

KOBELCO

Chromate-Free Electrogalvanized Steel Sheets

Properties of ZINKOBELLA GX-COTE



 **KOBE STEEL, LTD.**

Introduction

As worldwide attention grows on protecting the environment, manufacturing industries have been focusing attention on the recycling and the procurement of environment-friendly materials.

In response to customer demand, Kobe Steel ceased production of chromate-treated electrogalvanized steel sheet in March 2005. As an alternative on our product menu, we offer the chromate-free Zinkobella GX-COTE series, a product easy on the environment.

In the following pages, we introduce this well-balanced, outstanding line-up of chromate-free electrogalvanized steel sheet.

With a wealth of experience, strict attention to quality control and thorough control of substances that burden the environment, we are confident of satisfying your requirements for electrogalvanized steel sheet.

Nonuse of substances that burden the environment

The Zinkobella GX-COTE series does not use the following substances listed below that burden the environment. There may be impurities that are unavoidably contained in raw materials such as iron ore, but the substances below are not used:

(Substances not used in Zinkobella GX-COTE)

- Mercury (Hg) and its compounds
- Cadmium (Cd) and its compounds
- Lead (Pb) and its compounds
- Hexavalent chromium (Cr⁶⁺) and its compounds
- PBB (Polybrominated biphenyls)
- PBDE (Polybrominated diphenyl ethers)

Note: The above applies to products as shipped from Kobe Steel's facilities. It excludes cases of substance adhesion or corrosion that may occur during transportation and secondary processing, including cutting, and forming.

Notice and request:

The technical information contained in this document is an explanation of typical properties and performances of products valid at June 2005. It is not a guarantee.

We do not bear responsibility for the damage caused by mistaken or inappropriate use of the information contained in this document.

The information can be changed without previous notice when occasion demands. For the latest information, please contact us.

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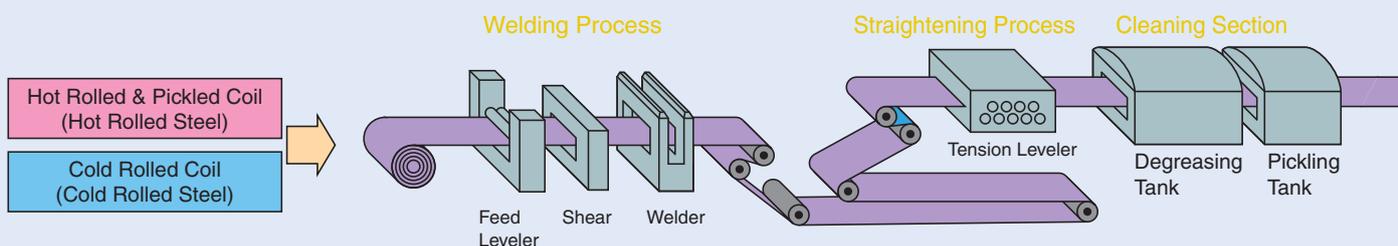
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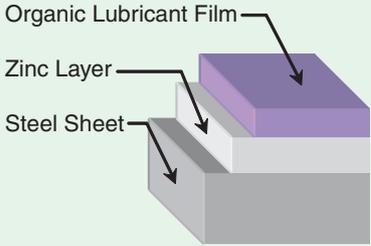
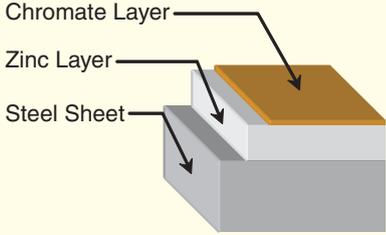
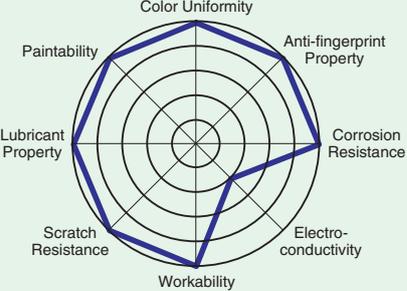
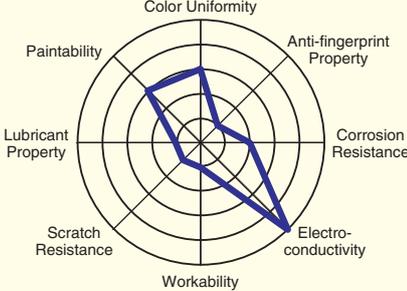
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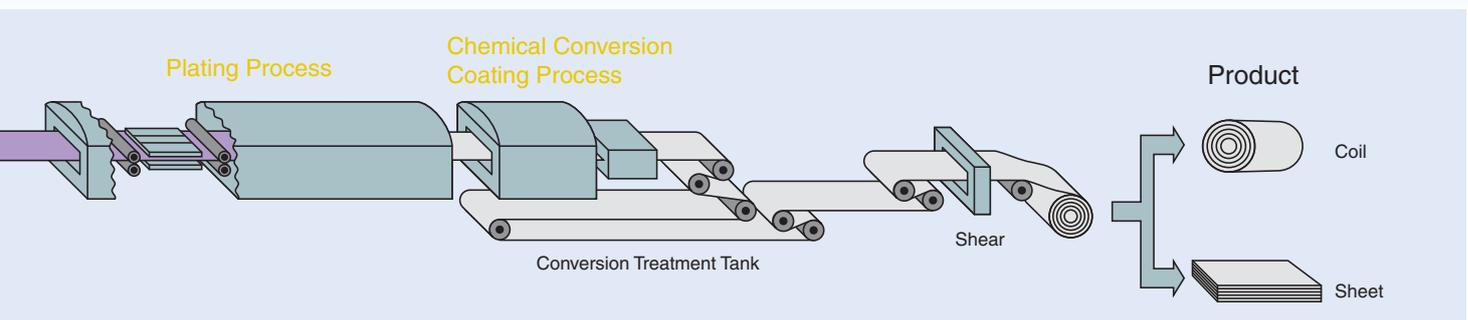
◆ Product list

Name of Treatment	Phosphate Treatment	Anti-fingerprint Treatment	
Type	Inorganic	Organic	Inorganic
Symbol	GX-GP	GX-K2	GX-KS
Structure	<p>Chromate-free Sealing Phosphate Film Zinc Layer Steel Sheet</p>	<p>Organic Composite Film Zinc Layer Steel Sheet</p>	<p>Inorganic Composite Film Zinc Layer Steel Sheet</p>
Properties (Image)			
Typical Applications	<ul style="list-style-type: none"> ● Electrical Distribution Panel ● Outer Panel of Vending Machine ● Top Cover of Audio Visual Equipment 	<ul style="list-style-type: none"> ● Body of Personal Computer ● Photocopier and Printer Parts ● Chassis for Audio Visual Equipment and Car Audio 	<ul style="list-style-type: none"> ● Motor Case ● Cover Parts of Data Storage for PC ● Chassis for Car Audio and Audio Visual Equipment

◆ Manufacturing Process



Lubricant Treatment	(Ref.) Chromate treatment
Organic	(Inorganic)
GX-J2	C
	
	
<ul style="list-style-type: none"> Motor Case 	



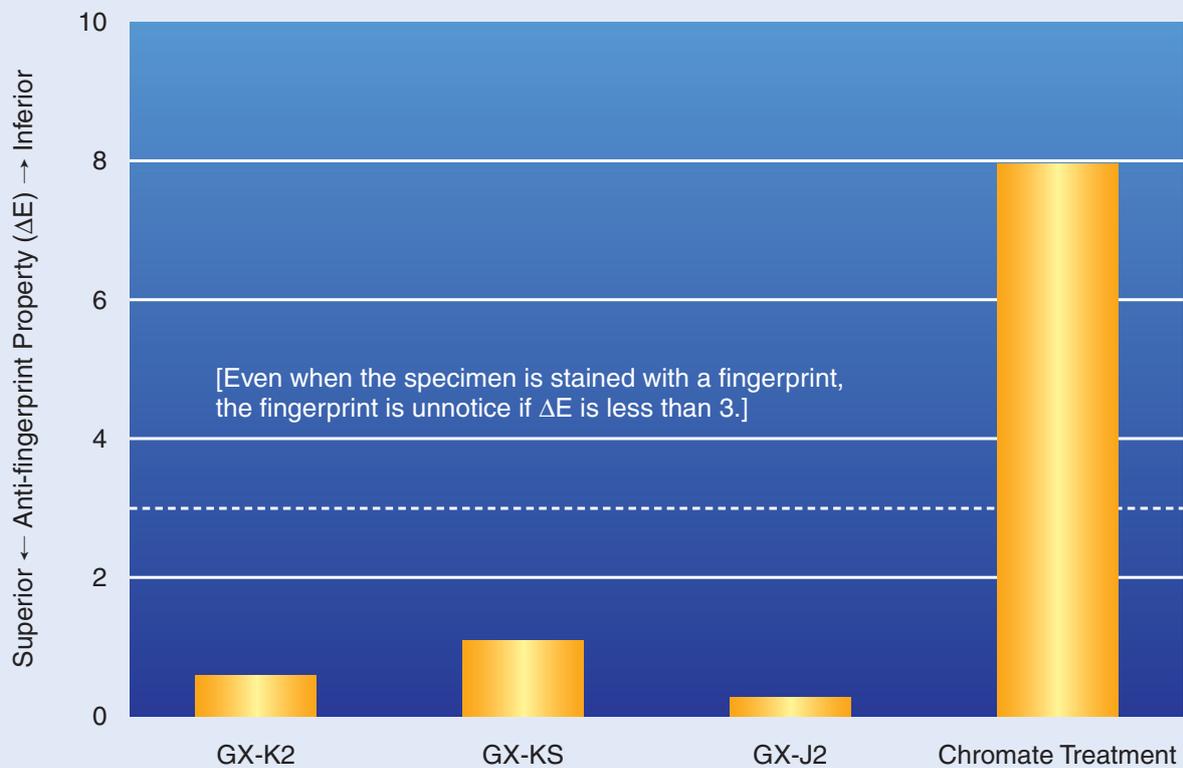
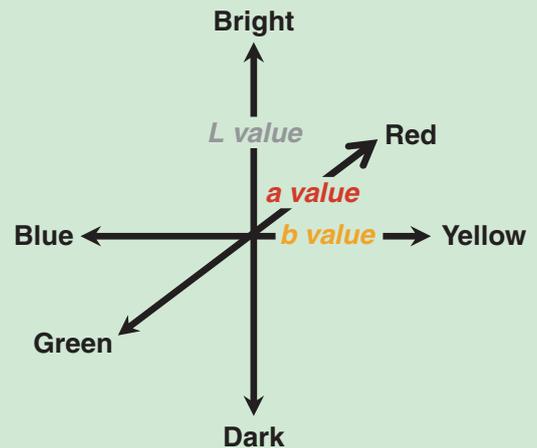
◆ Anti-fingerprint Property

Measuring Method of Anti-fingerprint Property

- ◆ **Measuring Method** : The color difference (ΔE) is measured before and after the specimen is dipped in a 50°C acetone solution saturated with white vaseline.
- ◆ **Measuring Equipment** : NIPPON DENSHOKU INDUSTRIES CO.,LTD., Color Measurement Instrument SZS-Σ90.
- ◆ **Measuring Mode** : In Conformity with JIS-Z8722.

$$\text{Color Difference } (\Delta E) = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$$

- * ΔL : Difference in Brightness
- Δa : Difference in Redness
- Δb : Difference in Yellowness

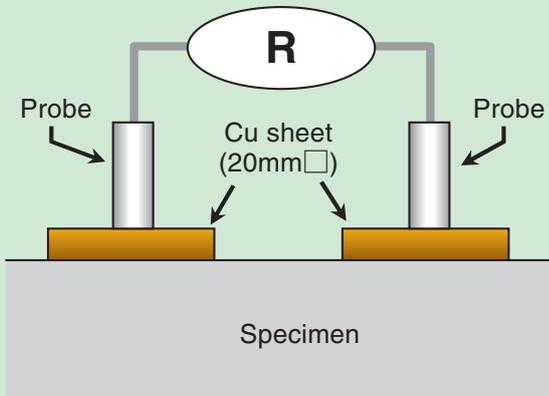


Test Results for Anti-fingerprint Property

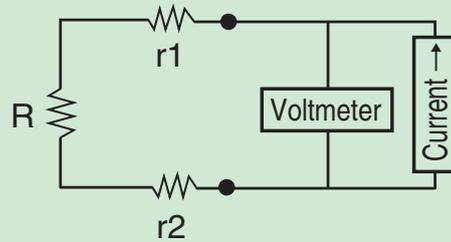
◆ Electroconductivity

1 Surface Resistance: 2-probe method

Conceptual Figure for the Resistivity Meter to Measure Surface Resistance



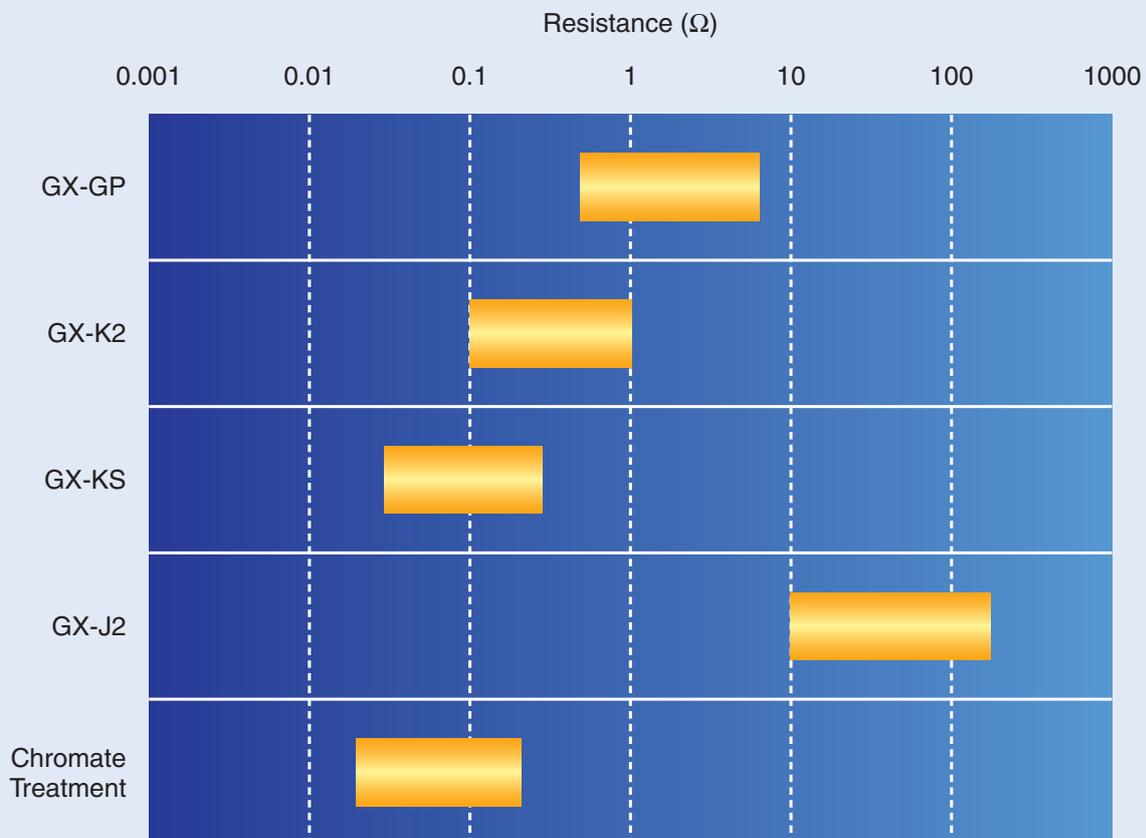
Measurement Theory



$$\text{Resistance} = R + r1 + r2 + \alpha$$

- ◆ **Resistivity Meter** : Loresta EP
(DIA INSTRUMENTS CO.,LTD.)
- ◆ **Probe** : AP probe
- ◆ **Measuring Mode** : Two-probe Mode

- By applying the copper sheet, the affection of surface condition shall be reduced.
Good method for relative evaluation of thin surface coating resistance ($r1, r2$).
Values include the resistance from mother steel (R) and wires (α).

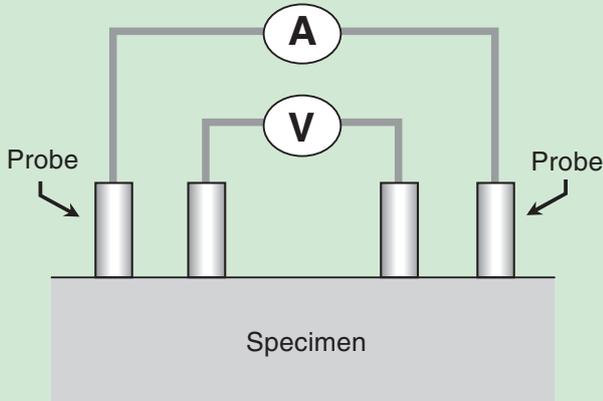


Measurement Results of Surface Resistance (2-probe method)

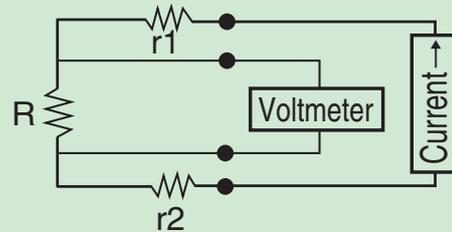
◆ Electroconductivity

2 Surface Resistance: 4-probe method

Conceptual Figure for the Resistivity Meter to Measure Surface Resistance

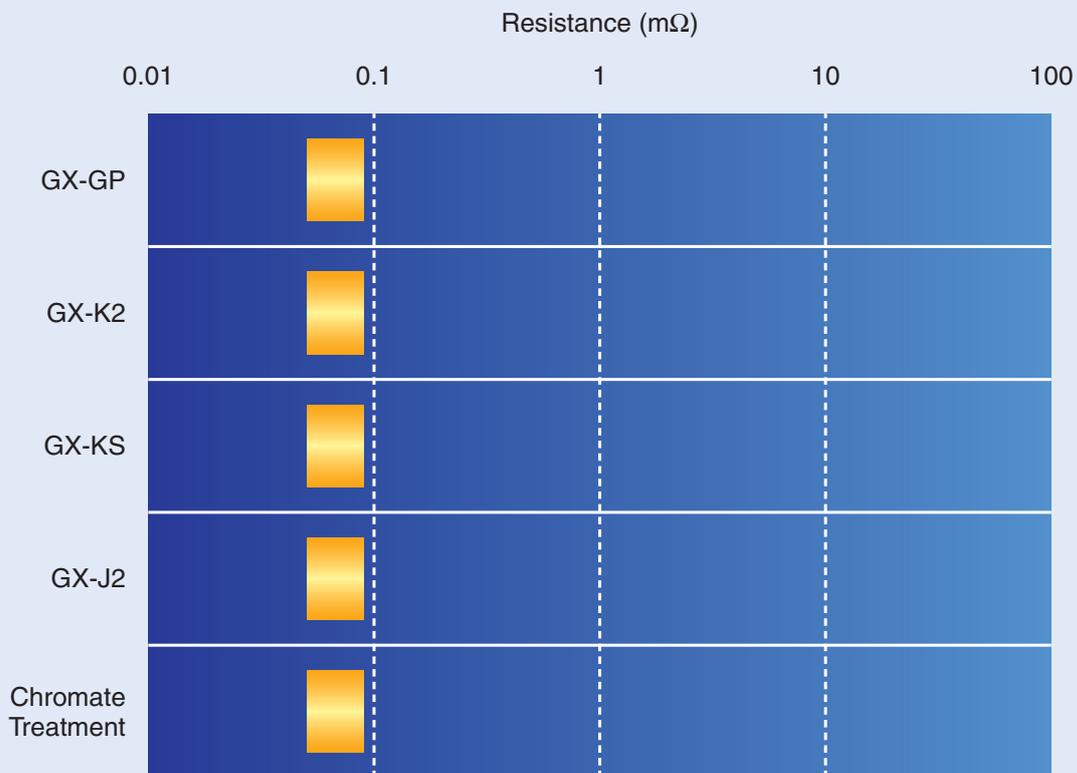


Measurement Theory



- ◆ **Resistivity Meter** : Loresta EP
(DIA INSTRUMENTS CO.,LTD.)
- ◆ **Probe** : ESP probe
- ◆ **Measuring Mode** : Four-probe Mode

- Voltage between 2 inside probe is measured after passing a constant current between 2 outside probe.
Measurement value is the resistance (R) except surface coating (r1,r2)

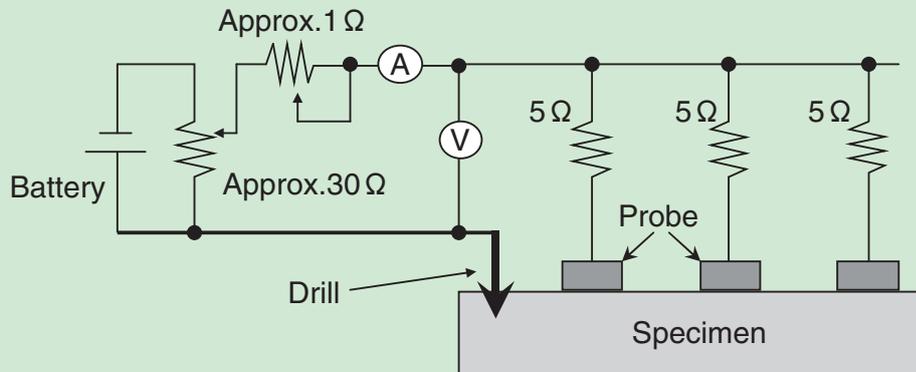


Measurement Results of Surface Resistance (4-probe method)

◆ Electroconductivity

3 Interlaminar Resistance

Conceptual Figure for the Measuring Interlaminar Resistance



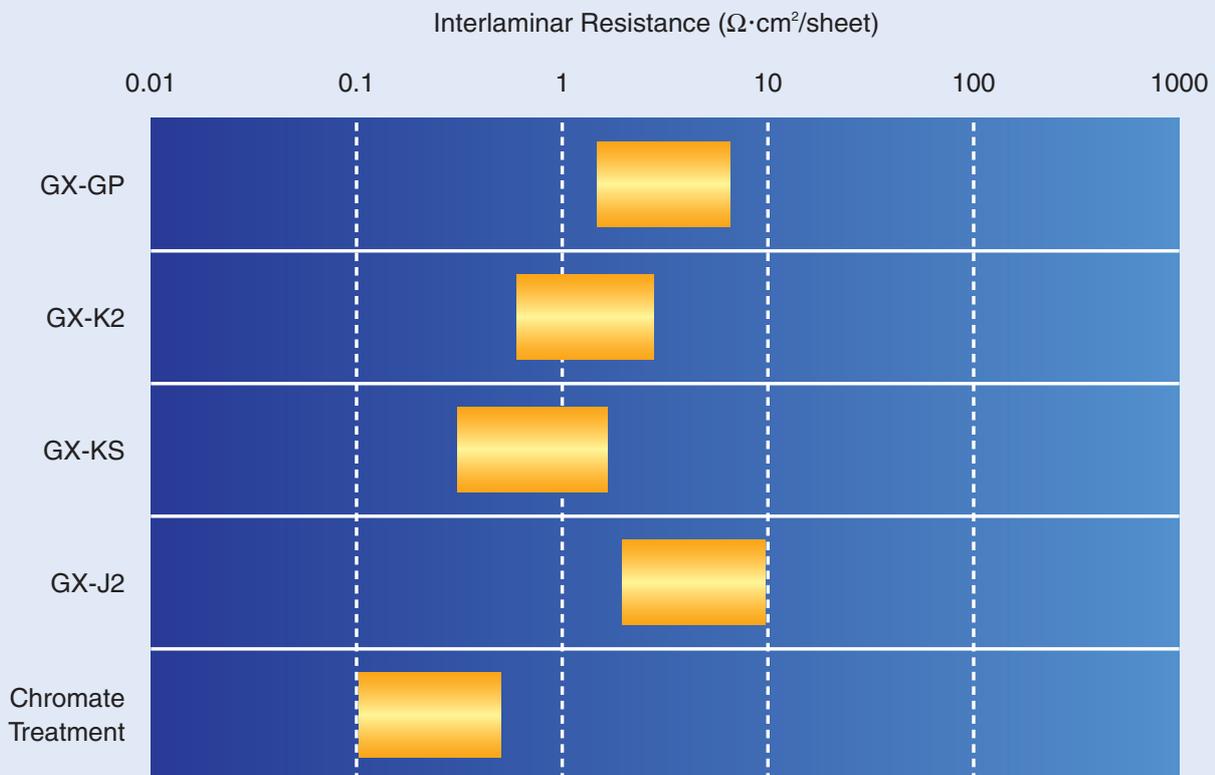
- Voltage 0.5V
- Current Range 0~1A
- Probe area $1\text{cm}^2 \times n = 10$
- Standard test pressure $2\text{N/mm}^2 \pm 5\%$
(In conformity with JIS C2550)

$$R_s = A (1/i - 1)$$

R_s : Interlaminar Resistance ($\Omega \cdot \text{cm}^2/\text{sheet}$)

A : Total contact area = 10 (cm^2)

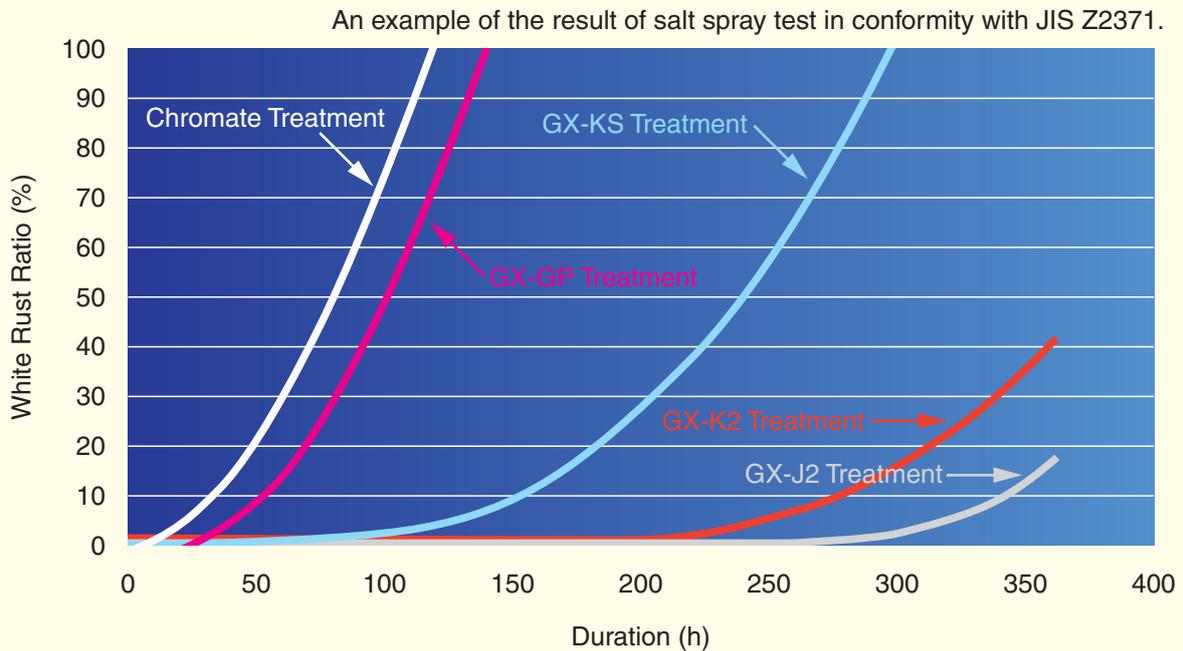
i : Average current (A)



Measurement Results of Interlaminar Resistance

◆ Corrosion Resistance

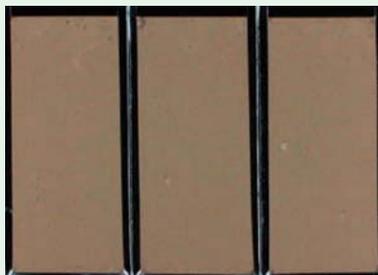
1 Corrosion Resistance of Flat Sheet



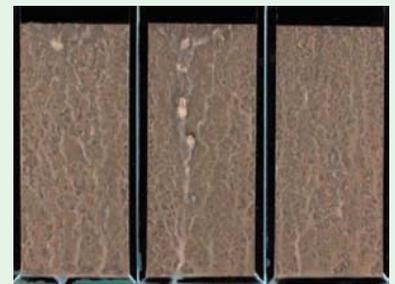
Salt Spray Test Results for Bare Flat Sheets (With Edge Sealing)



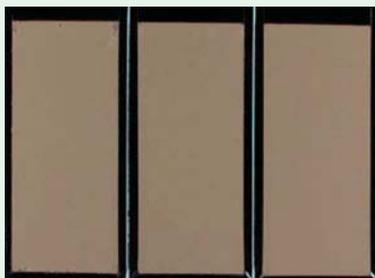
GX-GP (after 72h)



GX-K2



GX-KS



GX-J2



**Chromate Treatment
(after 72h)**

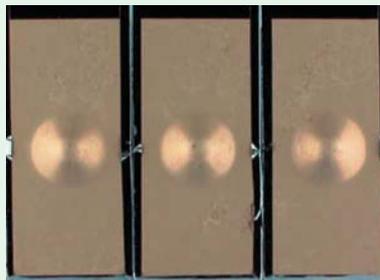
Appearances of Samples after 240 h Salt Spray Test

◆ Corrosion Resistance

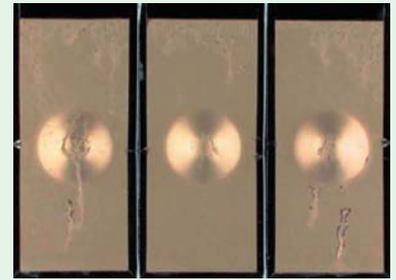
2 Corrosion Resistance after Erichsen Cupping



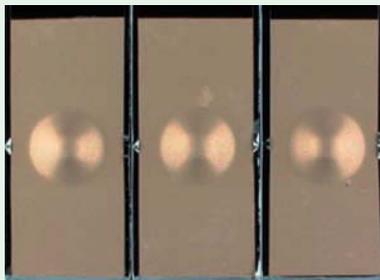
GX-GP



GX-K2



GX-KS



GX-J2



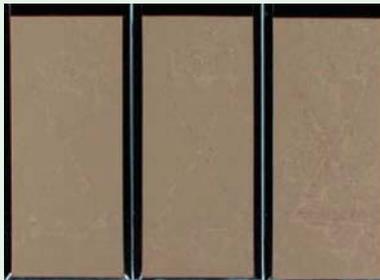
Chromate Treatment

Appearance of Samples
after 72 h
Salt Spray Test
(Erichsen Cupping)

3 Corrosion Resistance after Cross Cutting



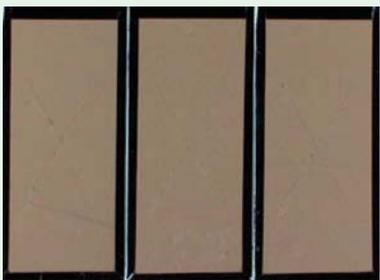
GX-GP



GX-K2



GX-KS



GX-J2

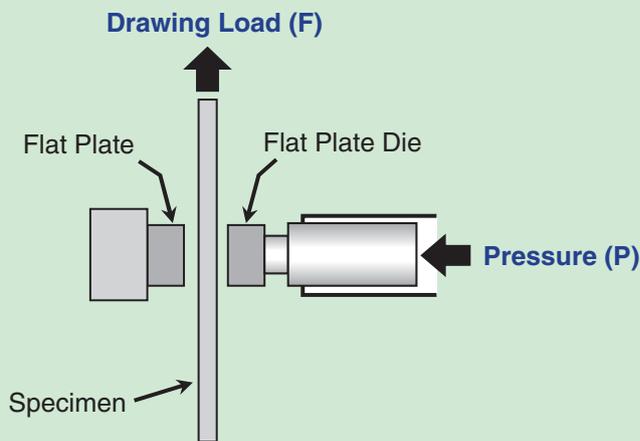


Chromate Treatment

Appearance of Samples
after 72 h
Salt Spray Test
(Cross Cutting)

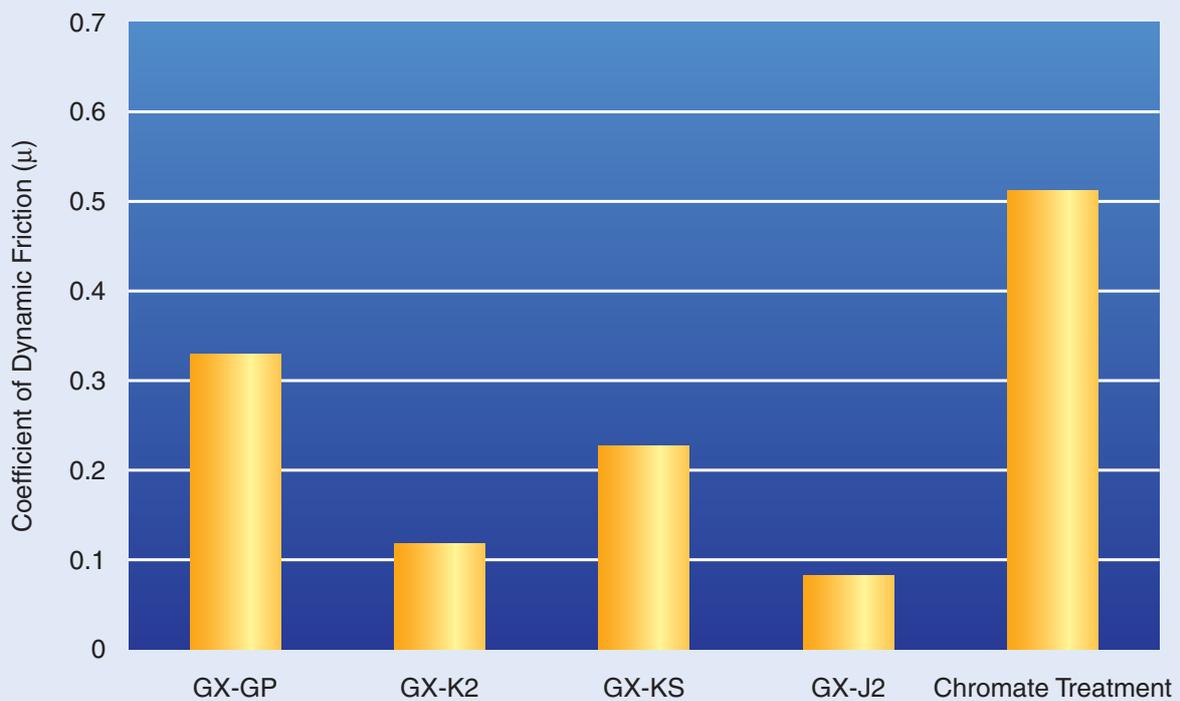
◆ Lubricant Property

Measuring Method for Coefficient of Dynamic Friction



- ◆ Sample Size : 40 × 300mm
- ◆ Pressure : 4.5MPa
- ◆ Drawing Speed : 300mm/min
- ◆ Material for Flat Plate Die : SKD11
- ◆ Oil-less

Coefficient of Dynamic Friction :
 $\mu = F / 2P$

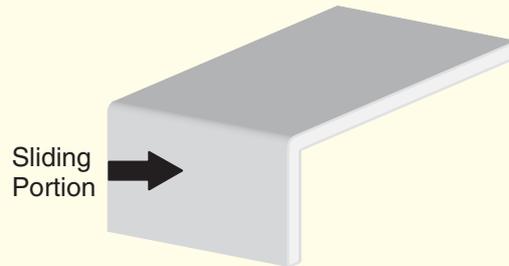
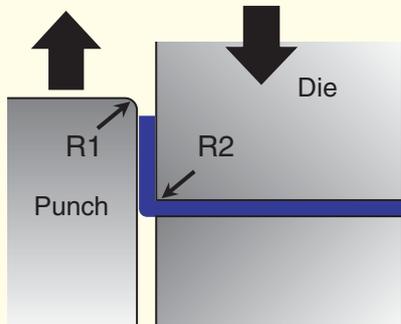


Measurement Results of Coefficient of Dynamic Friction

◆ Workability

1 90° Bending

Forming conditions and Shape of Forming



<Forming conditions>

- ◆ Press Used: 80-ton Crank Press
- ◆ Sheet Thickness: 0.8mm
- ◆ Oil-less
- ◆ Forming Speed: 40 Stroke/min

<Shape of Forming>

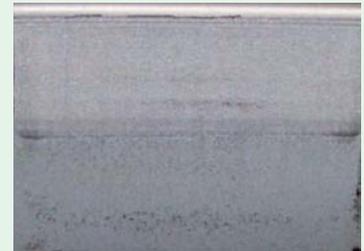
- ◆ Clearance: +20 μ m to Sheet Thickness
- ◆ R1: Punch Profile Radius 0.5mmR
- ◆ R2: Die Profile Radius 0.5mmR
- ◆ Blank Holding Force: 0.2MPa



GX-GP



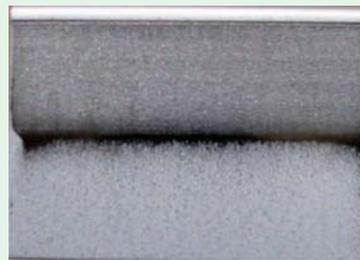
GX-K2



GX-KS



GX-J2



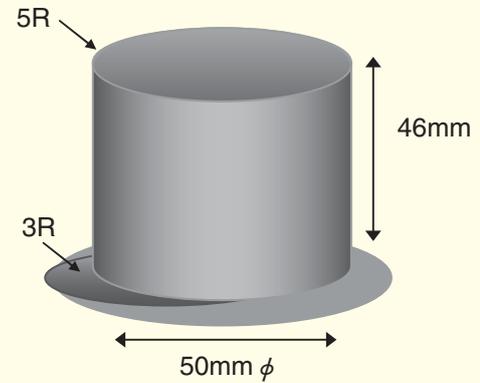
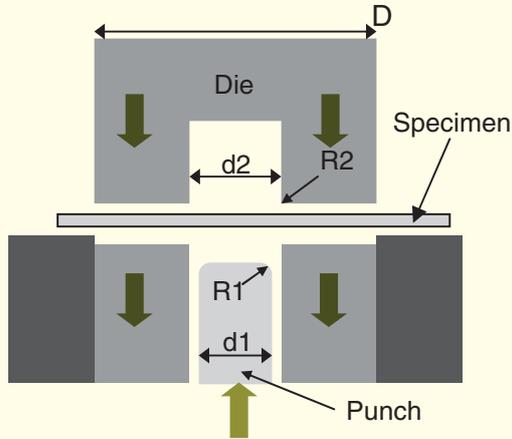
Chromate Treatment

Appearance of Sliding Portion after 90° Bending Test

◆ Workability

2 Cylindrical Deep Drawing

Forming Conditions and Shape of Forming



- D: Blank Diameter 110mm ϕ
- d1: Punch Diameter 50.0mm ϕ
- d2: Die Diameter 51.64mm ϕ
- R1: Punch Profile Radius 5mmR
- R2: Die Profile Radius 3mmR
- Clearance Sheet Thickness (0.8mm) +20 μ m

- Press Used: 80-ton Crank Press
- Die Assembly: Cylindrical Die Assembly
- Forming speed: 40 Stroke/min
- Blank Holding Force: 0.1MPa
- Drawing Ratio: 2.20
- Lubricant: Quick Drying Type Oil (PALACE CHEMICAL CO.,LTD Punching Oil AP209)



GX-GP



GX-K2



GX-KS



GX-J2



Chromate Treatment

Appearance of Sliding Portion after Cylindrical Deep Drawing Test

◆ Solvent Resistance

Evaluation of solvent resistance

◆ **Condition** : 50mm × 100mm Specimen was dipped for 168hr in 200cc solvent or punching oil in room temperature.

Color Difference was measured before and after dipping.

◆ **Apparatus** : NIPPON DENSHOKU INDUSTRIES CO.,LTD., Color Measurement Instrument SZS-Σ90.

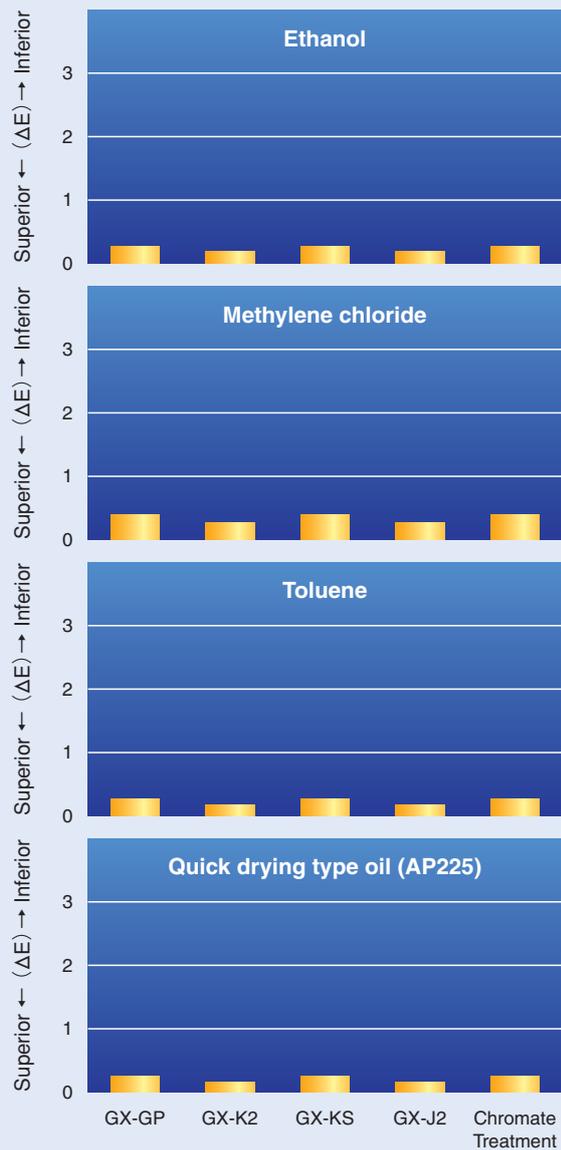
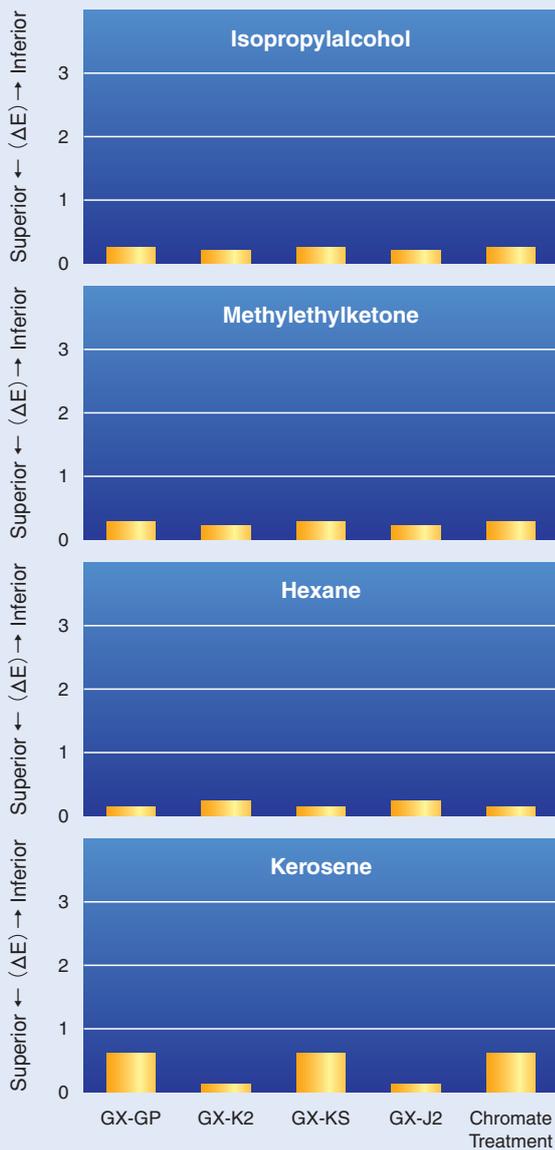
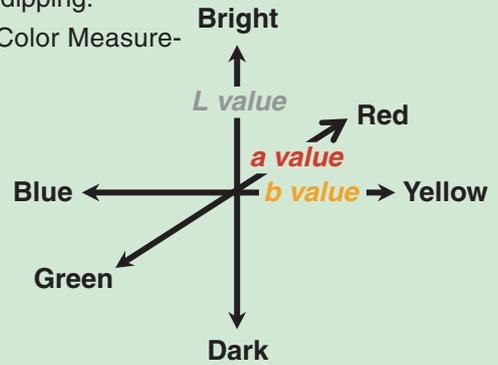
◆ **Measurement** : In Conformity With JIS-Z8722.

$$\text{Color Difference } (\Delta E) = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$$

※ ΔL : Difference in Brightness

Δa : Difference in Redness

Δb : Difference in Yellowness



◆ Paint Adhesion

● Painting Conditions

Type of Paint	Paint	Thickness	Baking Condition
Acrylic Type	MAGICRON #1000 / KANSAI PAINT CO.,LTD.	About 20 μm	160°C × 20 min
Melamine-alkyd Type	AMILAC #1000 / KANSAI PAINT CO.,LTD.	About 20 μm	130°C × 20 min

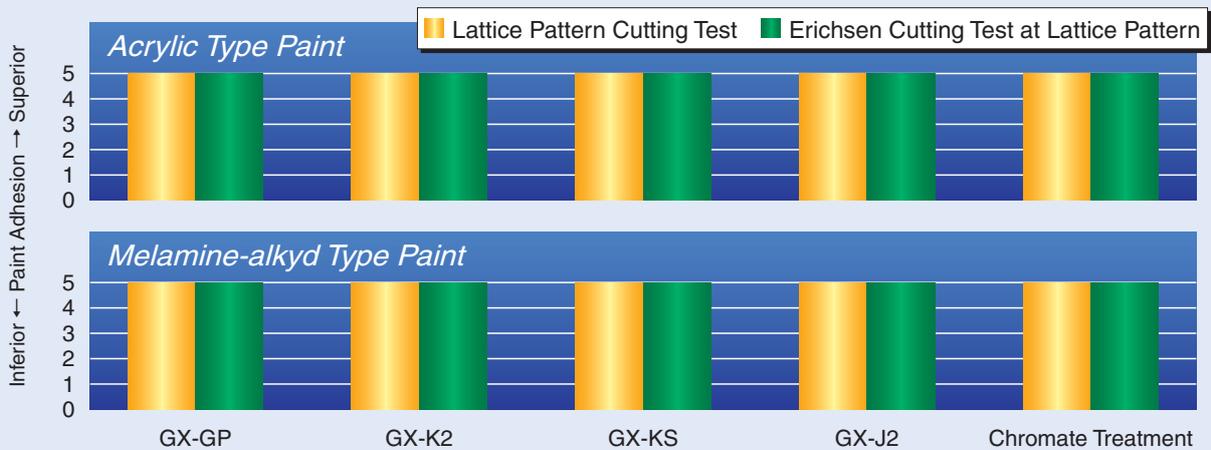
● Method of Evaluation

- Primary Adhesion : After lattice pattern cutting test with a lattice distance of 1mm and Erichsen cupping test at lattice pattern (Erichsen height : 6mm), the residual ratio of the painted film is determined by the tape peeling test.
- Adhesion after aging : After the specimen is dipped in the boiling water for 1 hr, the same evaluation as that for primary adhesion is made.

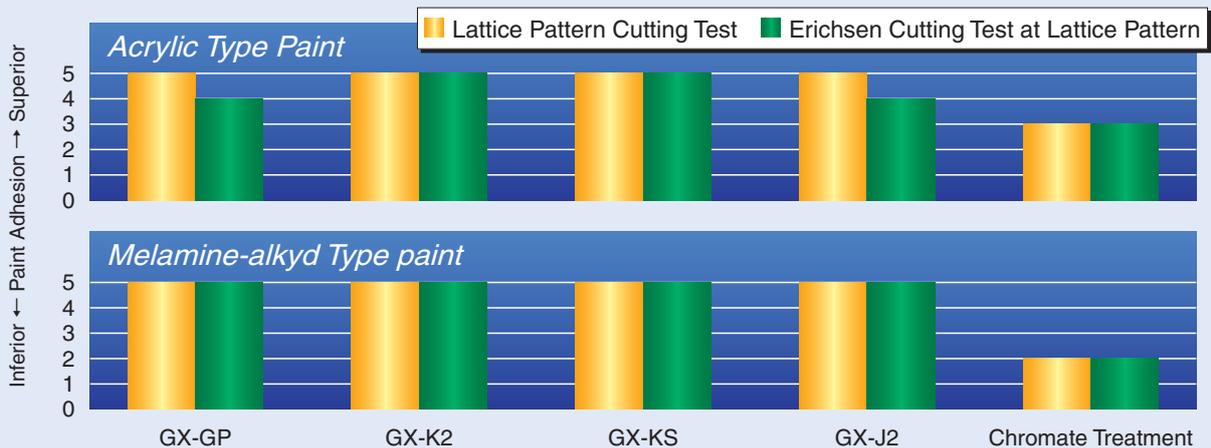
● Score

Score	5	4	3	2	1
Number of Residual Squares	100	99~90	89~80	79~70	69~0

Initial Adhesion



Adhesion after aging



◆ Silk Printing Performance

● Printing Conditions

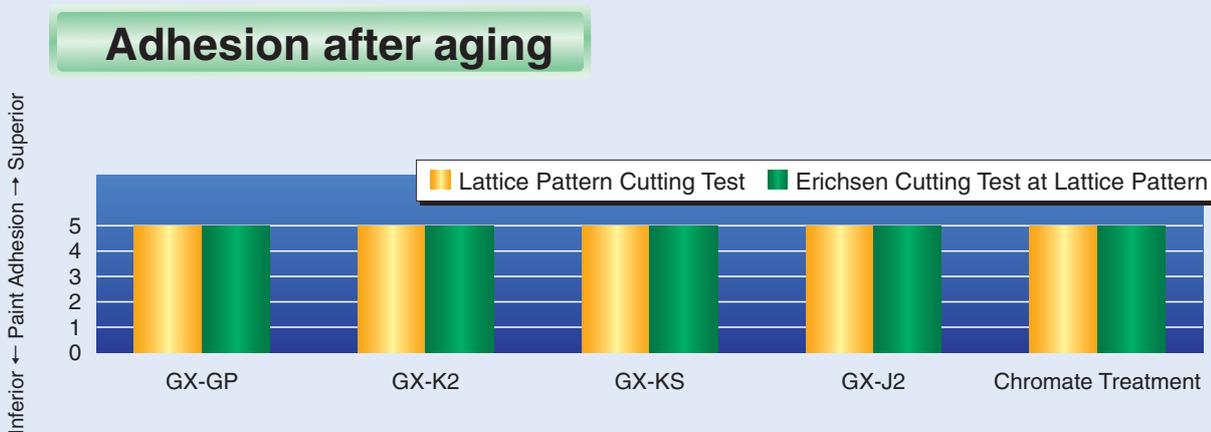
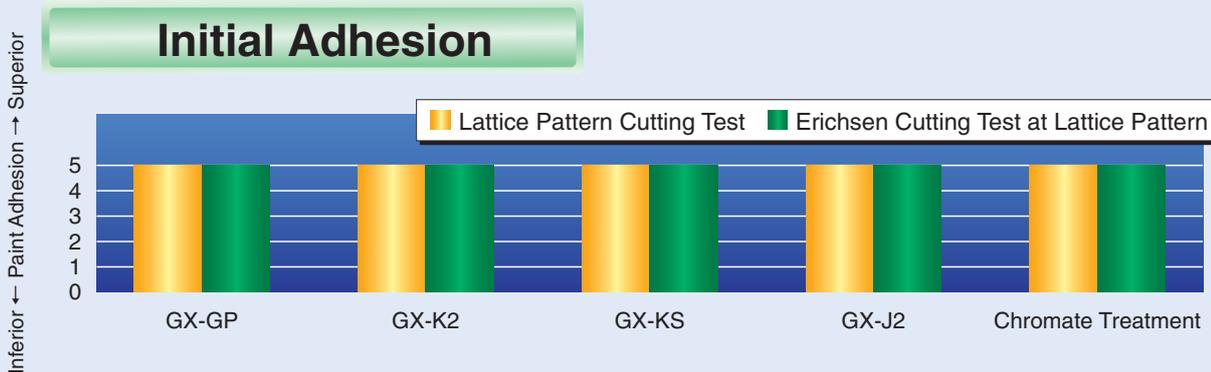
- ① Ink : SEIKO ADVANCE LTD. #1300
- ② Baking Condition: 150°C × 30 min

● Evaluation

- Primary Adhesion : After lattice pattern cutting test with a lattice distance of 1mm and Erichsen cupping test at lattice pattern (Erichsen height : 6mm), the residual ratio of the painted film is determined by the tape peeling test.
- Adhesion after aging : After the specimen is dipped in the boiling water for 1 hr, the same evaluation as that for primary adhesion is made.

● Score

Score	5	4	3	2	1
Number of Residual Squares	100	99~90	89~80	79~70	69~0



Note: Chromate treatment may be inadequate for silk printing, in particular, for printing fine letters.

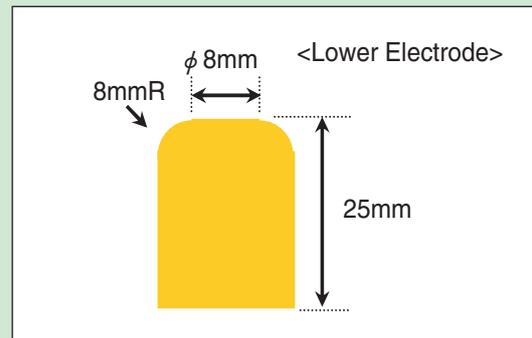
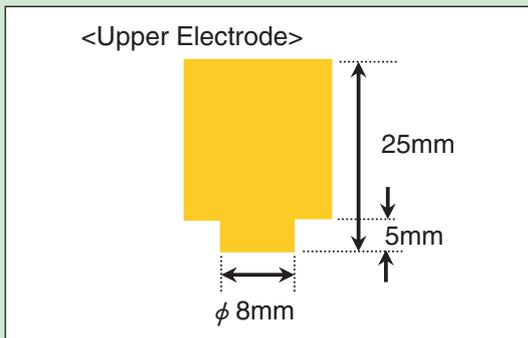
◆ Spot Weldability

Welding Conditions

<Welding Conditions>

- **Welder** : MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD. Resistance Welder (YR-500JMT10)
- **Electrode Force** : 2156N
- **Welding Time** : 12cycle (60Hz)
- **Electrode Tip** : 1%Cr-Cu

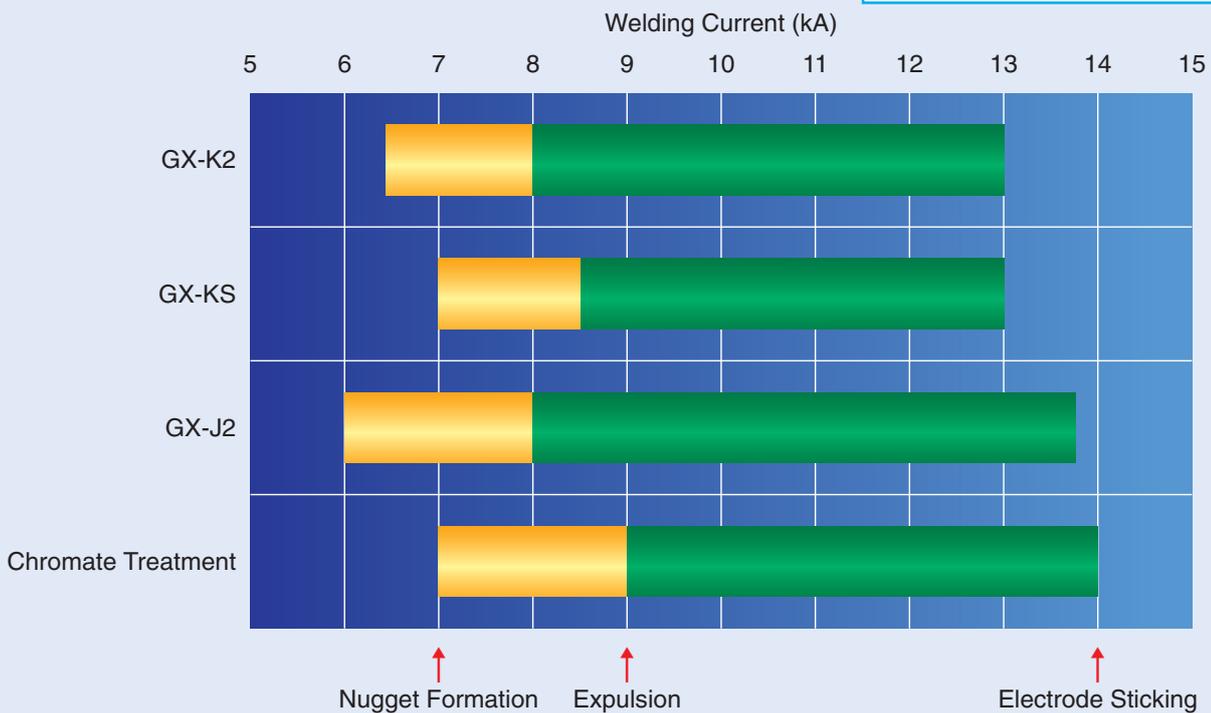
<Shape of Electrode Tip>



1 Acceptable Welding Current Range

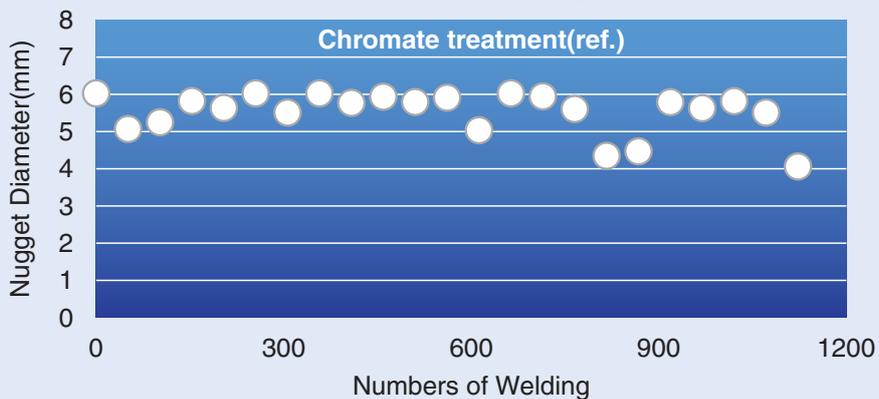
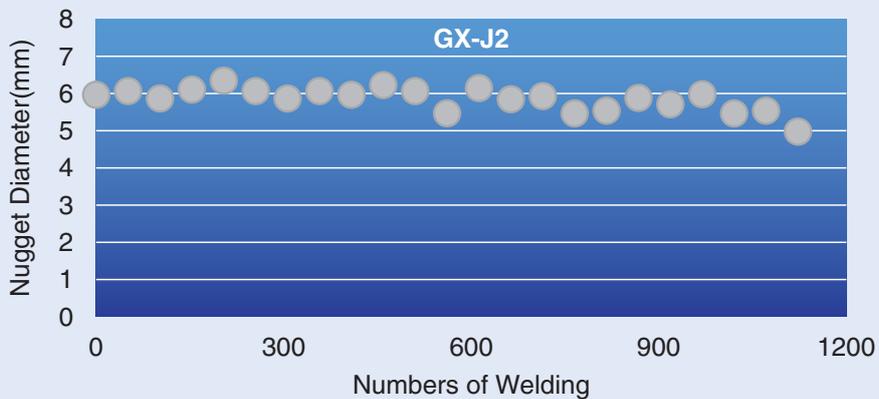
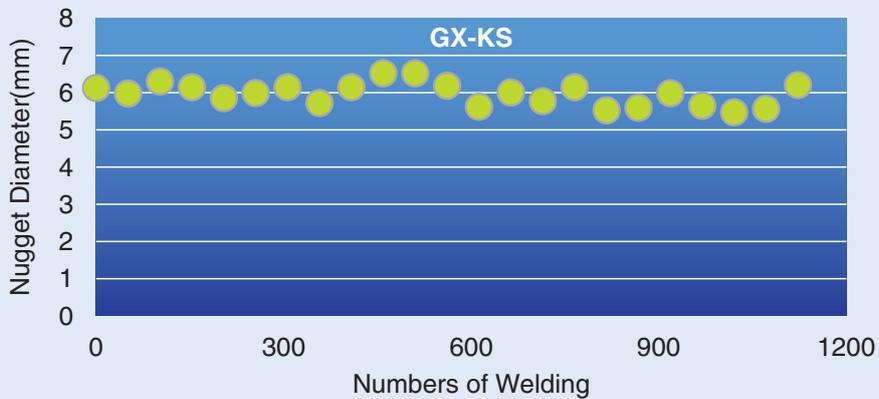
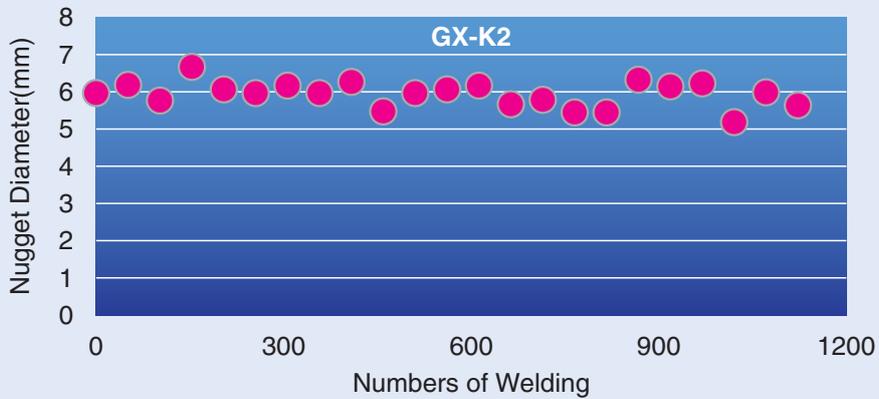
- ◆ Lower Limit : Current Where a Nugget Diameter of $4\sqrt{t}$ is Formed (t=Sheet thickness)
- ◆ Upper Limit : Current without the Sticking of Electrode.

● The acceptable welding current range depends upon the welding machine used, welding conditions and sheet thickness. An example for each treatment is shown below.



2 Continuous Spot Welding Performance

● The continuous spot welding performance depends upon the welding conditions and sheet thickness. An example for each treatment is shown below.



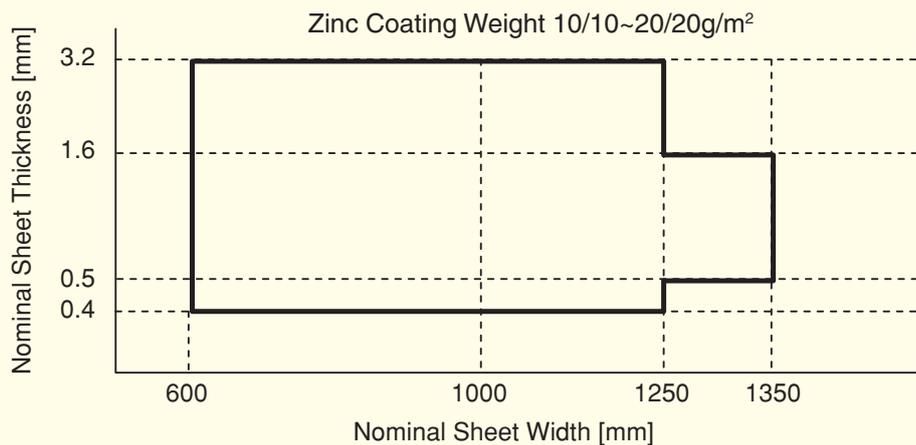
Changes in Nugget Diameter with the Number of Continuous Spot Welds.

◆ Range of Available Products

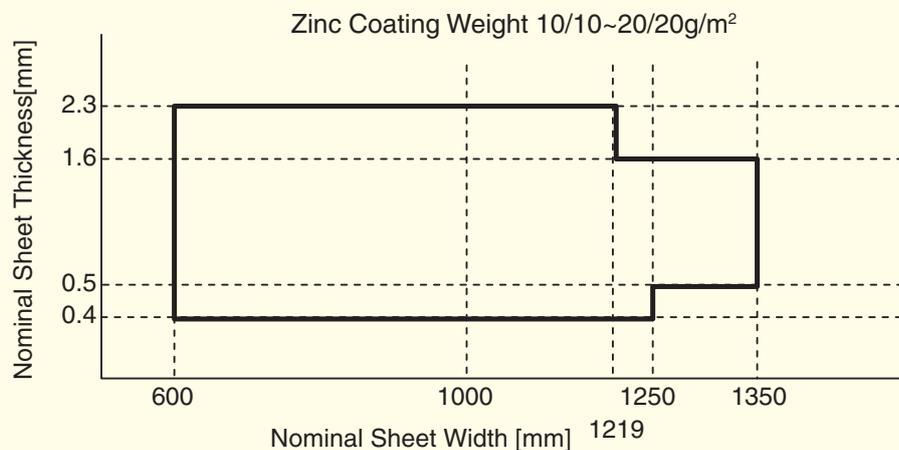
GX-GP Treatment



GX-K2, GX-KS Treatment



GX-J2 Treatment



Outside of the range shown above, please consult with us separately.

Proper Usage of Steel Sheets

1. Handling

- ◆ Since the steel sheet is slippery, be careful during handling. In particular, pay special attention to lubricant-treated (GX-J2 treatment) steel sheet, as this variety is the most slippery.
- ◆ The edges of the steel sheet are sharp and can cause cuts. It is recommended that protective gear such as gloves be used during handling.
- ◆ When the hoop binding the coil is released, be careful of the coil edge, which can spring back.

2. Processing

- ◆ When press forming, ensure that the die assembly is adequately maintained before using it.
- ◆ Press oil and quick-drying oil, depending on the variety, can damage the coating. Confirm the type of oil before application.
- ◆ When using press oil, it is recommended to use oil that does not contain extreme-pressure additives such as phosphate (P), sulfur (S) and chlorine (Cl) to prevent damage to the coating.

3. Degreasing

- ◆ For degreasing, a weak alkaline degreasing agent is recommended. Intermediate alkaline and strong alkaline degreasing agents should be avoided.
- ◆ Depending upon their variety, some degreasing agents can damage the surface coating. Check their degreasing properties before using.

4. Painting · Silk Printing

- ◆ The adhesive property of paint film depends upon the type of the paint. Use paint after verifying its applicability.

5. Welding

- ◆ Weldability depends upon the type of welding machine and welding conditions. Perform welding after checking weldability.
- ◆ During welding, fume mainly composed of zinc oxide is generated. Provide adequate ventilation during welding operations.

6. Others

- ◆ When using these sheet products under circumstances where they are exposed to high temperatures for a long time, check the sheet beforehand for damage.
- ◆ Do not expose the steel sheet to acids and strong alkalines.
- ◆ Adhesives and bonding agents (tapes and seals for example) can damage the coating.
- ◆ Performance data has been derived from tests conducted at our laboratories.

MEMO

MEMO



KOBE STEEL LTD. TOKYO HEADQUARTER STEEL EXPORT DEPARTMENT
9-12, KITA-SHINAGAWA 5-CHOME, SHINAGAWA-KU, TOKYO 141-8688 JAPAN
TEL +81-3-5739-6153 FAX +81-3-5739-6923

KOBELCO (CHINA) HOLDING CO., LTD.
ROOM 3701, HONG KONG NEW WORLD TOWER, 300 HUAI HAI ZHONG
ROAD, LUWAN DISTRICT, SHANGHAI 200021, PEOPLE'S REPUBLIC OF CHINA
TEL +86-21-6415-4977 FAX +86-21-6415-9409

KOBE STEEL LTD. BANGKOK REPRESENTATIVE OFFICE
10th Fl., SATHORN THANI TOWER II, 92/23 NORTH SATHORN ROAD.,
KHWAENG SILOM, KHET BANGRAK, BANGKOK 10500, KINGDOM OF THAILAND
TEL +66-2-636-8971 FAX +66-2-636-8675

KOBE STEEL ASIA PTE. LTD. SINGAPORE OFFICE
72 ANSON ROAD, #11-01A ANSON HOUSE, SINGAPORE 079911,
REPUBLIC OF SINGAPORE
TEL +65-6221-6177 FAX +65-6225-6631

KOBE STEEL ASIA PTE. LTD. HONG KONG REPRESENTATIVE OFFICE
ROOM 1604, MASSMUTUAL TOWER, 38 GLOUCESTER ROAD, WANCHAI, HONG KONG
TEL +852-2865-0040 FAX +852-2520-6347

KOBE STEEL USA INC. DETROIT OFFICE
19575 VICTOR PARKWAY, SUITE 250, LIVONIA MI 48152 U.S.A.
TEL +1-734-462-7757 FAX +1-734-462-7758