



www.nipponsteel.com



ECOTRIO™

NIPPON STEEL's environmentally friendly steel sheet
for electronic parts

Steel
Sheet



NIPPON STEEL CORPORATION
2-6-1 Marunouchi, Chiyoda-ku, Tokyo 100-8071 Japan
Tel: +81-3-6867-4111

ECOTRIO™
U012en_02_202004f
© 2019, 2020 NIPPON STEEL CORPORATION

NIPPON STEEL CORPORATION

Introduction

NIPPON STEEL's ECOTRIO is a Zn-Sn-Ni alloy coated steel sheet produced by electroplating Ni, Sn and Zn and alloying the sheet immediately after plating. Its coating is environmentally friendly being free of poisonous metals such as lead and chromium, and is composed of three metals. Hence the product's name "ECOTRIO".

In the electrical and electronic industry, products are often assembled by soldering, and electrolytic tinplates have typically been used. However, some time after products are released, needle-shaped single-crystals of tin are formed on the tinplate surface. (These needle-shaped crystals are called "whiskers".) Whiskers are problematic, as they can easily break off and fall on circuit, causing short circuits.

In 2000, NIPPON STEEL released ECOTRIO in an attempt to reduce whiskers on electrolytic tinplates. Over 10 years, ECOTRIO has been selected and used by electric and electronic parts manufacturers.

NIPPON STEEL now introduces new products to the ECOTRIO series, ECOTRIO (New-type) and High-Strength ECOTRIO.

We are confident that our customers' expectations will be surpassed. Try our new ECOTRIO.

Contents

Features of ECOTRIO	P. 1
Basic Properties	P. 2
Application Example	P. 4
ECOTRIO (New-type)	P. 6
High-Strength ECOTRIO	P. 7
Standards and Specifications of ECOTRIO	P. 9
Available Sizes	P. 10
Packaging and Labeling	P. 11
Precautions in Use	P. 12
Appendix Table	P. 13

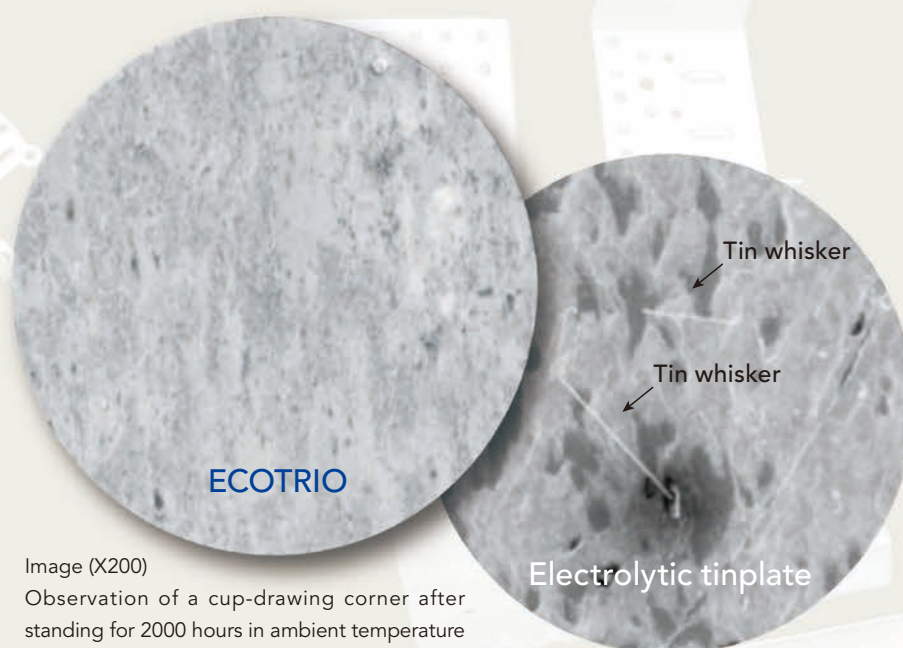


Image (X200)

Observation of a cup-drawing corner after standing for 2000 hours in ambient temperature of 60°C and 90% RH

ECOTRIO will offer solutions to the following issues:

- Unpredictable malfunctions occur due to whiskers of electrolytic tinplates.
- Electrolytic zinc coated sheets are used, and solder wettability is not stable.
- Looking for electrolytic zinc coated sheets that are thinner than 0.3mm.
- Planning to reduce cost for small stainless-steel parts.
- Copper alloy materials are too expensive. Looking for an alternative low-price material.
- It has become difficult to obtain tinplates with coating weight of 5.6 and 8.4 g/m².
- There is no tinplates with thickness of 0.4mm or more.
- Considering the use of chromium-free products (free of Cr⁶⁺ and Cr³⁺) to demonstrate the company's environmental commitment.

Notice: While every effort has been made to ensure the accuracy of the information contained within this publication, the use of the information is at the reader's risk and no warranty is implied or expressed by NIPPON STEEL CORPORATION with respect to the use of the information contained herein. The information in this publication is subject to change or modification without notice. Please contact the NIPPON STEEL CORPORATION office for the latest information. Please refrain from unauthorized reproduction or copying of the contents of this publication.

The names of our products and services shown in this publication are trademarks or registered trademarks of NIPPON STEEL CORPORATION, affiliated companies, or third parties granting rights to NIPPON STEEL CORPORATION or affiliated companies. Other product or service names shown may be trademarks or registered trademarks of their respective owners.

Features of ECOTRIO

Features

- 1 ECOTRIO is lead-free and chromate-free and complies with RoHS Directive.
- 2 Formation of whiskers is lower in comparison to electrolytic tinplates. *
- 3 The solderability and surface conductivity are equivalent to those of tinplates and superior to those of galvanized steel sheets.
- 4 Thinner gauge are available (minimum of 0.15 mm).
- 5 ECOTRIO (New-type): Lightly-coated products still retain the basic properties of ECOTRIO.
- 6 High-Strength ECOTRIO: Costs can be reduced by switching over from nickel silver and stainless steel.

* Whisker resistance varies depending on the plating code. If you can't select suitable one, please consult us before placing order.

Coating Structure

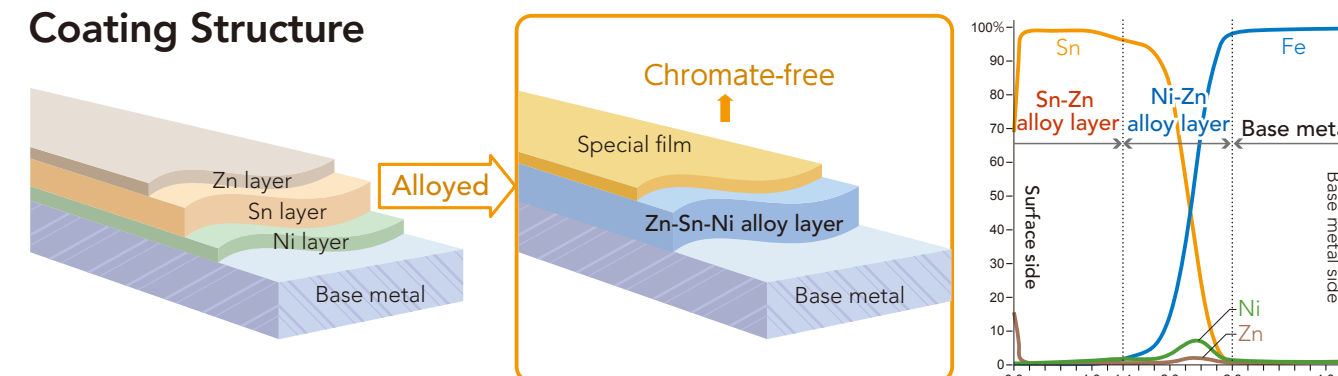
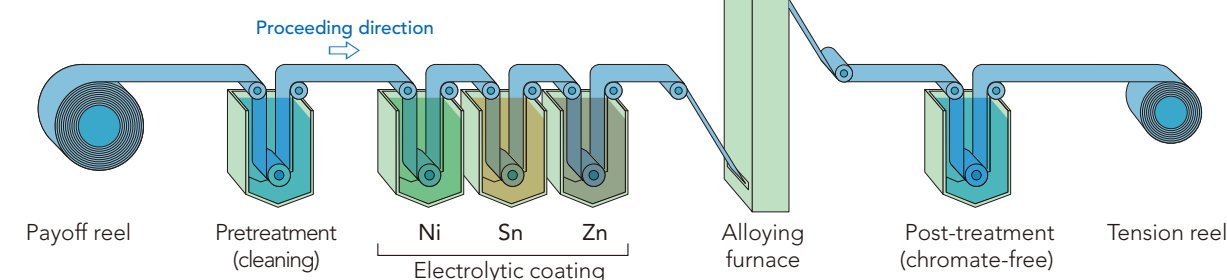


Fig.1. Element distribution profile in depth using GDS

Process

After electrolytic coating of Ni, Sn and Zn on steel sheets, these are alloyed by heating in the alloying furnace.



● Whiskers of electrolytic tinplates

In a dictionary, "whisker" is defined as "needle-shaped crystal, usually several mm long and 1-2 μm across; very strong". Whiskers also form on Zn and Cd, but tin whiskers have especially been an issue in the electric and electronic parts industry. As electronic parts continuously become more compact with increased density, the distance between circuit terminals has been shortened to several hundred μm. If whiskers that grow to a length of several mm fall on a circuit, it will cause short-circuiting and result in a failure of the electronic part. This can be prevented by avoiding use of tinplates and soldering. However, because of the thinness of tinplates, their high compatibility with soldering and the productivity by soldering, the combined use of tinplates and soldering is likely to continue for some time. While the basic research to solve the tin whisker issue is continuing, and new findings have been reported in regard to the tin whisker growth mechanism and mitigation method, no solutions have been suggested to eradicate this problem completely.

Basic Properties

Whisker resistance

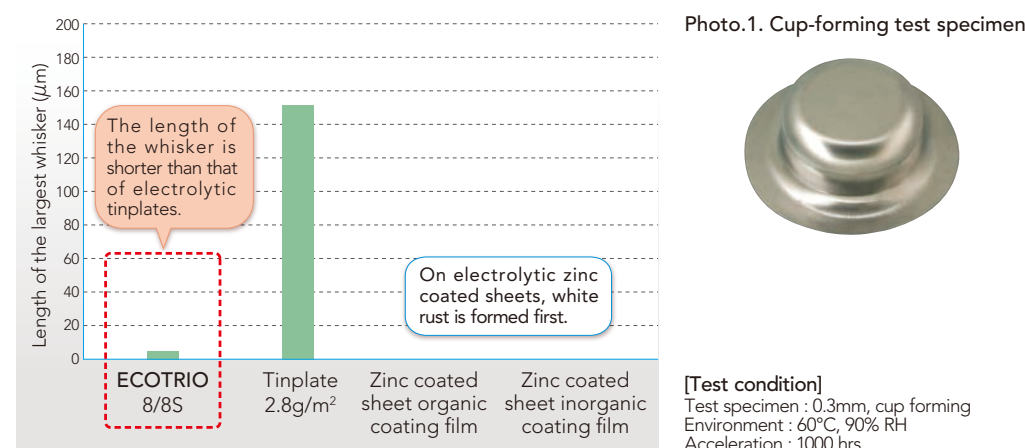


Fig.2. High temperature high humidity whisker formation test result

* The data presented here is an example of experimental results and does not guarantee performance.

Solder wettability (solder wetting time)

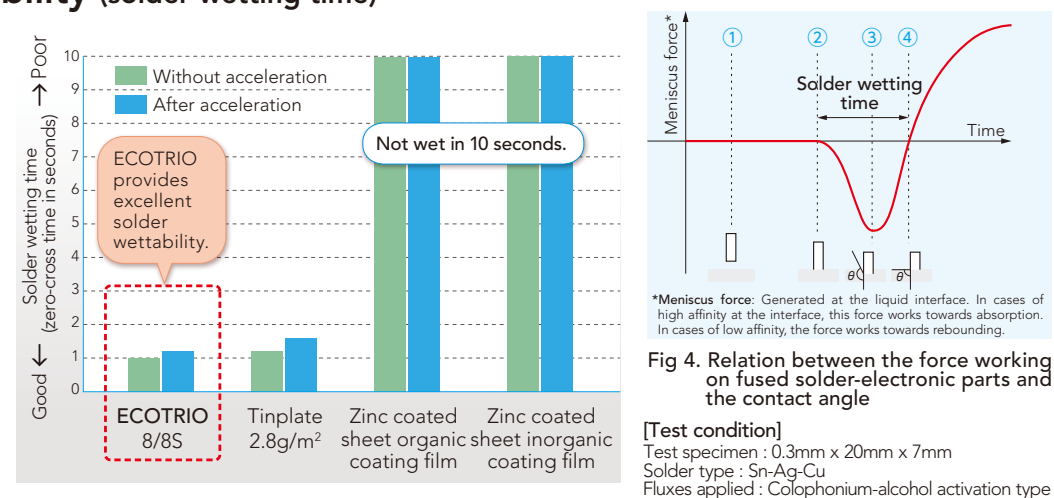


Fig.3. Solder wetting time measurement result

Solder wettability (solder spreadability)

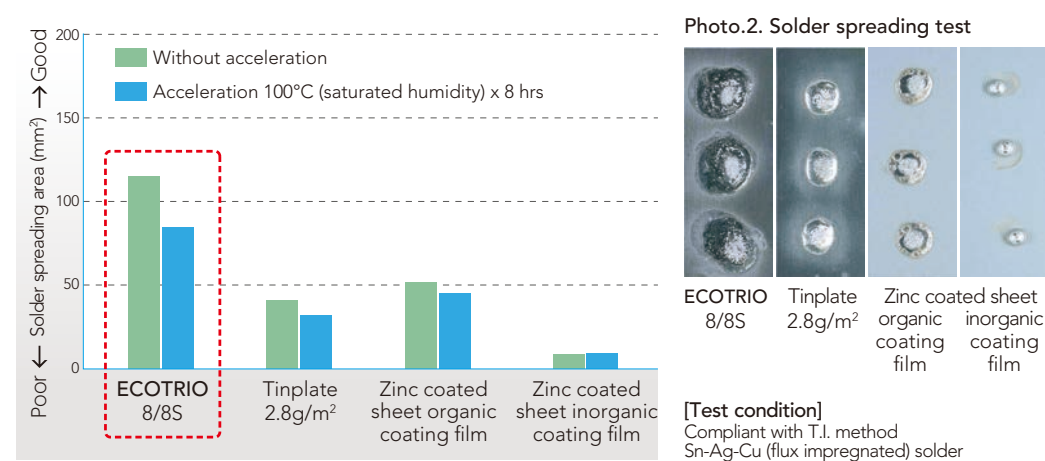


Fig.5. Solder spreading are measurement result

Corrosion resistance

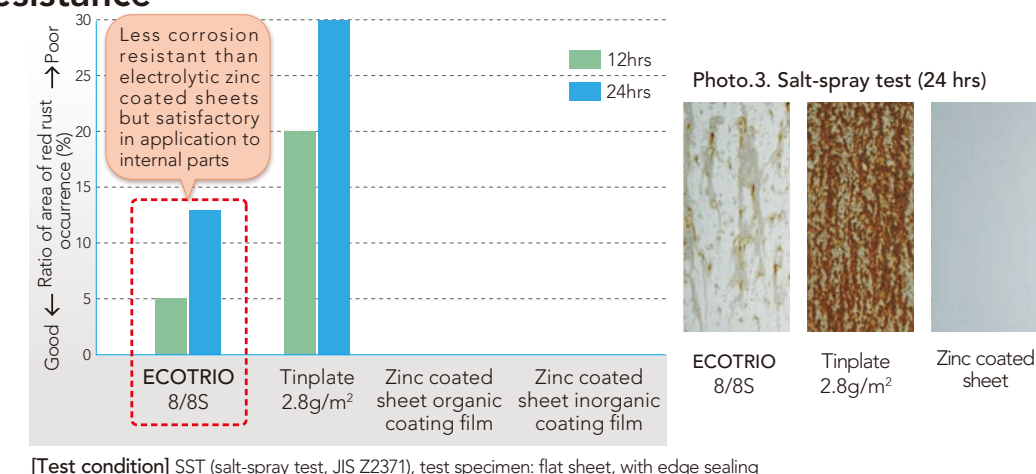
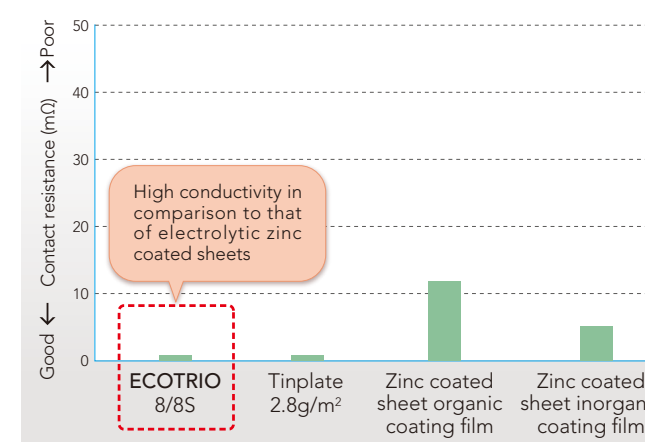


Fig.6. Corrosion resistance (salt-spray test)

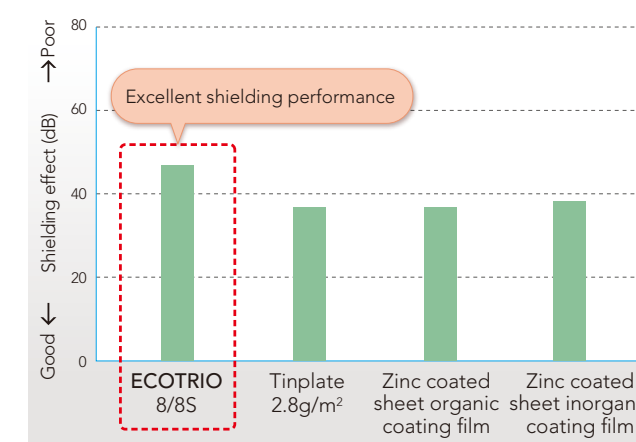
Surface conductivity (grounding property)



[Test condition] Yamasaki electric contact simulator, contact load = 1.0N, electrode size = φ0.5mm

Fig.7. Conductivity

Electromagnetic shielding



[Test condition] Simulation box method, 350MHz

Fig.8. Electromagnetic shielding

Surface sliding (kinetic friction coefficient)

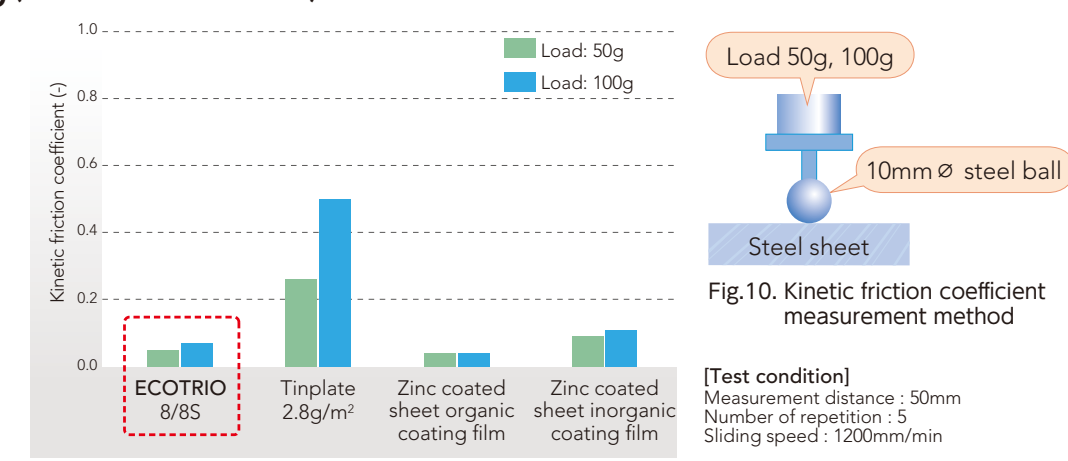


Fig.9. Surface sliding

Application Example

ECOTRIO can be used in the following applications.



ECOTRIO (New-type)

Features

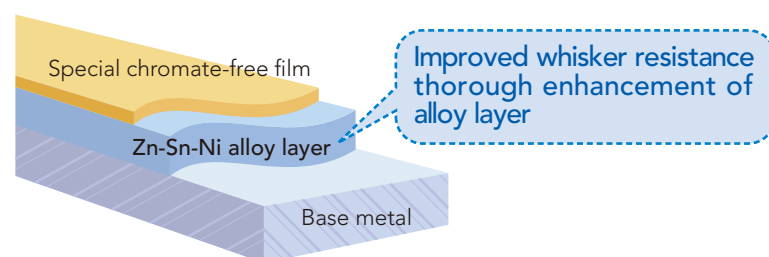
The existing ECOTRIO is designed with the optimal plating composition to exert its basic properties (whisker resistance, solder wettability and corrosion resistance) in a balanced manner. This has hindered reduction in coating thickness.

NIPPON STEEL has returned to its original development concept and reviewed the coating composition, and succeeded to reduce coating thickness without diminishing whisker resistance, solder wettability and corrosion resistance of the existing ECOTRIO.

NIPPON STEEL has added

- Standard ECOTRIO 3X/3X and
- Whisker resistant ECOTRIO 3W/3W

to its product lineup.



Performance

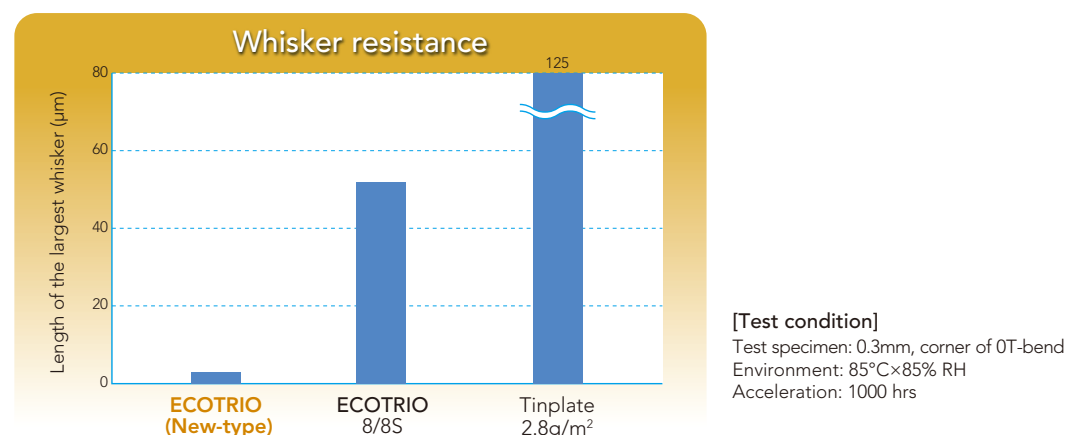


Fig. 11. High temperature high humidity whisker formation test result

* The data presented here is an example of experimental results and does not guarantee performance.

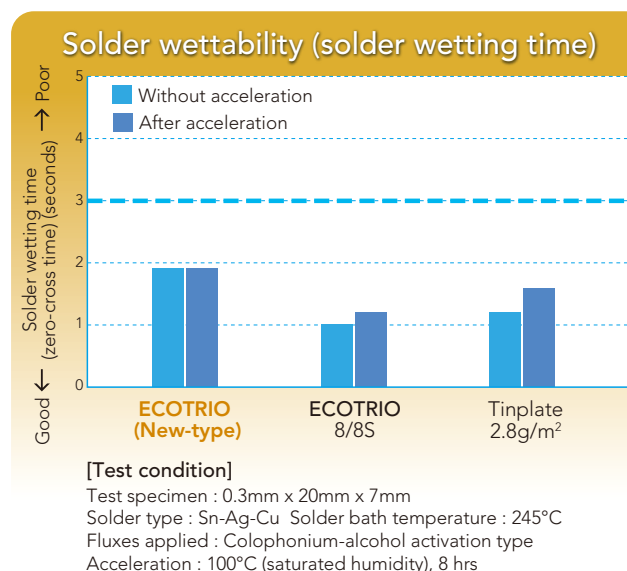


Fig. 12. Solder wetting time measurement result

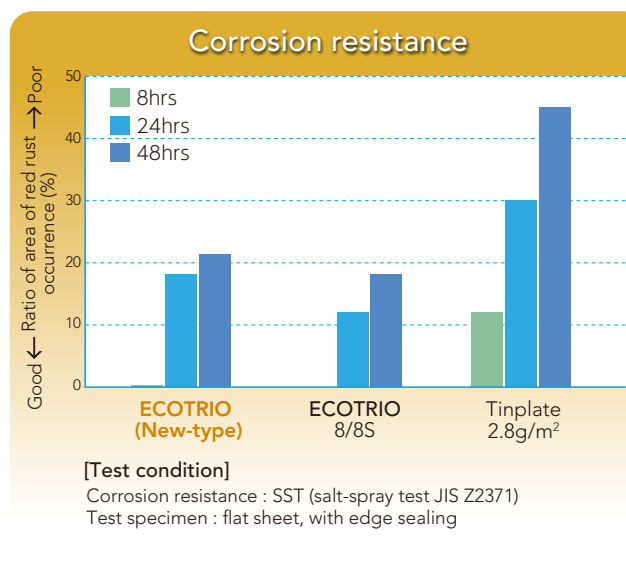


Fig. 13. Corrosion resistance (salt-spray test)

The excellent whisker resistance, solder wettability and corrosion resistance are inherited from the existing ECOTRIO.

High-Strength ECOTRIO

Features

Copper alloy sheets such as nickel silver sheets and phosphor bronze sheets are often used for connectors, shield and frames mounted in electric and electronic equipment. Copper alloy sheets are selected for their corrosion resistance, elasticity and thinness. On the other hand, copper alloy sheets are expensive. By combining the advanced rolling technology that has been cultivated over the years and the properties of ECOTRIO, NIPPON STEEL added to its product lineup **High-Strength ECOTRIO**, which is thin and uses iron as the base metal.

■ A wide variety of functions offered by High-Strength ECOTRIO

1. Variation of high-strength thin material equivalent to nickel silver, etc.
2. Excellent compatibility with lead-free solders and solderability
3. Excellent surface conductivity that enables welding

Performance

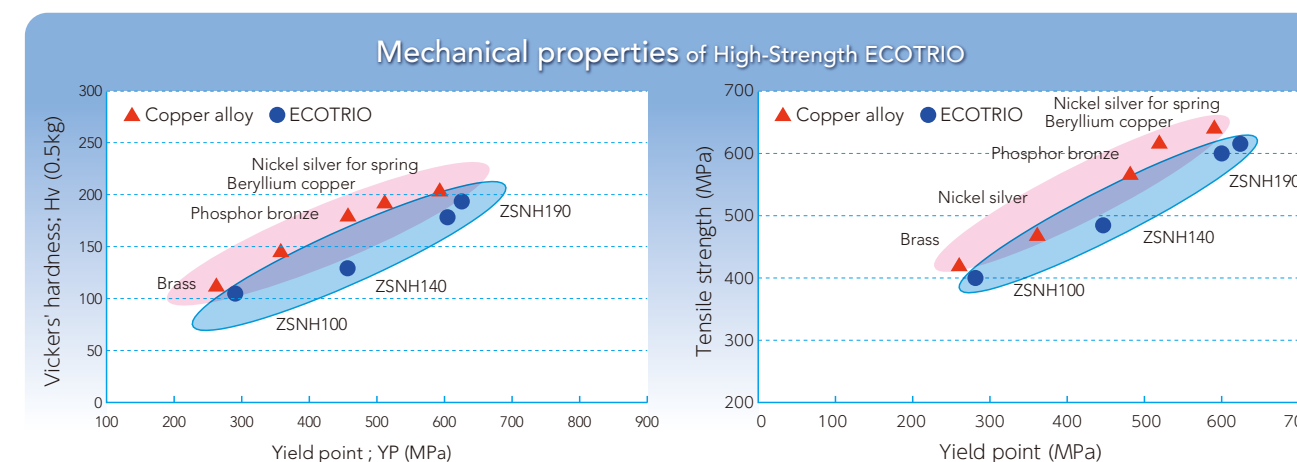


Fig. 14. Relation between yield point and hardness

Fig. 15. Relation between yield point and tensile strength

Hardness and balance between yield point and tensile strength of ECOTRIO are approximately equivalent to those of copper alloys. You can select ECOTRIO, the mechanical characteristics of which are equivalent to those of copper alloys currently being used.



Lead-free solder

On July 1, 2006, European RoHS Directive was implemented.

The aim of this directive was to control hazardous substances that leak out from discarded electric and electronic equipment, protect the environment and prevent hazards to human health. Specifically, the directive regulates Pb, Hg, Cd, Cr(VI), PBB and PBDE contained in electric and electronic parts. ELV Directive was implemented prior to RoHS Directive for Pb, Hg, Cd and Cr(VI). In order to comply with the directive, manufacturers have switched to alternative materials that are lead-free and chromium-free. This also applied to solders.

Suddenly, manufacturers were prohibited to use Sn-Pb eutectic solders (such as H63S), which had widely been used.

Fortunately, development of "lead-free solders" had already begun in Japan, and manufacturers were able to obtain several types of "lead-free solders" that were suitable for practical use by the time RoHS Directive came into effect. The well-known compositions include Sn-Ag-Cu, Sn-Ag-Bi-In, Sn-Cu and Sn-Zn.



High-Strength ECOTRIO

Performance

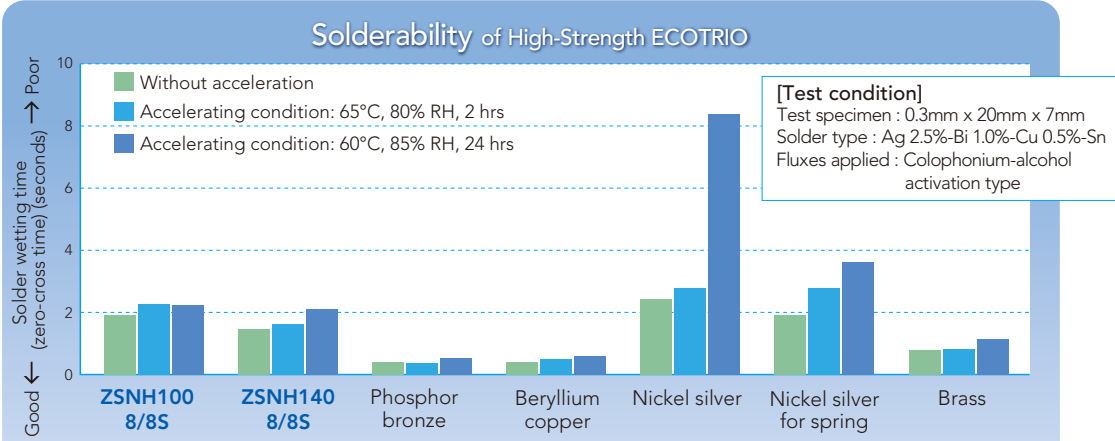


Fig.16.Solder wetting time measurement result

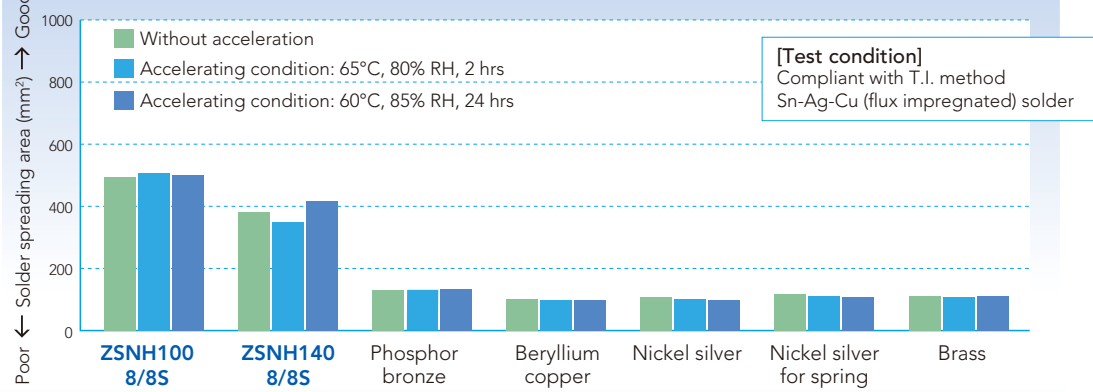
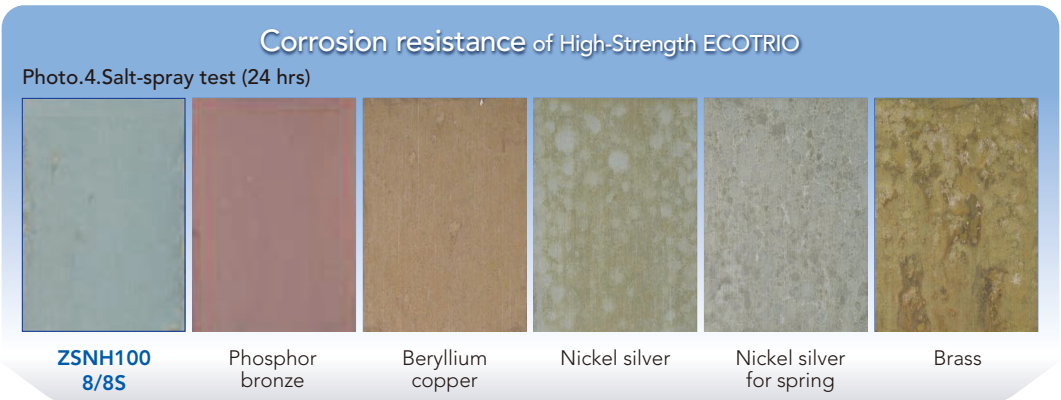


Fig. 17. Solder spreading area measurement result

Solder wetting time : Slightly inferior to phosphor bronze, beryllium copper and brass but equivalent or superior to nickel silver and nickel silver for spring
Solder spreadability : Superior to any copper alloys.



The rust ratio of ECOTRIO is minimal in areas other than the edges.
Rust formation of copper alloys is different from that of ECOTRIO, but a significant amount of rust is formed on brass.

(Note) Red rust may be formed on the edges of ECOTRIO because iron is exposed on the edges.
Please take this point and the work environment into account when considering the use of ECOTRIO.

Standards and Specifications of ECOTRIO

Table-1.Standards and specifications of ECOTRIO, ECOTRIO (New-type) and High-Strength ECOTRIO

Standard symbol	Coating mass symbol					
	4/4	6/6	8/8	15/15	3X/3X	3W/3W
ZSNC						
ZSND		ECOTRIO			ECOTRIO (New-type)	
ZSNE						
ZSNH100						
ZSNH140		High-Strength ECOTRIO				
ZSNH190						

Table-2.Type and description of standard symbol

Grade	Standard symbol	Description
General purpose	ZSNC	For general use
	ZSND	For drawing
	ZSNE	For deep-drawing
High strength	ZSNH100	Hv100 (targeted)
	ZSNH140	Hv140 (targeted)
	ZSNH190	Hv190 (targeted)

Table-3.Type and description of surface finish

Surface finish symbol	Description	Remarks
B	Bright	Generally not applicable
R1	Stone finish	Applicable to ZSNH190
S1	Silver finish Type I (dull finish)	Standard

Table-4.Type and description of surface treatment

Surface treatment	Description
S、MS	Special film coating (Cr ⁶⁺ -free, Cr ³⁺ -free)

Table-5.Type and description of coating mass

Grade	Coating mass symbol	Description (tin plating amount on one surface)
General purpose	4/4	Generally not applicable
	6/6	Target value of principal component (Sn) is 5.6g/m ²
	8/8	Target value of principal component (Sn) is 8.4g/m ²
	15/15	Target value of principal component (Sn) is 15.0g/m ²
ECOTRIO (New-type)	3X/3X	Target value of principal component (Sn) is 3.0g/m ²
	3W/3W	Target value of principal component (Sn) is 3.0g/m ²

Table-6.Type and description of oiling

Oiling symbol	Description
8	Special rust-preventive oil 8.0mg/m ² (targeted)

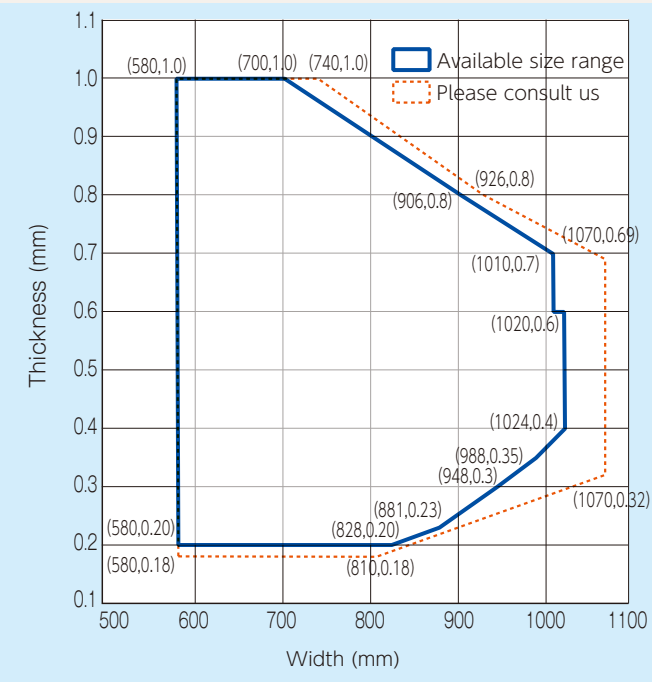
Table-7.Type and mechanical properties of standard symbol

Grade	Standard symbol	Yield point and yield strength (MPa)	Tensile strength (MPa)	Elongation (%)				Test specimen	Grade	Standard symbol	Hardness target value (Hv)
				Thickness classification (mm)							
				0.18 or more, less than 0.4	0.4 or more, less than 0.6	0.6 or more, less than 0.8	0.8 or more, less than 1.0				
General purpose	ZSNC	—	(270)	25 or more	31 or more	32 or more	33 or more	JIS No. 5 rolling direction	High strength	ZSNH100	90 ~ 130
	ZSND	—	—	30 or more	36 or more	37 or more	38 or more			ZSNH140	110 ~ 170
	ZSNE	—	—	32 or more	38 or more	39 or more	40 or more			ZSNH190	150 or more

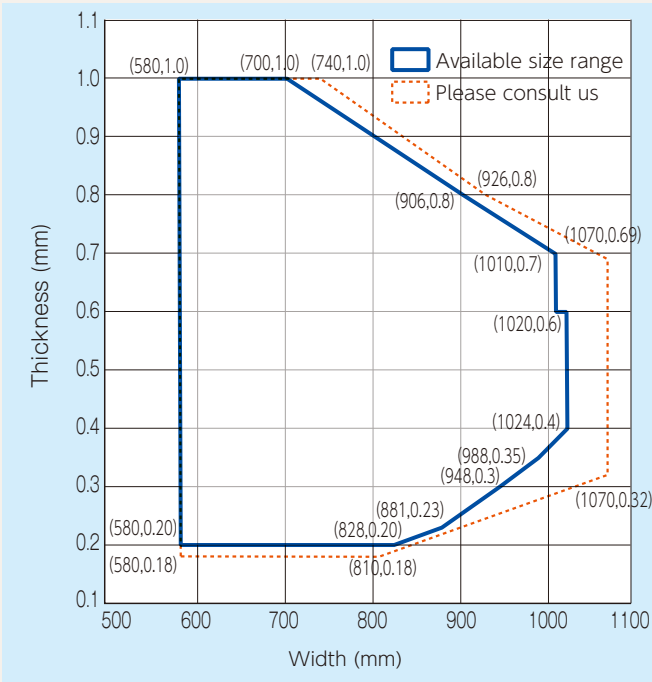
Available Sizes

Please contact us as available sizes differ depending on the specification.

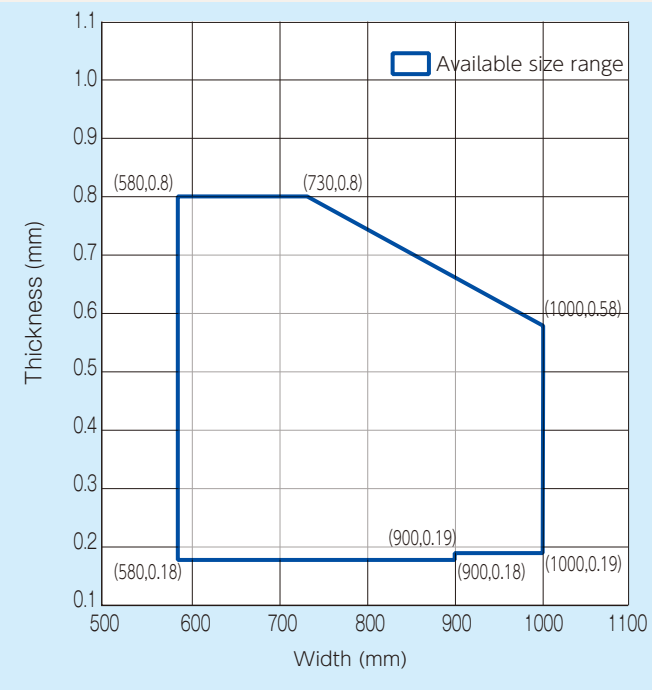
[1]Standard symbols ZSNC, ZSND and ZSNE



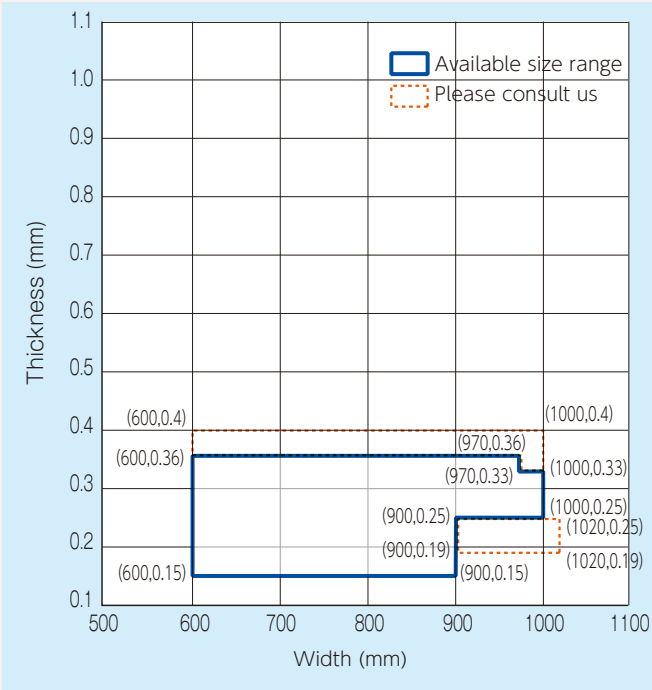
[2]Standard symbol ZSNH100



[3]Standard symbol ZSNH140



[4]Standard symbol ZSNH190



Packaging and Labeling

The products are shipped in packaging in order to prevent them from being damaged under normal handling, storage conditions between manufacturing and use. Package labels indicating detailed information on the products are attached to the exterior packaging. Additionally, a package card to provide the product information is attached to the actual article. Use these forms when you receive and check the product. The forms provide the following information.

Standard symbol labeling example

Example

ZSNC:S1 S3X/3X 8

① Standard symbol
② Surface finish
③ Surface treatment symbol
④ Coating mass symbol
⑤ Oiling

【How to interpret symbol】

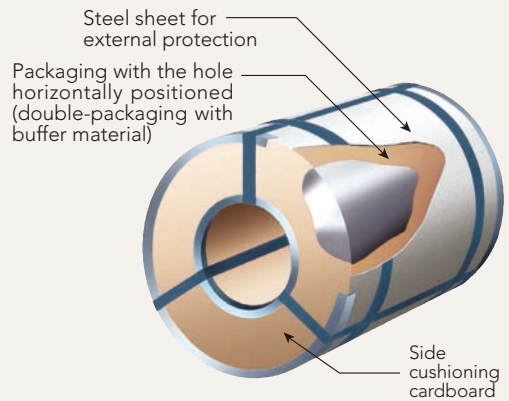
① Standard symbol : ZSNC, original sheet is equivalent to SPCC, etc.
② Surface finish : S1, silver finish, etc.
③ Surface treatment symbol : S, special chromate-free film
④ Coating mass symbol : 3X/3X, etc.

The number before the slash indicates the coating mass symbol of the top surface, and the number after the slash indicates the coating mass symbol of the back surface.
Standard symbol Surface finish Surface treatment symbol Coating mass symbol Oiling

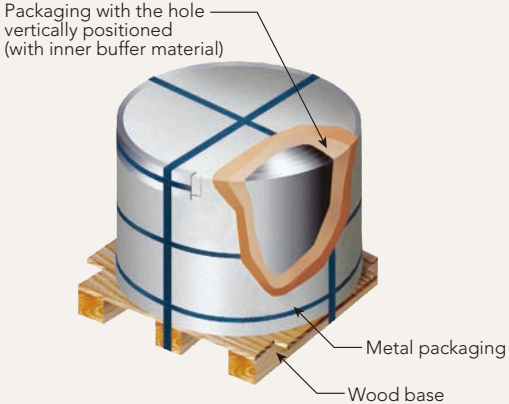
Table-8. Items included in packaging label and package card

Item No.	Item	Included on forms		Method and description
		Domestic	Export	
A	Product name	○	○	Indicates the name of the product.
B	Grade	○	—	Grade 1
C	Standard symbol	○	○	Indicates the standard symbol as shown above.
D	Coating	○	○	Indicates the coating mass symbol.
E	Contract number	—	○	Indicates the contract number between customer.
F	Case number	—	○	Indicates the serial number representing the quantity of products in the delivered lot.
G	Size	○	○	Indicates the order size (thickness x width x length). Indicates "C" instead of length in case of a coil.
H	Net weight	○	○	Indicates the net weight of the product.
I	Weight including packaging	—	○	Indicates the product weight including packaging on the packaging label.
J	Length	○	—	Indicates the length of the product.
K	Inspection number	○	○	Indicates the inspection number of each product.
L	Coil number	○	○	Indicates the coil number of each manufacturing lot.
M	Manufacturing date	○	○	This item must be indicated unless the material is specified as indication not available.
N	Customer name	○	○	Indicated in the shipping mark area.
O	Company name	○	○	NIPPON STEEL CORPORATION
P	Works name	○	○	Setouchi Works Hirohata area

Domestic packaging mode example



Export packaging mode example



Example of packaging label

A ECOTRIO

C ZSNC:S1 S 8 **D 8/8**

G 0.60 X 975 X C

H 5,860KG **I 6,030KG**

K 21U01-0001 **E 2-3-EH49-01** **F 1**

L K-80422-3

O NIPPON STEEL CORPORATION **HIROHATA AREA** **P MADE IN JAPAN**

Example of package card

検査票

PACKAGE CARD

A ECOTRIO **C ZSNC-S1 S 8** **D 8/8** **E 2-8-KT05-02** **F 2**

G 0.60 X 825 X C **H 5,440KG** **I 71M02-0002** **K**

L 0-80355-1

O NIPPON STEEL CORPORATION **広畑地区** **P HIROHATA AREA**

Precautions in Use

With its excellent characteristics, we are confident that ECOTRIO will meet our customer demands. Please note the following points when using ECOTRIO in order to maximize its performance.

Loading/ unloading and storage

- Collapse of heavy load is very dangerous. Strict care must be taken during loading/unloading and storage.
- Exposure to moisture during loading/unloading and storage may cause corrosion. Strict care must be taken against dew condensation and when loading/unloading in rain.
- It is recommended that this product be stored in a dry and clean indoor location.
- In particular, care must be taken to protect the product from dew condensation when open packages are stored.
- Damaged parts may turn black. This occurs when the product is shaken repeatedly, and the plated surfaces are rubbed against each other, depending on the sea state and road condition during transport. This is called abrasion, a common appearance defect found on tinplates. Abrasion may also be caused by dents during freight handling and storage. At a glance, it may be mistaken for a stain on the plating surface. Handle the product with care to prevent loss by abrasion.

Handling

- Care must be taken when handling the product to prevent damage to the coating.
- Care must be taken to prevent sweat and fingerprints being left on the surface, which can cause corrosion.
- Due care must be taken to prevent cuts when handling thin sheets.

Fabrication

- Please select an appropriate material (standard symbol) based on the method and speed of fabrication.
- For heavy-load fabrication such as drawing, it is recommended that materials suitable for fabrication be selected. When materials are fabricated under normal conditions that are suitable to the sheet thickness, excellent results will be obtained.

Orders and inquiries :

When placing orders, please provide the following information in detail.

① Specifications of steel sheet	Thickness, width, standard symbol, coating mass, surface finish, oiling, etc.
② Application and application conditions	Application, application conditions, fabrication conditions (fabrication method, degree, etc.), quality standards
③ Quantity	
④ Delivery term	

● To place orders for ECOTRIO and/or for technical inquiries related to its use, please contact sales divisions of NIPPON STEEL.



● Chemical substance regulation for electric and electronic parts

The major laws and regulations (mainly European) related to electric and electronic parts are listed below.

- **ELV (End of Life Vehicles) Directive:** A directive about post-consumer vehicles
- **WEEK Directive (Waste Electrical and Electronic Equipment):** A directive by European Parliament and European Council about disposal of electrical and electronic equipment
- **RoHS Directive (Restriction of the use of the certain Hazardous Substances in Electrical and Electronic Equipment):** A directive by European Parliament and European Council about restriction of the use of certain hazardous substances contained in electrical and electronic equipment
- **REACH Regulation (Registration, Evaluation, Authorization and Restrictions of Chemicals):** Restriction of the use of hazardous substances in electrical and electronic equipment
- **EuP Directive (Directive on Eco-Design of Energy-using Products):** A directive to establish a framework for defining eco-design requirements for energy-using products

The movement to regulate chemical substances led by Europe is spreading all over the world. Similar laws and regulations are being approved in other countries such as the U.S., China and Korea. Although these regulations that are enacted in each country are similar, some operations are significantly different. When products are exported, the laws and regulations of the destination must be checked carefully.

Appendix Table

Table-9.Hardness conversion table (HR30T, HRB, HV)

HR30T	HRB	HV	HR30T	HRB	HV	HR30T	HRB	HV
53.7	55	100	63.1	70	125	73.1	85	165
54.0	56	101	63.7	71	127	73.8	86	169
54.4	57	103	64.4	72	130	74.4	87	172
55.0	58	104	65.1	73	132	75.1	88	176
55.7	59	106	65.7	74	135	75.8	89	180
56.4	60	107	66.4	75	137	76.4	90	185
57.0	61	108	67.1	76	139	77.1	91	190
57.7	62	110	67.7	77	141	77.8	92	195
58.4	63	112	68.4	78	144	78.4	93	200
59.0	64	114	69.1	79	147	79.1	94	205
59.7	65	116	69.7	80	150	79.8	95	210
60.4	66	117	70.4	81	153	80.4	96	216
61.0	67	119	71.1	82	156	81.1	97	222
61.7	68	121	71.8	83	159	81.8	98	228
62.4	69	123	72.4	84	162	82.5	99	234

HR30T : Rockwell Superficial Hardness 30T Scale, 30-kgf Load 1/16inch Ball

HRB : Rockwell B Scale, 100-kgf Load 1/16inch Ball

HV : Vickers Hardness Number

Table-10.Physical property of element

Element \ Property	Fe	Ni	Sn	Zn
Atomic number	26	28	50	30
Atomic mass	55.85	58.69	118.7	65.39
Melting point (°C)	1540	1450	231.97	419.60
Boiling point (°C)	2750	2730	2270	907
Gravity (g/cm³)	7.87 (20°C)	8.90 (25°C)	7.28 (20°C)	7.13 (25°C)
Young's modulus (N/m²)	200×10 ⁹	207×10 ⁹	41.4×10 ⁹	96.5×10 ⁹
Heat conductivity (W/(m·K))	80.3	90.5	66.6	121
Thermal expansion coefficient (1/K)	11.76×10 ⁻⁶	13.3×10 ⁻⁶	23×10 ⁻⁶	39.7×10 ⁻⁶
Specific resistivity (Ω·cm)	9.71×10 ⁻⁶	6.84×10 ⁻⁶	11.0×10 ⁻⁶	5.92×10 ⁻⁶

(memo)