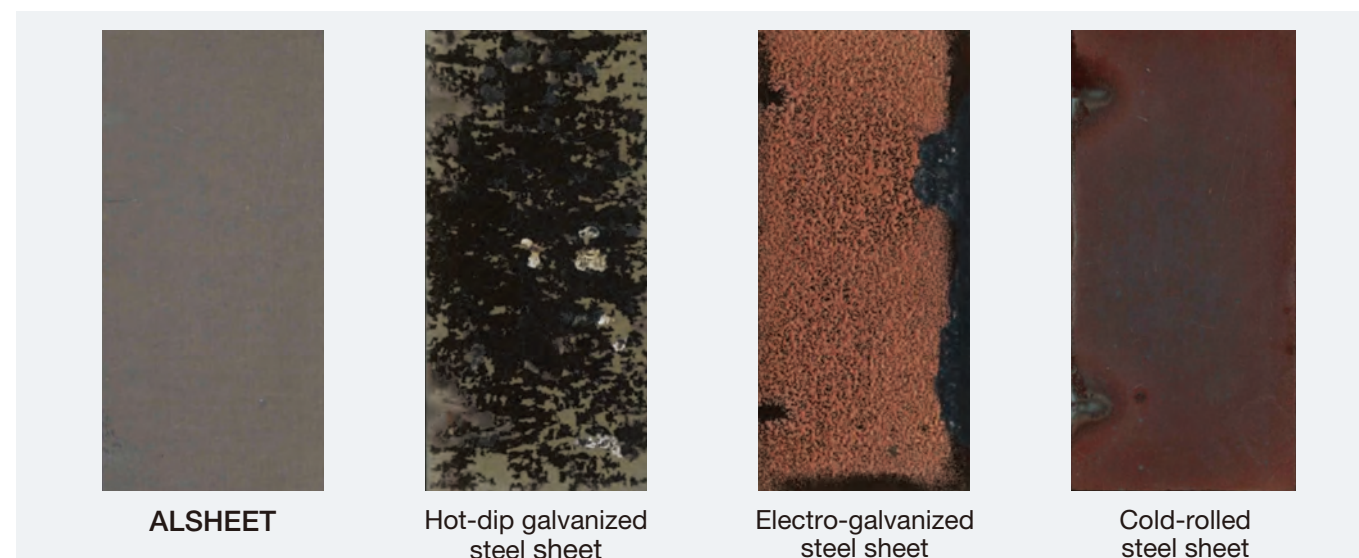
• Surface condition after heating [As an example] (35°C×200hours)

The surface color of ALSHEET does not change after heating at up to 350°C, and maintains its beautiful appearance.



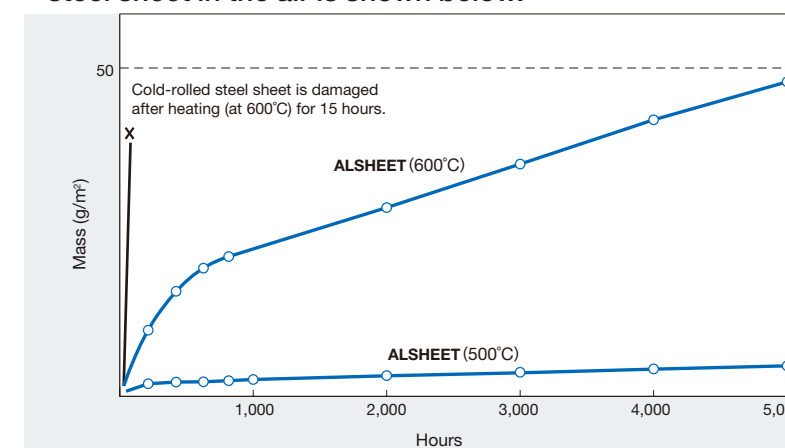
• Oxidization resistance (600°C × 200 hours)

Flakes of oxidized metal do not form even after heating the ALSHEET at up to 600°C.



• Change in mass when heated (up to 600°C)

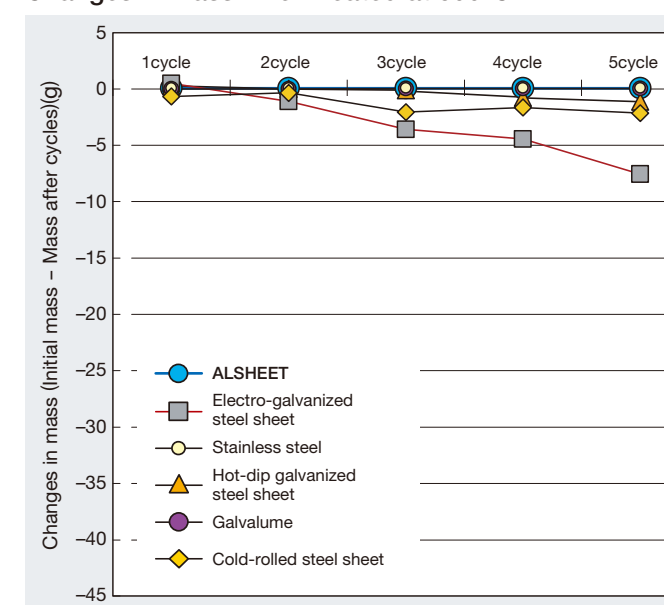
An example of the change in mass when continuously heating ALSHEET and cold-rolled steel sheet in the air is shown below.



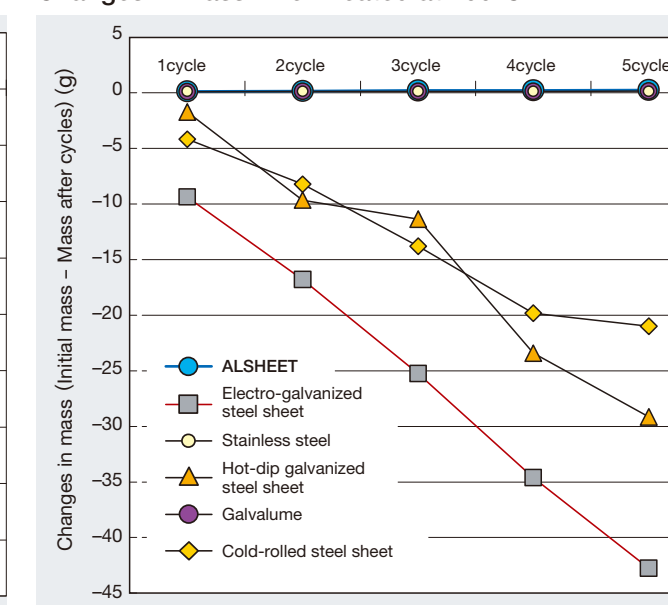
• Changes in mass when heated (at 600°C, at 700°C)

Heat cycle: Normal temperature ⇒ Heating ⇒ Kept at the specified temperature for 48 hours ⇒ Air cooled ⇒ Normal temperature (Maximum: Five cycles)

Changes in mass when heated at 600°C



Changes in mass when heated at 700°C



3.Heat reflectivity

The heat reflectiveness of ALSHEET is outstanding, as its surface is very smooth, demonstrating 80% heat reflection at temperatures up to 450°C. Accordingly, it is well suited for use as a heat shield panel in toasters and the top reflector for gas ovens and oil stoves that operate more effectively with heat reflection.

• Heat reflectivity of various materials [As an example]

(unit: %)

| Item | Material Test condition | ALSHEET | NS Zinc chromate coat (Electro-galvanized steel sheet) | Electro-galvanized steel sheet | |
|----------------------|----------------------------|---------|---|--------------------------------|-----------------------|
| | | | | Aluminum coating designation | Zero spangle material |
| Heat reflection rate | 100°C×24Hr | 90 | 95 | 95 | 95 |
| | 400°C×24Hr | 80 | 30 | 20 | 20 |

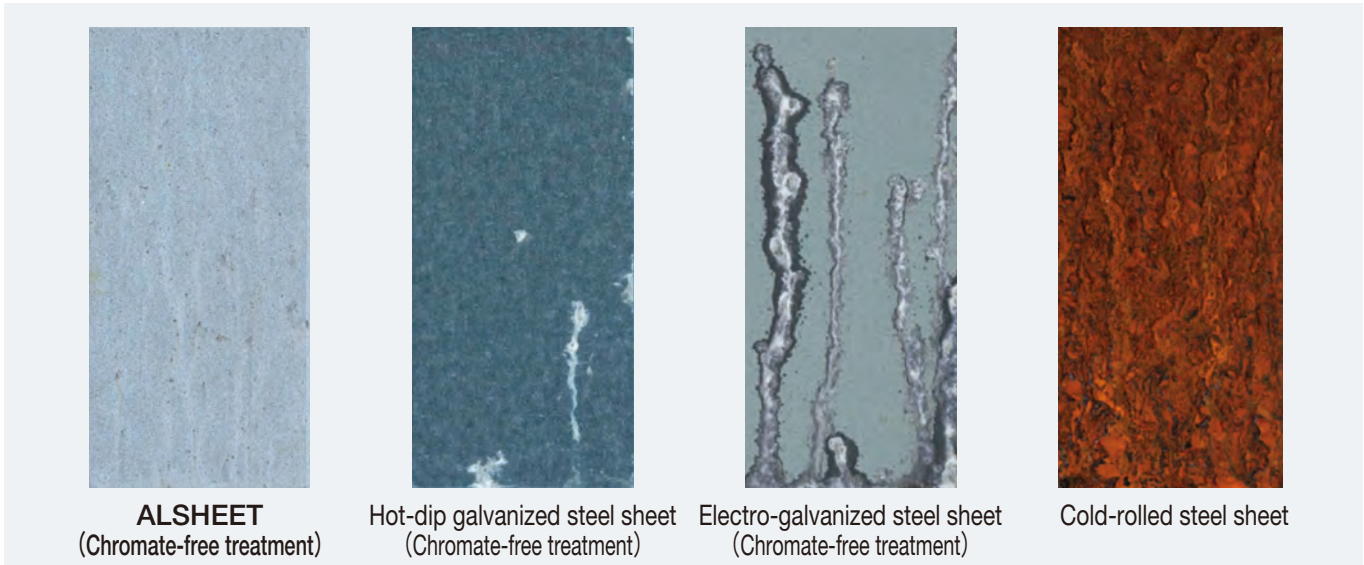
- Measured at normal temperature after heating
- Using D&S AERP emissometer (Measured wavelength: 3~30μm)

4. Corrosion resistance

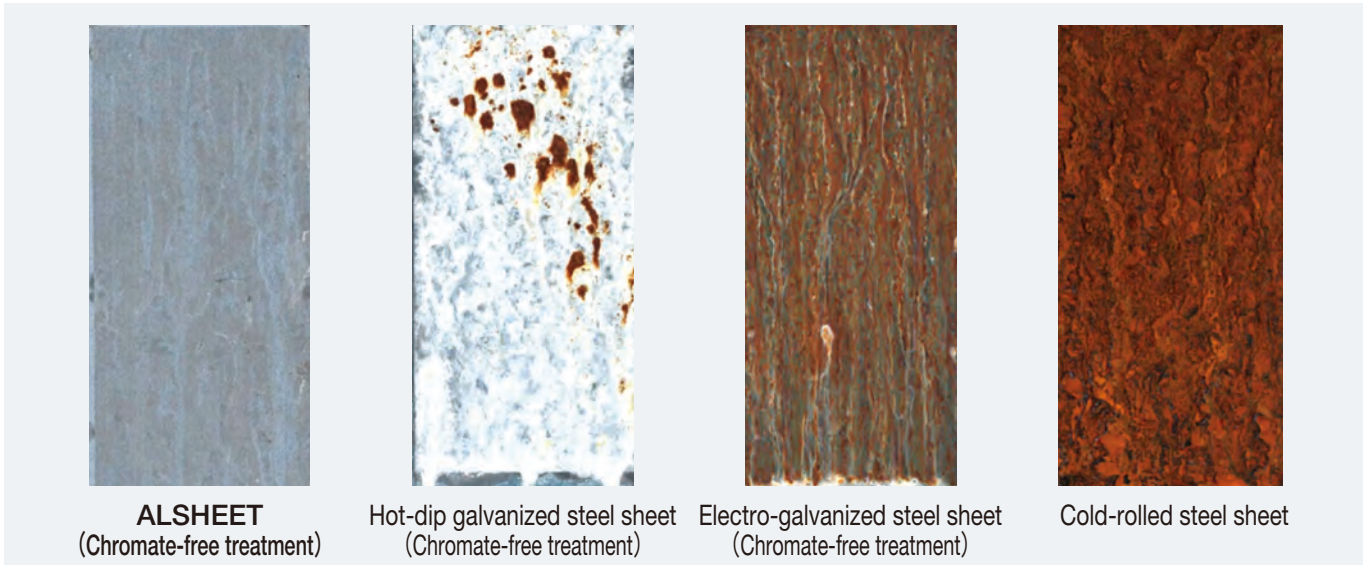
ALSHEET affords better corrosion resistance than galvanized steel sheet under various conditions because microscopic and stable oxide or hydroxide films readily form in air or water, in the same way as aluminum. However, unlike galvanized steel sheet, this product does not designed to provide galvanic reactions (sacrificial corrosion as a preventative measure), so care must be taken in how it is used. Its corrosion resistance under various conditions is presented below.

4-1. Saltwater spray test assessment

• External appearance examples after saltwater spray test (after SST 168 hours)



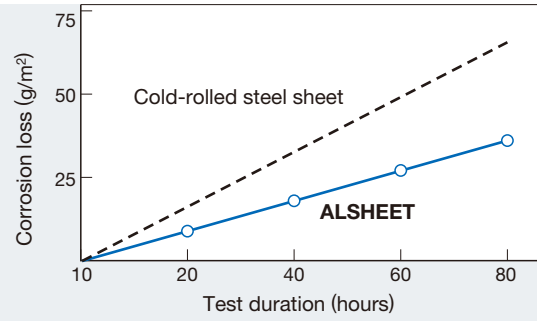
• External appearance examples after saltwater spray test (after heating at 300°C × 200 hours+SST168 hours)



4-2. Example of resistance to gaseous sulfur oxides

ALSHEET's resistance to gaseous sulfur oxides is much better than galvanized steel sheet and cold-rolled steel sheets. Test results for resistance to gaseous sulfur oxides are shown on the right as an example.

Notes: Test conditions
SO₂ density: 400 ppm
Air + SO₂ flow: 20 l/min.
Temperature: 40°C
Humidity: 95~100%



4-3. Cyclical wet/dry test (Corrosion resistance to exhaust gases)

As per the results of the corrosion resistance test to automotive exhaust gases using condensate simulated solution, ALSHEET demonstrates better corrosion resistance than electro-galvanized steel sheet and cold-rolled steel sheet.

• Muffler test result examples

(Chrysler' Spec 461H-83) (With cold-rolled steel sheet data benchmarked as 100)

| Type | Corrosion rate (%) | |
|---|--------------------|-----|
| | 50 | 100 |
| 18%Cr Stainless steel | 22.9% | |
| 13%Cr Stainless steel | 27.5% | |
| ALSHEET 80g/m² | 30.1% (16µm) * | |
| Electro-galvanized steel sheet 20/20 g/m² | 92.8% (80µm) * | |
| Cold-rolled steel sheet | 100% (87µm) * | |

* : Numeric values in parentheses show reduction in thickness

Muffler test method
1) Immerse test pieces in a mixed solution of 0.01N hydrogen bromide (HBr) – 0.05N sulfuric acid (H₂SO₄) at 180°F (82°C) for five seconds.
2) Remove and hang in the air to dry for an hour.
3) Repeat processes 1) and 2) above twenty times.
4) Then heat in a furnace at atmospheric temperature of 1,000°F (538°C) for two hours.
5) Remove from furnace and allow to cool in air.
6) Repeat the above processes 1) to 5) another 24 times. (Total 25 times)
7) Finally, remove any corrosion from the test pieces, weigh them, and calculate the corrosion rate by comparing the difference with the sample weight before implementing the test.

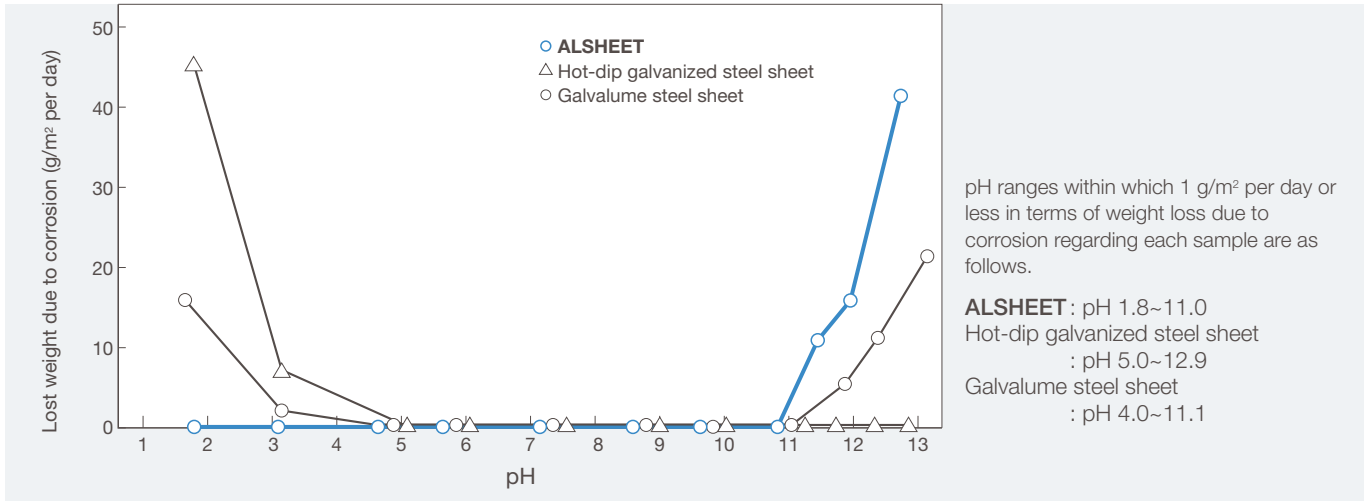
5. Chemical resistance

Aluminum is strongly resistant to mild acidity but weak against alkaline reagents, in contrast to zinc. Examples showing the weight loss due to corrosion caused by several chemicals are shown below.

(Unit: mg/dm²)

| Test type | ALSHEET | Hot-dip galvanized steel sheet | Cold-rolled steel sheet |
|--|---------|--------------------------------|--------------------------------|
| 16% SO ₂ gas test (96 hours) | 130 | 2,825 | 1,510 |
| 18% NH ₃ gas test (192 hours) | 10 | 180 | 25 |
| 20% HNO ₃ test (30 min.) | 2 | Original form is not retained. | Original form is not retained. |
| 1/10N NaCl + 0.3% H ₂ O ₂ test | 18 | 173 | Red rust over entire surface |

Example of relationship between pH and weight loss due to corrosion

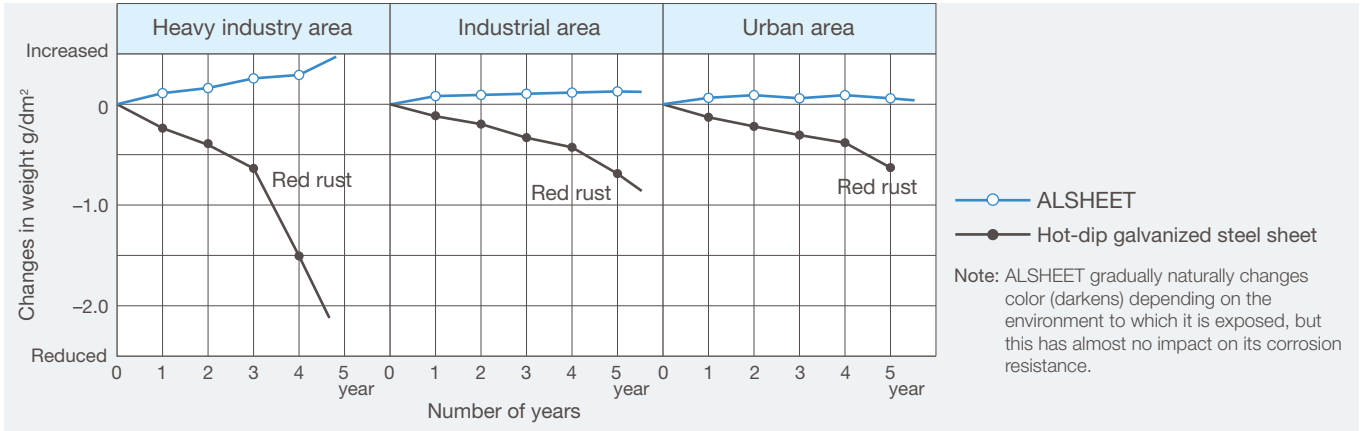


6.Weather resistance

ALSHEET forms a microscopic yet stable oxide film on the surface even in harsh environments, such as industrial areas, and affords outstanding resistance to weather.

• Result examples for ALSHEET outdoor exposure test

Changes in weight of flat sheet as test piece



7.Formability

7-1.Mechanical Property

Mechanical test value examples per grade are shown below.

| Type | Grade | Code | Tensile test | | | Hardness (HRB) | Ranford value (r) |
|-------------------------|--------------|------|------------------------|------------------------|-------|----------------|---------------------|
| | | | YP(N/mm ²) | TS(N/mm ²) | El(%) | | |
| ALSHEET | Commercial | SA1C | 245 | 353 | 38 | 56 | – |
| | Drawing | SA1D | 196 | 314 | 42 | 44 | – |
| | Deep drawing | SA1E | 176 | 304 | 44 | 41 | 1.6 |
| Cold-rolled steel sheet | Commercial | SPCC | 196 | 323 | 43 | 45 | – |

Note: Each of the above materials is based on 0.8-mm examples.

7-2. Press forming

A comparison of drawing limits per grade is shown below. All demonstrate a favorable nature equivalent to cold-rolled steel sheet in the same manner as their mechanical properties.

Example of comparison in drawing limits

| Type | Grade | Code | 2.0 | 2.1 | 2.2 | 2.3 |
|-------------------------|--------------|------|-----|-----|-----|-----|
| ALSHEET | Commercial | SA1C | | | | |
| | Drawing | SA1D | | | | |
| | Deep drawing | SA1E | | | | |
| Cold-rolled steel sheet | Commercial | SPCC | | | | |

Materials used:
Sheet thickness: 0.80 mm
Coating mass: 80 g/m²

Test conditions:
Punch diameter: 60 mm
Punch shoulder diameter: 6.5 mm
Die diameter: 6.6 mm
Die shoulder diameter: 6.5 mm
Lubricant: Press working oil #620

8.Welding

Appropriate conditions for ALSHEET's resistance welding differ slightly from those for cold-rolled steel sheet for both spot welding and seam welding. This is because aluminum itself is soft, flexible, and has good electrical conductivity, so the amount of heat generated within layered sheets is less than with cold-rolled steel sheet.

8-1.Spot welding

- Mechanical test value examples per grade are shown below.
- Better welds can be achieved using electrodes with a smaller edge diameter.
- In terms of the electrode shape, better results can be achieved with a truncated cone type than radial type.
- Increase both the welding current and welding duration.
- Ensure the electrode is clean and allowed to cool down.

Recommended conditions for spot welding

| Type | Sheet thickness (mm) | Electrode | | Welding | |
|-------------------------|----------------------|------------------------|-----------------------|------------------------|--------------|
| | | Edge diameter d (mm ø) | Pressure applied (kg) | Electrical current (A) | Current (kA) |
| ALSHEET | 0.6 | 4.0 | 150 | 8~10 | 6.8~8.7 |
| | 0.8 | 4.5 | 200 | 10~12 | 9.7~12.2 |
| Cold-rolled steel sheet | 0.6 | 3.5 | 175 | 7 | 6.8 |
| | 0.8 | 4.5 | 250 | 8 | 8.0 |

8-2.Seam welding

- Increase current for welding, and reduce pressure applied.
- Narrow the width of the electrode edge by 15~20%.
- In order to prevent aluminum from attaching to the electrode, adopt a knurl-gear driving system to ensure sufficient cooling with water from the top and bottom.

Recommended conditions for seam welding

| Type | Sheet thickness (mm) | Electrode | | Welding | | | |
|-------------------------|----------------------|------------------------|-----------------------|------------------------|---------------|-----------------|--------------|
| | | Edge diameter W (mm ø) | Pressure applied (kg) | Electrical current (A) | Cessation (s) | Speed (cm/min.) | Current (kA) |
| ALSHEET | 0.6 | 4.5 | 200~300 | 4~5 | 3 | 100 | 12.5~15.5 |
| | 0.8 | 5.0 | 200~300 | 4~5 | 3 | 100 | 13.0~16.9 |
| Cold-rolled steel sheet | 0.6 | 5.5 | 275 | 2 | 2 | 180 | 12.0 |
| | 0.8 | 6.0 | 305 | 2 | 2 | 180 | 14.5 |

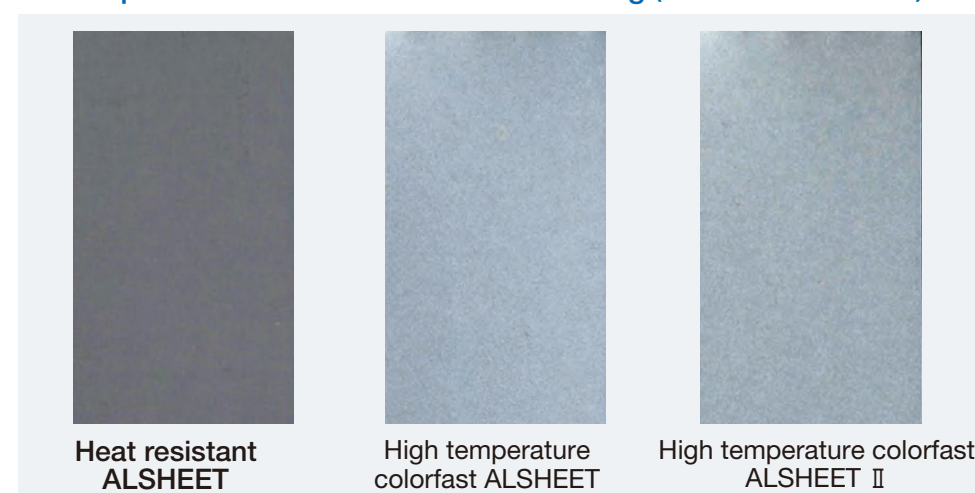
High temperature colorfast ALSHEET (NSA1D-P)

High temperature colorfast ALSHEET does not change color when heated to temperatures up to 500 - 550°C because an assaying restraining element is added to the base metal, which enables it to maintain the original glossiness of aluminum at high temperature.

However, although alloying is restrained, if degreased at temperatures higher than 410°C, the color may change due to degreasing.

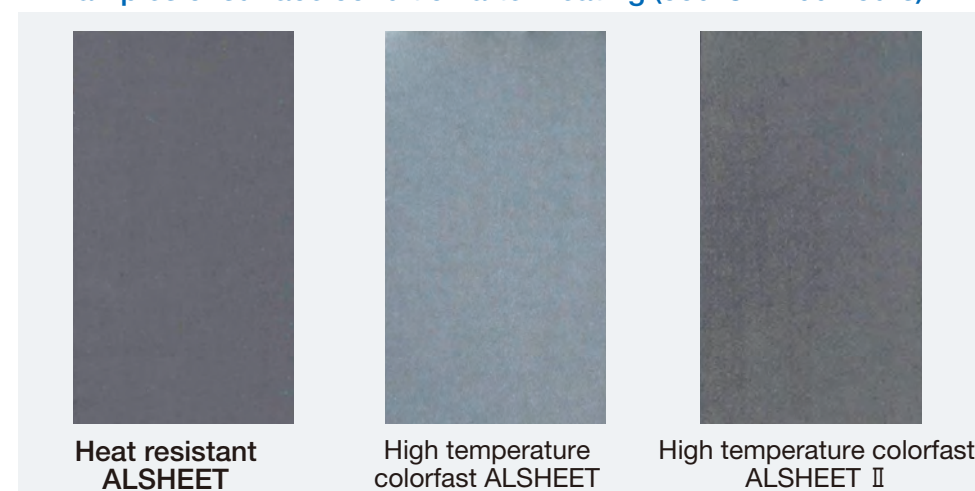
| Materials \ Heating temperature | 250°C | 350°C | 450°C | 500°C | 550°C |
|--|-------|-------|-------|-------|-------|
| High temperature colorfast ALSHEET (NSA1D-P) | ○ | ○ | ○ | ○ | ○ |
| High temperature colorfast ALSHEET (II) (NSA1D-PQ) | ○ | ○ | ○ | ○ | ● |
| Heat resistant ALSHEET (commercial) | ○ | ○ | ● | ● | ● |
| Hot-dip galvanized steel sheet | ○ | △ | ● | ● | ● |
| Electro-galvanized steel sheet | ● | ● | ● | ● | ● |

• Examples of surface condition after heating (500°C × 200 hours)

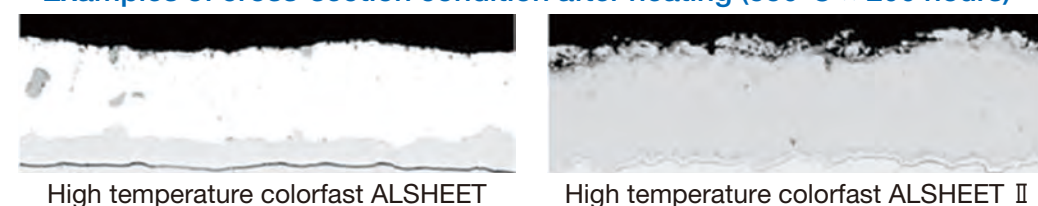


- No change
- △ Significant color change
- Entire surface changes color

• Examples of surface condition after heating (550°C × 200 hours)

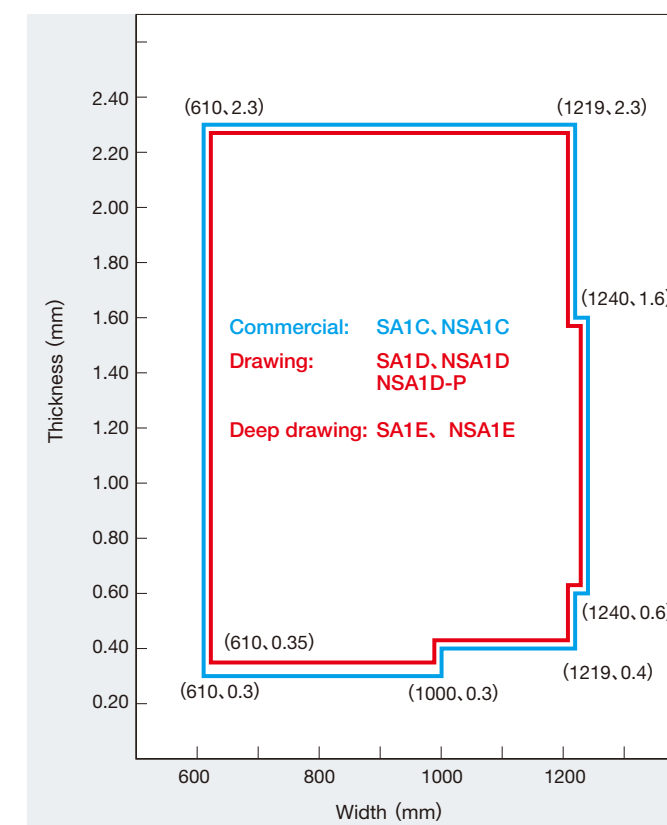


• Examples of cross-section condition after heating (550°C × 200 hours)

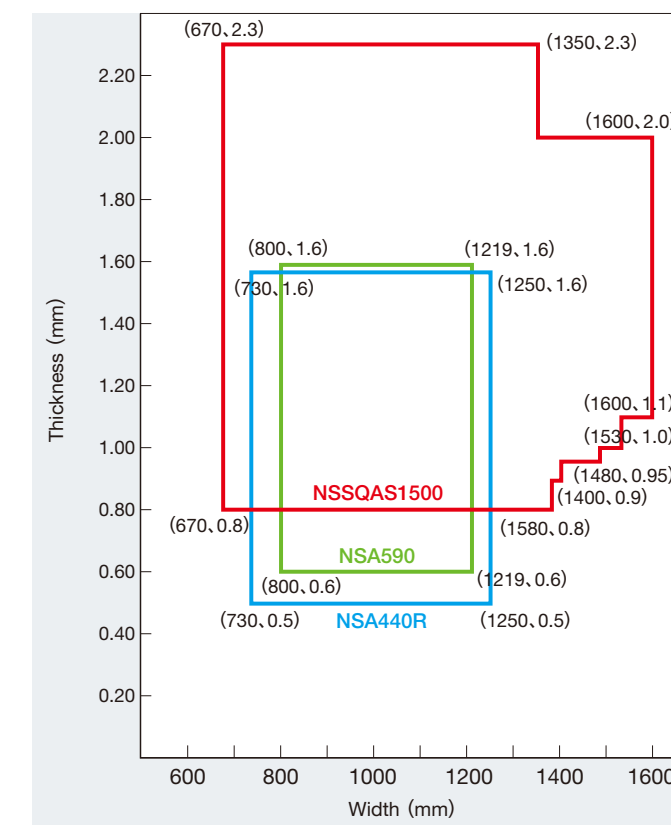


Size Availability

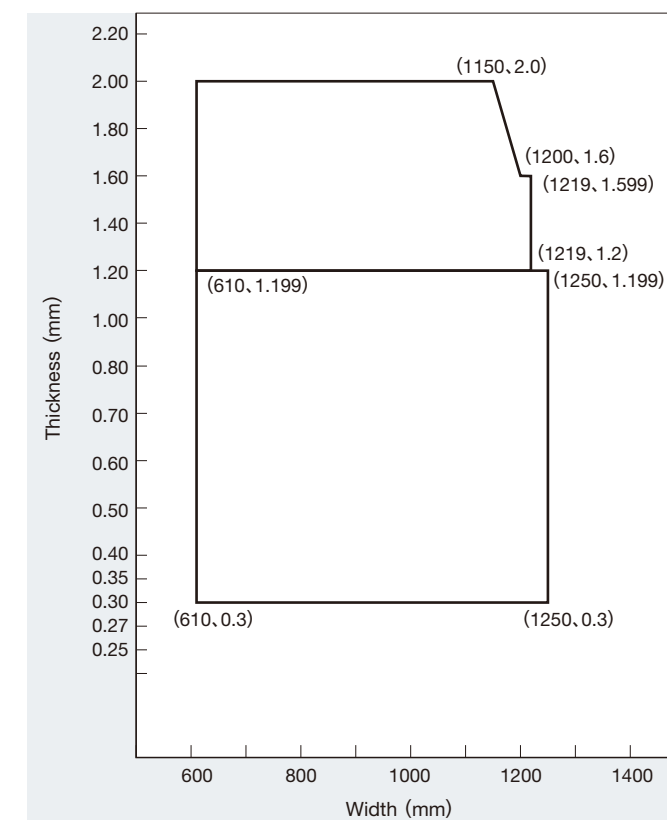
1. Commercial, Drawing, Deep Drawing



2. High Strength, Hot Stamp Drawing




3. Surface Treatment (non-chromate)



Food Hygiene

- ① ALSHEET is composed of elements that are harmless to the human body, namely, Al, Si, and Fe, and there are no concerns about contamination of metals, such as Pb and Cd, in the manufacturing process, so it is well suited to use as a material for food-contact equipment, such as cookers.
 - ② It is approved as material for use in food equipment by the Food & Drug Administration (FDA) in the United States as well.
 - ③ Chromate treatment is normally applied to the surface of aluminum coating to prevent white rust, but this is not desirable for food-contact equipment. A chromate-free (QM) type developed by us for use in domestic electrical appliances passed the elution test specified by the FDA, and received a Recommendation Letter for items that come into contact with food.
- (*) When oil is applied to materials, they must be degreased after processing.



DEPARTMENT OF HEALTH & HUMAN SERVICES Public Health Service

Food and Drug Administration
College Park, MD 20740

November 20, 2009

Dr. Masao Kurosaki
Yawata R&D Lab
1-1 Tobihatacho Tobihata-ku
Kitakyushu-City 804-8501 Japan

Dear Dr. Kurosaki:

This is in response to your inquiry of August 27, 2009, concerning the regulatory status and use of your product (called "ALSHEET-QM"), identified as aluminum plated steel sheet, manufactured by Nippon Steel Corporation. To be more specific, you state that the aluminum plated layer onto the steel consists of 90 - 94 % of aluminum and 6-10 % silicon. The finished product is intended for use in household appliances such as electric oven toasters, rice cookers, micro-wave ovens, etc.

You have identified the components of "ALSHEET-QM" coating as follows:

| Components | CFR Ref. | Comments |
|---------------------------------|--------------------|----------------------|
| Zirconium | 175.300 (176.1 70) | As indirect additive |
| Silicon dioxide | 182.1711 | GRAS |
| Ammonium phosphate | 184.1114 | GRAS |
| Calcium inositol hexa-phosphate | GRAS | |

In Dr. Smith's letter of January 23, 2007, he stated that zirconium is listed in 21 CFR 175.300(b)(3)(xxii) for use in the manufacture of driers, when reacted with an acid and that zirconium, by itself, not in 21 CFR 175.300. Also, you should be aware that 21 CFR 176.170 pertains to additives intended for use in the manufacture of paper and paperboard and does not authorize use of zirconium in resinous and polymeric coatings on metal. Nonetheless, the agency has previously reviewed the use of zirconium under the "Threshold of Regulation Policy" and concluded that this substance is acceptable for use in the manufacture of food-contact articles. We have no reason to alter or change our conclusion regarding the safe use of zirconium.

In addition, it should also be mentioned that ammonium phosphate is listed in 21 CFR 184.1141, not in 21 CFR 184.1114. Therefore, the corrected regulatory status of the components of "ALSHEET-QM" coating material is listed below:

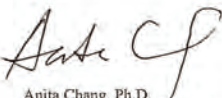
| Components | CFR Ref. | Comments |
|---------------------------------|----------|----------|
| Zirconium | 175.300 | |
| Silicon dioxide | 182.1711 | GRAS |
| Ammonium phosphate | 184.1141 | GRAS |
| Calcium inositol hexa-phosphate | GRAS | |

Furthermore, it should also be pointed out that the extraction test, provided in your letter, is not useful for our safety review for the intended use of your product. Instead, you should measure the hardness of your product as well as conduct corrosion and abrasion tests for your product. However, you do not need to submit the above-mentioned hardness measurement and corrosion and abrasion tests for your product at this time. This conclusion is based on the likelihood that all the components and the potential migrants of the "ALSHEET" coating material would migrate to food at insignificant amounts since they will remain stable and intact, chemically inert and resistant to corrosion and abrasion under your conditions of use.

In conclusion, we consider the "ALSHEET" coating material will be acceptable for its intended use as described above, assuming that your product (ie., "ALSHEET" coating material) will remain stable and intact, chemically inert and resistant to corrosion and abrasion under its conditions of use. As such, your intended use of your product will not need to submit a food contact notification, a food additive petition or a threshold of regulation exemption request for premarket approval as food additives under section 409 of the Federal Food, Drug and Cosmetic Act.

If you have additional questions, please feel free to contact us.

Sincerely,



Anita Chang, Ph.D.
Division of Food Contact Substance
Notification Review, HFS-275
Office of Food Additive Safety
Center for Food Safety
and Applied Nutrition

ALSHEET Pipe

"ALSHEET Pipe" is manufactured from "ALSHEET" using high frequency induction welding. The strength of the steel is combined with the advantages of aluminum, so this pipe affords outstanding heat resistance and corrosion resistance. It is widely used for automobile exhaust pipes subsequent to stainless steel.

1. Characteristics

Appearance

The surface is very smooth as is typical for aluminum, but about a 3-mm width of the iron base appears through the bead cut in the case of high frequency welding on the outer surface. A slight bead is raised along the weld on the inner surface, but the protrusion can be controlled (0.2~0.5mm) by pressure if required.

Formability

JIS G 3445 STKM-11A carbon steel tubes for mechanical structural purposes can be formed.

Impact on aluminum coating layer through pipe manufacturing

The aluminum coating of the steel sheet material remains almost unchanged during pipe manufacturing.

Corrosion resistance in welding area

The iron base is exposed through the bead cut in welding area (outer surface), so rust forms quickly if exposed to salt-water spray test.

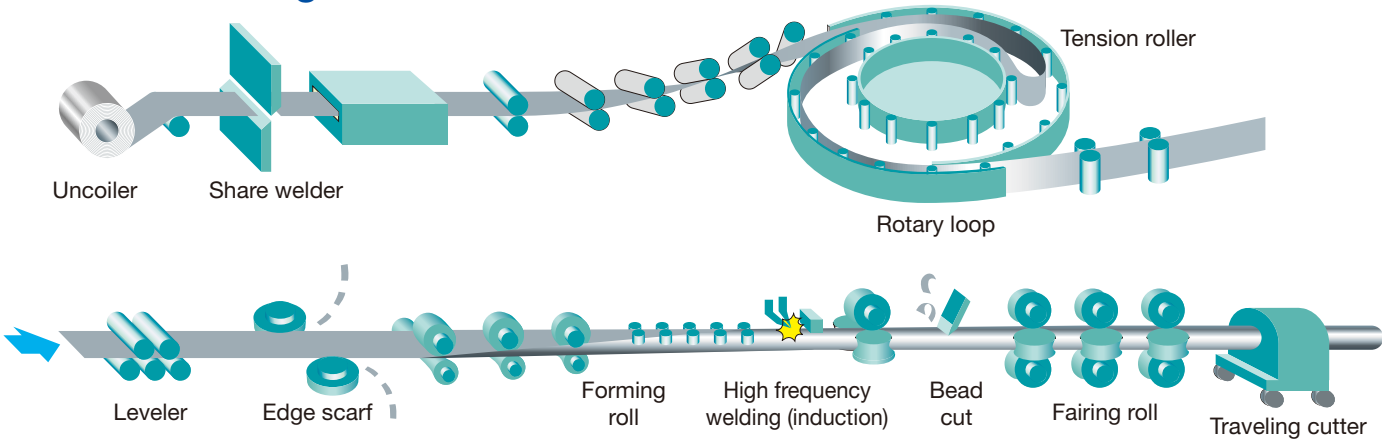
Generally, the bead cut on the external surface is used as it is for automobile and heat resistance purposes, and there is no problem with its functionality.

2. Uses



- Passenger car muffler
- Special muffler

3. Manufacturing Process



4. Specifications

| Pipe code | Material specifications | Coating mass designation for aluminum sheet | Mechanical properties | | |
|-----------|-------------------------|---|-------------------------|-------------------------|--------|
| | | | YP (N/mm ²) | TS (N/mm ²) | EL (%) |
| AL80-TK | SA1D NSA1D | 40, (60), 80, (100), (120) | — | 290≤ | 35≤ |

5. Scope of Manufacturing

| External diameter (mm) | Thickness (mm) | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.3 |
|------------------------|----------------|-----|-----|-----|-----|-----|-----|-----|-----|
| 21.7 | | | | | | | | | |
| 22.2 | | | | | | | | | |
| 25.4 | | | | | | | | | |
| 27.2 | | | | | | | | | |
| 31.8 | | | | △ | △ | △ | △ | △ | △ |
| 34.0 | | | | △ | △ | △ | △ | △ | △ |
| 35.0 | | | | △ | △ | △ | △ | △ | △ |
| 38.1 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 40.0 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 42.7 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 45.0 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 47.6 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 48.6 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 50.8 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 54.0 | | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 57.0 | | | | | ○ | ○ | ○ | ○ | ○ |
| 57.2 | | | | | ○ | ○ | ○ | ○ | ○ |
| 60.5 | | | | | ○ | ○ | ○ | ○ | ○ |
| 65.0 | | | | | | ○ | ○ | ○ | ○ |
| 68.9 | | | | | | | | | |
| 70.0 | | | | | | | | | |
| 75.0 | | | | | | ○ | ○ | ○ | ○ |
| 76.3 | | | | | | | | | |
| 80.0 | | | | | | | | | |
| 82.6 | | | | | | | | | |
| 85.0 | | | | | | | | | |
| 89.1 | | | | | | | | | |
| 90.0 | | | | | | | | | |
| 94.0 | | | | | | | | | |
| 101.6 | | | | | | | | | |

△ : Please contact us for details within the blue frame

○ : Indicates internal surface where bead pressing is possible.

△ : Indicates internal surface where bead pressing is impossible.

6. Quality Attributes

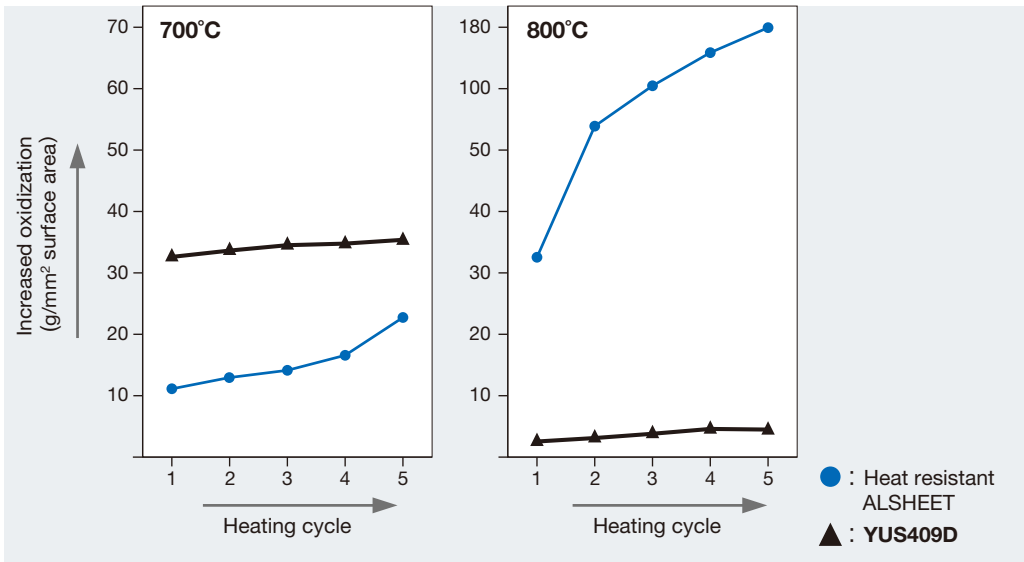
6-1. Heat resistance

• Appearance examples for 5-cycle test

| Pipe code (°C) | 600 | | 650 | | 700 | | 750 | | 800 | |
|------------------------|------------|--------------------------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|
| | Flat sheet | Bent pipe | Flat sheet | Bent pipe | Flat sheet | Bent pipe | Flat sheet | Bent pipe | Flat sheet | Bent pipe |
| Heat resistant ALSHEET | ◎ | Internal ◎ External ◎ | ○ | ○ △ | ○ | △~× | △ | △~× | △~× | × |

◎ : Good, ○ : Some scale spots, △ : Many scale spots, × : Covered in scale

• Examples of increase in oxidation after cycle heating test on straight pipe

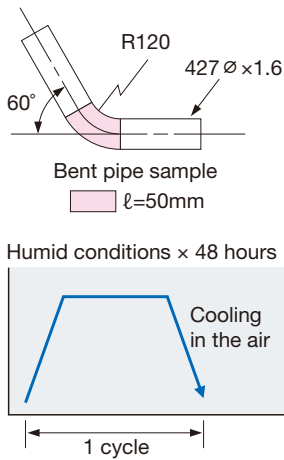


6-2. Mechanical properties

| Pipe designation | Pipe size | Mechanical properties | | |
|------------------|-----------------|-------------------------|-------------------------|---------|
| | | YP (N/mm ²) | TS (N/mm ²) | EL (%) |
| AL80-TK | 45 ϕ × 1.6 | 270 ~ 310 | 300 ~ 340 | 59 ~ 70 |

6-3. Dimensional tolerance

Please contact us regarding the dimensional tolerances in each case.



Cautions for Use

If inappropriately handled or used, ALSHEET cannot demonstrate its characteristic properties. Please pay attention to the following usage precautions.

■ Storage and Loading/Unloading

1. Exposure to water during loading/unloading and storage may cause white rust. Strictly avoid loading/unloading during rain and prevent exposure to seawater and condensation. Also, avoid storage in atmospheres of high humidity or sulfur dioxide. Indoor storage under dry, clean conditions is recommended.
2. Broken or torn packaging paper must be repaired.

⚠ Warning !

- Falling and rolling coils are very dangerous, as is the collapse of piled sheets.
To prevent such accidents during storage, due care should be paid to storing products in a stable, secure state.

■ Handling

1. This product must be handled carefully to avoid damaging the coating or film treatment on the surface. Perspiration and fingerprints may impair paint adhesion and corrosion resistance.
2. In these cases, post-processing or repairs must be implemented if necessary.

⚠ Attention !

- When removing (cutting) the coil binding hoops (bands) prior to use, make sure that the end of the coil is pinned down directly beneath the center of the coil in order to prevent the end of the coil from suddenly springing out. Alternatively, be certain to remove the binding in a location where safety can be assured and no danger would be posed if the coil end were to spring out upon release.
- Coils are formed by winding flat sheets. When the binding hoops or other external restraints that keep the sheet in coil form are removed and the coil end is freed, the end of the coil will spring out to return to its flat state. Furthermore, there have also been cases when the coil bindings work loose, allowing the coil to spring out. Such cases may endanger people nearby and cause damage, so great care must be paid when removing the coil binding hoops (bands).

■ Press Forming

1. Care must be taken regarding the following as—depending on the press forming method—the coating layer is soft and may be damaged during drawing and bending processes.
 - For best results, we recommend having a larger clearance for drawing, and six or more times the sheet thickness for the radius of the die shoulder.
 - Press forming that involves strong abrasion of the coating surfaces should be avoided as far as possible in the case of both drawing and bending.

Approximate standards for die and shoulder radius Unit (mm)

| Sheet thickness (mm) | Drawing | | Tensile bending |
|----------------------|---------------------|-----------------------|---------------------|
| | Die shoulder radius | Punch shoulder radius | Die shoulder radius |
| 0.6 | 4≤ | 2≤ | 4≤ |
| 0.8 | 5≤ | 3≤ | 5≤ |
| 1.0 | 6≤ | 3≤ | 6≤ |

2. When press forming, some types of extreme pressure additives contained in lubricating oil can cause corrosion of the surface coating. Prior confirmation is requested when such additives are to be used. In the event that such types must be used, post-treatment—such as degreasing—should be applied swiftly with all due care.

■ Welding

In resistance welding, because the electrodes are soiled by the pick up of metal coating, they should be properly maintained and replaced at regular intervals. In seam welding, the service life of electrodes can be extended by using a knurl-gear driving system.

■ Degreasing

The use of weak alkaline-type, neutral detergents and organic solvents is recommended for degreasing. Some types of degreasing agents such as strong alkaline agents cause corrosion of the metal coating. Prior confirmation is requested when such agents are to be used.

■ Aging

Generally, steel sheets tend to show deterioration in quality over time. For example: degraded formability, stretcher stains, and coil breaks. To avoid this, usage at the earliest possible time is recommended. However, this problem can be avoided if products with aging resistance are selected.

■ Repairing the surface

In the event that the film coating is damaged while welding, bending or drawing, use a brush to apply a corrosion-resistant aluminum paint containing powdered aluminum to restore the surface to a premium condition.

Order Guidelines

When placing an order, please confirm the following matters in accordance with the purpose of the order.

■ Specifications

Depending on the severity and method of fabrication to be undertaken, choose the appropriate material specifications from the options in this catalog.

■ Surface Treatment

Select the most suitable surface treatment from among those described in this catalog according to the treatment method after fabrication and the application conditions.

■ Coating Mass

Select the most suitable coating mass according to the required corrosion resistance, application conditions, and fabrication methods. In the event that corrosion resistance is prioritized, a thicker plating should be selected, whereas thinner plating is better suited to workability.

■ Oiling

The decision whether or not to apply rust-preventive oil can be made separately from the kind of surface treatment. Oiling is recommended in order to improve intermediate rust resistance, to mitigate fingerprints and damage during handling, and to maintain lubrication during press forming. However, oiling is indispensable for uncoated materials.

■ Dimensions

The dimensions of the steel sheets (thickness, width and length) should be appropriately designed within the manufacturing scope.

■ Coils

Select coils or sheets according to shear and fabrication conditions.

The selection of coils will effectively improve product yield by allowing continuous and automated operation. In the case of coils, however, some defective parts may unavoidably be included because their removal, based on inspection, is impossible. Off-gauge from both edges of the coil will be removed, but some off-gauge may remain in proximity to the welding sections. Accordingly, inspection, selection and repairs, etc. must be thoroughly implemented prior to use.

■ Edge Finish

Please indicate if the order requires a milled edge or slit edge in accordance with the conditions. Select slit edge when an end finish is required, such as materials to be used directly as products.

■ Package Mass

Specify the package mass according to the local loading/unloading capacity and work efficiency.

The heavier the unit mass, the higher the work efficiency. In the case of coils, specify the maximum mass (minimum mass if necessary).

The average unit mass to be actually shipped will be determined based on the relationship between the maximum mass and dimensions when divided into the manufacturing mass.

■ Internal and External Diameters

In the case of coils, specify the inside and outside coil diameters according to the specifications of the uncoilers on the shearing line.

When selecting inside diameters, it is necessary to consider the occurrence of break and reel marks on the area of the inside diameter, depending on the thickness. Based on this point, our internal diameter standards are shown as follows.

| Sheet thickness (mm) | |
|----------------------|-----------|
| ≤1.6 | 1.6< |
| ⌀20", 24", 28" | ⌀24", 28" |

■ Dimensional Accuracy (Sheet thickness, width, length)

Dimensional accuracy of thickness, width and length is guaranteed within the range of sizes described in this catalog.

However, there are cases that require strict size specifications with respect to assembly accuracy and dimensional accuracy of the parts, depending on the application conditions of the finished products. In such cases, please consult us in advance to clarify your specifications.

■ Applications and Fabrication Methods

NIPPON STEEL implements quality control to better suit the intended application. For that purpose, it is requested that the intended application, fabrication method, and any other requirements be clearly indicated.

Packaging and Labeling

The finished product is packaged and shipped as per normal procedure for steel to ensure that it is handled and stored with care prior to its use. The external layer of packaging consists of a packaging label that contains details of the finished product that it is affixed to. Furthermore, the Package Card is also included, which is the warranty for the product in question.

The Package Card is used when taking receipt of the product and confirming its condition. The information contained on the Package Card and labels is detailed herein.

Packaging Labels and Package Cards

| Item | Title name | Notation method |
|---|-------------------|--|
| | Packaging label | |
| Product name | Not shown | Product name is displayed |
| Class/Grade | Not shown | Class and grade of materials used are displayed |
| JIS certification mark,JIS certifying body,JIS certification number | Not shown | Only the applicable materials are displayed. These are not shown on the Package Card |
| Spec designation | Specification | The spec code for the finished product is displayed (see note below) |
| Coating | Coating | The weight is displayed |
| Dimensions | Dimensions | The dimensions are displayed |
| Number of sheets | Number of sheets | Only for cut sheets |
| Mass | Net mass | This is displayed depending on the contractual arrangements (actual quantity or estimated value) |
| | Gross mass | This indicates total mass of the products and package. |
| Length | Length | Contractual estimate or specific coil length is displayed |
| Inspection number | Inspection number | Displayed on each package |
| Coil number | Coil number | Displayed for each production lot |
| Customer name | Not shown | The customer name is displayed |
| Company and works name | Not shown | (Location Name) WORKS (or AREA), NIPPON STEEL CORPRATION is displayed |
| Month and date of manufacture | — | The date of manufacture is displayed |

Note: Notation Used for Specifications

For JIS Standards

JIS G 3314 SA1D : Z MO(N)

① : Spec number ④ : Surface finish code
② : Spec designation ⑤ : Surface treatment code
③ : Skin-pass code ⑥ : Oiling designation (when no oils are used, this is given the value X)

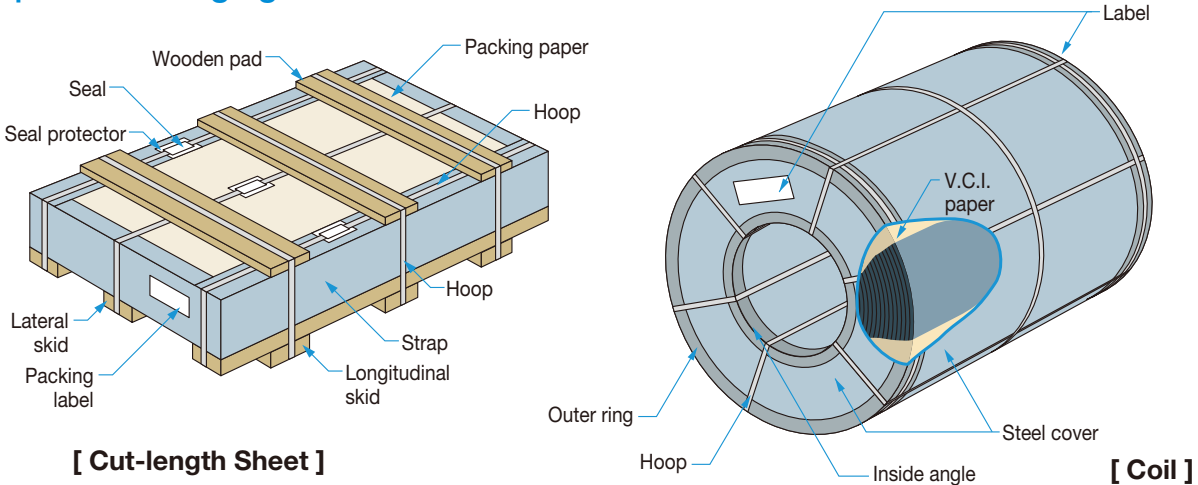
For NIPPON STEEL Specifications

NSA1D : Z M N

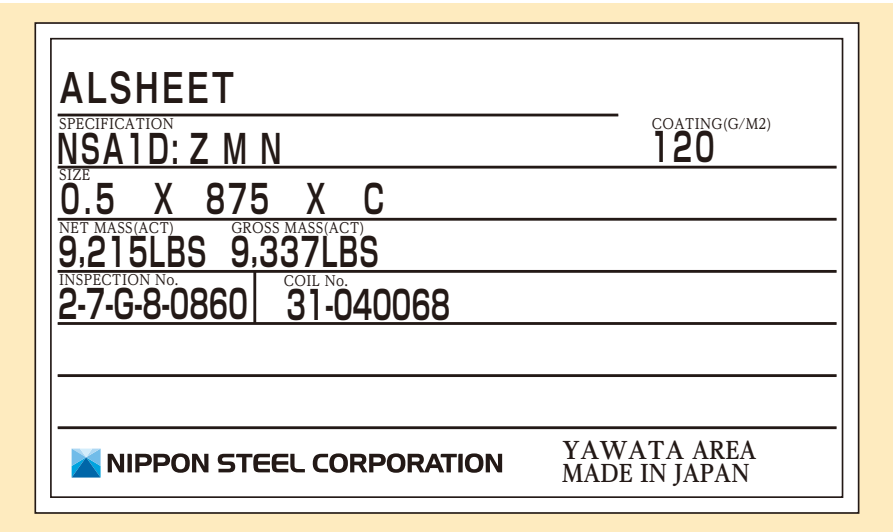
① : Spec number ④ : Surface treatment code
② : Skin-pass code ⑤ : Oiling designation (when no oils are used, this is given the value X)
③ : Surface finish code

Note: In the event of no specific skin-pass being defined, all items following the surface finishing code are displayed on the left.

Example of Packaging



Example of a Packaging Label



Unit Mass Table for Sheets

• Unit Mass Table for Sheets (kg/m²)

| Nominal thickness (mm) | Aluminum coating mass designation | | | | |
|---------------------------|-----------------------------------|-------|-------|-------|-------|
| | 40 | 60 | 80 | 100 | 120 |
| 0.30 | 2.242 | 2.186 | 2.130 | 2.065 | 2.017 |
| 0.35 | 2.635 | 2.578 | 2.552 | 2.458 | 2.409 |
| 0.40 | 3.027 | 2.971 | 2.915 | 2.850 | 2.802 |
| 0.50 | 3.812 | 3.756 | 3.700 | 3.635 | 3.587 |
| 0.60 | 4.597 | 4.541 | 4.485 | 4.420 | 4.372 |
| 0.70 | 5.382 | 5.326 | 5.270 | 5.205 | 5.157 |
| 0.80 | 6.167 | 6.111 | 6.055 | 5.990 | 5.942 |
| 0.90 | 6.952 | 6.896 | 6.840 | 6.775 | 6.727 |
| 1.0 | 7.737 | 7.681 | 7.625 | 7.560 | 7.512 |
| 1.2 | 9.307 | 9.251 | 9.195 | 9.130 | 9.082 |
| 1.4 | 10.88 | 10.82 | 10.76 | 10.70 | 10.65 |
| 1.6 | 12.45 | 12.39 | 12.33 | 12.27 | 12.22 |
| 2.0 | 15.59 | 15.53 | 15.47 | 15.41 | 15.36 |
| 2.3 | 17.94 | 17.89 | 17.83 | 17.77 | 17.72 |
| 2.5 | 19.51 | 19.46 | 19.40 | 19.34 | 19.29 |