Coated Steel Sheets
Hot-dip Galvanized Sheets, Electrogalvanized Sheets and Precoated Sheets

NIPPON STEEL & SUMITOMO METAL
http://www.nssmc.com/
Coated Steel Sheets of Nippon Steel & Sumitomo Metal Corporation

Steel sheets are applied throughout a broad spectrum of life and industry—including automobiles, home electric appliances, building materials, housing, beverage cans, and transformers. Economic growth in the emerging countries and other parts of the world has spurred an expansion in steel sheet use.

By its speedy response to a wide range of needs and its rich line-up of products, Nippon Steel & Sumitomo Metal Corporation is renowned for its coated steel sheets. Nippon Steel & Sumitomo Metal develops and markets high-performance steel materials capable of responding to increasingly stringent needs, such as growing concern for the environment and energy conservation.

Coated steel sheets, in particular, are required to possess not only rust resistance but press formability, weldability, paintability, and various other properties as well. In addition to metallurgy, a growing diversity of other technologies is indispensable for meeting those needs. They include electro-chemistry, thin-film engineering, paint engineering, interface engineering, corrosion science, thermal technology, and alloying control (diffusion) technology. In the case of coated steel sheets, if any of these technologies is lacking, customer needs cannot be fulfilled.

Nippon Steel & Sumitomo Metal has outstanding command of these various elemental technologies and continues to develop products that precisely meet the performance requirements of its customers.

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### Lineup of Coated Steel Sheets of Nippon Steel & Sumitomo Metal

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<th>Brand name</th>
<th>Coating structure (representative example)</th>
<th>Coating mass (g/m²)</th>
<th>Plate thickness (mm)</th>
<th>Width (mm)</th>
<th>Features</th>
<th>Post treatment</th>
<th>Main applications</th>
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<td>Zn-Al alloyed 40g/m² (0.1μm)</td>
<td>30</td>
<td>0.5</td>
<td>610</td>
<td>Corrosion resistance, Paint adhesion</td>
<td>○</td>
<td>Automobile outer and inner panels, home appliance</td>
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<td>Hot-dip galvanized steel sheet and strip</td>
<td>DURGRIP™</td>
<td>Zn-120g/m² (1.7μm)</td>
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<td>0.23</td>
<td>580</td>
<td>Corrosion resistance</td>
<td>○</td>
<td>Structural member (sheet metal), automotive, home appliance</td>
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<td>0.27</td>
<td>580</td>
<td>Corrosion resistance</td>
<td>○</td>
<td>Structural member (sheet metal), automotive, home appliance</td>
<td>7</td>
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<td>Structural member (sheet metal)</td>
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</tr>
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<td>Hot-dip aluminum-coated steel sheet and strip</td>
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<td>Al-Si alloy 50g/m² (0.1μm)</td>
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<td>0.3</td>
<td>610</td>
<td>Corrosion resistance</td>
<td>○</td>
<td>Automobile exhaust system parts, Heating equipment</td>
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</tr>
<tr>
<td>Sn-Zn coated steel sheet and strip</td>
<td>ECOKOTE™-S</td>
<td>Sn-Zn layer Special Fin</td>
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<td>0.3</td>
<td>610</td>
<td>Corrosion resistance (for fuel)</td>
<td>○</td>
<td>Fuel tank</td>
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</tr>
<tr>
<td>Electrolytic zinc-coated steel sheet and strip</td>
<td>ZINKOTE™</td>
<td>Zn 28g/m² (0.2μm)</td>
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<td>0.4</td>
<td>600</td>
<td>Corrosion resistance</td>
<td>○</td>
<td>All equipment, electronic device, home appliance</td>
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<tr>
<td>Electrolytic zinc-nickel alloy-coated steel sheet and strip</td>
<td>DURZINKLITE™</td>
<td>Zn-Ni alloy 20g/m² (0.2μm)</td>
<td>10</td>
<td>0.4</td>
<td>600</td>
<td>Corrosion resistance</td>
<td>○</td>
<td>Automobile outer and inner panels, home appliance</td>
<td>12</td>
</tr>
<tr>
<td>Zn-Si-Ni alloy coated steel sheet and strip</td>
<td>ECOTRIO™</td>
<td>Zn-Si-Ni alloy Special Fin</td>
<td>4</td>
<td>0.15</td>
<td>580</td>
<td>Whisker resistance</td>
<td>○</td>
<td>All equipment, electronic device, OA equipment</td>
<td>14</td>
</tr>
<tr>
<td>Nickel Coated Steel Sheet and strip</td>
<td>SUPERNICKEL™</td>
<td>Fe-Ni alloy Ni layer</td>
<td>1</td>
<td>0.15</td>
<td>25</td>
<td>Corrosion resistance (particularly after forming)</td>
<td>○</td>
<td>Battery</td>
<td>15</td>
</tr>
<tr>
<td>VIEWKOTE™</td>
<td></td>
<td>EG type 10~40</td>
<td>10</td>
<td>0.4</td>
<td>600</td>
<td>Corrosion resistance</td>
<td>○</td>
<td>Home appliance, AV equipment, heating</td>
<td>16</td>
</tr>
</tbody>
</table>
**DURGRIP™**
Hot-dip galvannealed steel sheet and strip

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**Main Characteristics**
- Excellent paint adhesion and weldability—provided by reheating the zinc-iron alloyed layer produced by heating.
- Exceptional post-painting corrosion resistance.
- Excellent press-formability, ranging from bending to deep drawing.
- Availability of sheet with highly lubricative film treatment.

**Coating structure**
(Representative example)

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**Production Process**

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**Typical Properties**

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**Press Formability**

The application of lubricative film treatment imparts good press formability.

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**Paint Adhesion**

DURGRIP has a finely textured yet rugged surface, ensuring good paint adhesion.

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**Weldability**

The resistance weldability of galvanized steel sheet, in contrast to that of cold-rolled steel sheet, generally requires appropriate welding conditions in the region of high heat input. This is because zinc is a soft metal that easily conforms to the partner metal and because zinc's low melting point causes it to melt and spread out during the initial welding stage, thereby resulting in lower current density. Consequently, less heat is generated in the overlapped areas.

**Direct Spot Weldability**

The appropriate welding conditions for coated steel sheets are shown in the figure below. Adequate welding current regions for coated steel sheets are higher than those for cold-rolled steel sheets.

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**Main Applications**

- **Electric appliances**
  - Washing machine, refrigerator, air conditioner, automatic vending machine (outer plate, side plate, back plate, bottom plate, parts)
- **Building and furniture**
  - Signboard, door, sash, shutter, cabinet, steel furniture, office equipment
- **Automobile (outer, inner, parts)**
  - Hood outer, inner, trunk lid outer, inner, quarter panel, wheel house outer, front floor, locker outer, inner, door outer, door inner
**DURGRIP™**
Hot-dip galvanized sheet and strip

**Main Characteristics**
- High corrosion, and rust resistance similar to that of conventional chrome-treated sheet even with chromate-free treatment
- Excellent zinc adhesion and responsiveness to severe fabrication conditions
- Product lineup with excellent tribological properties by means of chromate-free treatment

**Typical Properties**

**Corrosion Resistance Mechanism of Conventional Chromate Treatment and Chromate-free Coating Film**

- **Structure and Function of Coating Films**
  - Chromate-free Coating Film
  - Zinc coating layer
  - Steel sheet

- **Chromate Coating Film**
  - Corrosion protection effect
  - Suppression effect

- **Corrosion Resistance of Flat Surfaces**
  - Initial period (5 days~6 months)
  - Middle period (Several years~Until zinc around the cut-end surface is lost)
  - Final period (5% NaCl solution, 24 hours)

**Coating Structure (representative example)**

**Main Applications**

- **Container for transporting agricultural product**
- **Industrial machinery**
- **Refrigerator, washing machine, heating equipment, air conditioner, automatic vending machine, showcase parts**
- **Car, panel**
- **Floor, various parts**
- **Automobile**
- **Civil engineering structure and building construction**
  - Sash, door, housing structural member (column, beam)
- **SuperDyma™**

**Main Characteristics**
- With remarkably high corrosion resistance compared to hot-dip galvanized steel sheet, inhibits corrosion resistance in cut-end surfaces
- Strong alkaline resistance even in direct contact with mortar and concrete
- Superior substitute for stainless steel (weak in chlorine resistance) and aluminum (weak in alkaline resistance)
- Availability of chromate-free sheet having properties similar to those of chrome-treated sheet

**Typical Properties**

**Coating Layer Composition and Corrosion Resistance (Salt Spray Tests)**

**Acid and Alkaline Resistance of Various Coated Sheets**

**Scratch Resistance**

The coating layer of SuperDyma is hard, thus offering high scratch resistance.

**Main Applications**

- **Container for transporting agricultural product**
- **Industrial machinery**
- **Refrigerator, washing machine, heating equipment, air conditioner, automatic vending machine, showcase parts**
- **Car, panel**
- **Floor, various parts**
- **Automobile**
- **Civil engineering structure and building construction**
  - Sash, door, housing structural member (column, beam)
**Main Characteristics**

- Exceptional durability and corrosion resistance
- Beautiful silvery white appearance with a finely spangled pattern
- Excellent thermal resistance and high heat reflectivity due to aluminum contained in the coating
- Available with chromate-free film

**Typical Properties**

**Thermal Resistance**

The surfaces of GALVALUME STEEL SHEET exhibit excellent heat reflectivity, showing no substantial deterioration after long-term exposure to high temperatures. Materials with high heat reflectivity show a minimal rise in temperature. The use of materials with high heat reflectivity particularly in roofing subjected to large thermal loads is highly effective in preventing increases in indoor temperature.

Because of the combination of this property with the aforementioned excellent heat reflectivity, GALVALUME STEEL SHEET is suitable for such applications as the heat shields and the heat reflectors for toasters and microwave ovens.

**Corrosion Resistance**

Because of its extremely beautiful surface, ALSHEET shows exceptional heat reflectivity—nearly 80% at temperatures of 450°C or below. Accordingly, ALSHEET is ideal for use in applications requiring heat reflectivity, including the inner heat shields for toasters and the upper reflectors for gas ovens and kerosene heaters.

**Main Applications**

- Building construction and civil engineering structure
- Roofing material, wall material, partition, other structural metal fittings
- Electric appliance

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**Main Applications**

- Hot-water system
- Oven toaster
- Bread machine
- Stove
- Fan heater
- Cloth dryer
- Automobile (muffler, manifold cover, converter cover)

**Corrosion Resistance**

Because ALSHEET, like aluminum, easily generates fine yet stable oxide and hydroxide films in the atmosphere and in water, its corrosion resistance under various conditions is superior to that of galvanized steel sheets. In application, however, it should be borne in mind that, contrary to galvanized steel sheet, galvanic action (sacrificial action) cannot be expected of ALSHEET.

**Typical Properties**

**Thermal Resistance**

The surface appearance of ALSHEET at high temperatures is far superior to that of hot-dip galvanized steel sheet or that of cold-rolled steel sheet. No surface discoloration occurs at 350°C or under. At temperatures above that, the surface becomes an Al-Fe alloy, causing a discoloration. However, this conversion to an alloy prevents oxidation of the base metal, helping to retain the steel sheet’s thermal resistance.

**Corrosion Resistance**

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**Chemical resistance**

Unlike zinc, aluminum has the property of being resistant to weak acidity and vulnerable to alkalinity.

**Main Applications**

- Hot-water system
- Oven toaster
- Bread machine
- Stove
- Fan heater
- Cloth dryer
- Automobile (muffler, manifold cover, converter cover)
ECOKOTE™-S
Sn-Zn coated steel sheet and strip

Main Characteristics
• Higher corrosion resistance than found in conventional fuel tank metallic materials
• High corrosion resistance, even when used with bio fuels
• Meets hydrocarbon permeation regulations; is free of environmental load substances
• Highly recyclable

Characteristic Properties of Fuel Tank Material

<table>
<thead>
<tr>
<th>Property</th>
<th>ECOKOTETM-S (Sn-Zn coating)</th>
<th>ALSHEET™ (Aluminum coating)</th>
<th>TERNESHEET (Pb-Sn coating)</th>
<th>Resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation for upper limit for fuel permeation</td>
<td>No fuel permeation because of steel sheet</td>
<td>No fuel permeation because of steel sheet</td>
<td>No fuel permeation because of steel sheet</td>
<td>Interior permeation shut-off performance</td>
</tr>
<tr>
<td>Promotion of recycling</td>
<td>High recyclability because of steel sheet</td>
<td>High recyclability because of steel sheet</td>
<td>High recyclability because of steel sheet</td>
<td>Interior recyclability</td>
</tr>
<tr>
<td>Lighter weight</td>
<td>Lighter weight by use of steel’s rigidity instead of identical capacity</td>
<td>Lighter weight by use of steel’s rigidity instead of identical capacity</td>
<td>Lighter weight by use of steel’s rigidity instead of identical capacity</td>
<td>Lighter weight by use of steel’s rigidity instead of identical capacity</td>
</tr>
<tr>
<td>Regulation for environmental burden substance</td>
<td>No inclusion of environment burden substance</td>
<td>No inclusion of environment burden substance</td>
<td>No inclusion of environment burden substance</td>
<td>No inclusion of environment burden substance</td>
</tr>
<tr>
<td>Lighter weight</td>
<td>No inclusion of environment burden substance</td>
<td>No inclusion of environment burden substance</td>
<td>No inclusion of environment burden substance</td>
<td>No inclusion of environment burden substance</td>
</tr>
</tbody>
</table>

Main Applications
• Fuel tank

ZINKOTE™
Electrolytic zinc-coated steel sheet and strip

Main Characteristics
• Demonstrates similar effects in application as chromate-treat sheet due to ZINKOTE’s special film containing a corrosion inhibitor
• Availability of characteristic properties that conform to respective customer needs thanks to ZINKOTE’s diverse post-treatment lineup

Main Properties of ZINKOTE
• Corrosion resistance • Abruptness • Spot weldability
• Thermal resistance • Alkaline resistance • Solvent resistance
• Fingerprint resistance • Paint adhesion

Corrosion Resistance Mechanism of Chromate-free Coating Film

<table>
<thead>
<tr>
<th>Property</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film</td>
<td>Needs performance</td>
</tr>
<tr>
<td>Organic film</td>
<td>Excellent formability and substrate due to film surface action</td>
</tr>
<tr>
<td>Inorganic film</td>
<td>Excellent formability and substrate due to film surface action</td>
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</tbody>
</table>

Conductivity (Grounding Property)

<table>
<thead>
<tr>
<th>Property</th>
<th>Effect</th>
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</thead>
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<tr>
<td>Loresta 4 Prove Type</td>
<td>Concept of Contact Resistance Measurement Device</td>
</tr>
<tr>
<td>Measurement</td>
<td>Loresta EP type made by Mitsubishi Chemical Corp.</td>
</tr>
</tbody>
</table>

Conducting rate (%): Conducting cycle 5 x 100
* Conducting less than 60%
**Main Characteristics**

- Excellent cost performance and reduced manufacturing term at user plant by coating only one side of ZINKOTE with a beautiful topcoat
- Available colors (3): black, silver and white, and preparation of improved scratch-resistant type
- Black coated sheets (2): both-sided black coated type, and high-conductivity/good heat-absorption type

**Product Lineup**

<table>
<thead>
<tr>
<th>Color</th>
<th>Type</th>
<th>Heat treatment symbol</th>
<th>Surface finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Standard type</td>
<td>KJ1</td>
<td>D (general)</td>
</tr>
<tr>
<td></td>
<td>Improved scratch-resistant type</td>
<td>KJ2</td>
<td>D</td>
</tr>
<tr>
<td>Silver</td>
<td>Standard type</td>
<td>S1J1</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Improved scratch-resistant type</td>
<td>S2J2</td>
<td>D</td>
</tr>
<tr>
<td>White</td>
<td>Standard type</td>
<td>HJ1</td>
<td>D</td>
</tr>
<tr>
<td>Black</td>
<td>Standard both-sided black type</td>
<td>K1K1</td>
<td>D (general)</td>
</tr>
<tr>
<td></td>
<td>Conductive, heat-absorbing black type</td>
<td>KNC</td>
<td>D (general)</td>
</tr>
<tr>
<td></td>
<td>Conductive, heat-absorbing black type with conductive clear film</td>
<td>KJC</td>
<td>D (general)</td>
</tr>
</tbody>
</table>

**Main Applications**

- Home appliance
- AV equipment, electronic device
- OA equipment
- Housing equipment (interior, steel furniture)

**Typical Properties**

**Bare Corrosion Resistance**

In commonly conducted salt spray testing, the bare corrosion resistance of DURZINKLITE coated surfaces is more than 3 times greater than galvanized sheets with equal coatings. This product shows favorable corrosion resistance even with a thin coating mass, but the provision of a special chromate treatment further improves corrosion resistance.

- Example of Corrosion Resistance Assessment of DURZINKLITE (Non-treated Sheet Salt Spray Test)

**Weldability**

Individual spot or seam welding of DURZINKLITE can be conducted using low welding current, and because the welding current range is wide, welding is easy.

Examples of single spot welding at a wide range of welding currents for both-side galvanized sheet are shown at right. In each case, adequate nuggets are formed using a comparatively low welding current, and the recommended range of welding currents is wide to allow easy welding.

**Main Applications for Welding**

- Home appliance
- AV equipment, electronic device
- OA equipment
- Housing equipment (interior, steel furniture)
**ECOTRIO™**
Zn-Si-Ni alloy coated steel sheet and strip

**Main Characteristics**
- Lead-free and chrome-free, and conforms to RoHS (Restriction of Hazardous Substances) Directive
- Greater suppression of whiskers compared to electrolytic tinplate
- Solubility and conductivity that are similar to electrolytic tinplate and higher than those of galvanized steel sheet
- Availability of thin-gauge products with a minimum thickness of 0.15 mm
- NEW ECOTRIO even in thin coating mass specifications: Taking over the basic properties of ECOTRIO
- High-strength ECOTRIO: Cost-cutting substitute for nickel silver and stainless steel sheets

**Typical Properties**

**Chromium-free Coating Film**
- Test Result for Occurrence or No Occurrence of Whisker under High Temperature and High Humidity Condition

**Solder Wettability (Solder Wetting Time)**
- Measurement Results for Solder Wetting Time

**Corrosion Resistance**
- Corrosion Resistance (Salt Spray Test)

**Main Applications**
- Game console
- Automobile AV equipment
- TV set
- Personal computer
- Electric and electronic parts
- Audio system
- Switch metal fitting
- Flow regulating valve
- Condenser case
- Shield cover
- Heat sink metal fitting
- Electrical equipment metal fitting
- Flat sheet with edge seal

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**SUPERNICKEL™**
Nickel Coated Steel Sheet and strip

**Main Characteristics**
- High adhesion and corrosion resistance due to formation of Fe-Ni alloy layer
- Availability of material quality that conforms to the particular application and the degree of fabrication
- Diverse surface finishes are available, from an outstandingly fine mirror finish to a rough dull finish.
- Availability of coatings from thin to heavy and of differential coatings on front and rear surfaces
- Same thermal resistance as that of stainless steel

**Typical Properties**

**Surface gloss**
- Glossiness of surface finish

**Coating Adhesion (workability)**
- An example of evaluation of coating adhesion (workability)

**Post-fabrication Corrosion Resistance**
External appearances of the top and body parts of size C and AA batteries made of SUPERNICKEL steel sheets and Ni-coated sheets without alloy layer, after subjected to 60 minutes of salt spray tests are shown below.

**Main Applications**
- Game consoles
- Instruments
- Portable cooking stove
- Stove reflection plate
- Audio system
- Electric and electronic parts
- Automobile AV equipment
- Game console
- Switch metal fitting
- Flow regulating valve
- Condenser case
- Shield cover
- Heat sink metal fitting
- Electrical equipment metal fitting
- Flat sheet with edge seal

---

**Post-fabrication Corrosion Resistance**
External appearances of the top and body parts of size C and AA batteries made of SUPERNICKEL steel sheets and Ni-coated sheets without alloy layer, after subjected to 60 minutes of salt spray tests are shown below.

**Main Applications**
- Game consoles
- Instruments
- Portable cooking stove
- Stove reflection plate
- Audio system
- Electric and electronic parts
- Automobile AV equipment
- Game console
- Switch metal fitting
- Flow regulating valve
- Condenser case
- Shield cover
- Heat sink metal fitting
- Electrical equipment metal fitting
- Flat sheet with edge seal
VIEWKOTE™
Pre-Coating Steel Sheet and Strip

Main Characteristics

- Smooth and fine painted surface
- Selection of colors and material properties that meet specific needs, through the combined use of diverse paints and base substrates
- Improved factors as process, space, energy and load savings at user plant

[Paint type of VIEWKOTE]
- Type I: Highly workable type
- Type II: Balanced type in workability surface physical properties
- Type III: Stain-resistant type
- Type IV: Highly workable, stain-resistant type(universal type)
- Type V: Highly corrosion-resistant type

Typical Properties

<table>
<thead>
<tr>
<th>Application</th>
<th>Application part / materials</th>
<th>VIEWKOTE recommended specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting equipment</td>
<td>Reflecting board</td>
<td>VIEWKOTE Type I</td>
</tr>
<tr>
<td></td>
<td>Front side</td>
<td>VIEWKOTE Type I</td>
</tr>
<tr>
<td></td>
<td>Back side</td>
<td>VIEWKOTE Type I</td>
</tr>
<tr>
<td>Flat-panel TV</td>
<td>Back panel</td>
<td>VIEWKOTE Type IV</td>
</tr>
<tr>
<td>Digital recorder</td>
<td>Chassis</td>
<td>VIEWKOTE Type IV</td>
</tr>
<tr>
<td></td>
<td>Front side</td>
<td>VIEWKOTE Type IV</td>
</tr>
<tr>
<td></td>
<td>Back side</td>
<td>VIEWKOTE Type IV</td>
</tr>
<tr>
<td>Auto-on-board equipment</td>
<td>Chassis</td>
<td>VIEWKOTE Type IV</td>
</tr>
<tr>
<td></td>
<td>Front side</td>
<td>Heat Absorption Type</td>
</tr>
<tr>
<td></td>
<td>Back side</td>
<td>Heat Absorption Type</td>
</tr>
</tbody>
</table>

Types

- High Heat Absorption Type VIEWKOTE
  - Type I: Highly workable type
  - Type II: Balanced type in workability surface physical properties
  - Type III: Stain-resistant type
  - Type IV: Highly workable, stain-resistant type (universal type)
  - Type V: Highly corrosion-resistant type

- Antistatic Type VIEWKOTE
  - Prevents static electricity caused by friction from conveyors and rubber suction disks in the processing production process
  - Reduces dust adhesion caused by static electricity
  - Reduces electric shocks caused by static electricity

- Orange-Peel-Surfaced VIEWKOTE
  - A pebbled surface like that of an orange peel is achieved by special beads in the coating. These beads then melt during heating when the coating is enamelled
  - This coating improves processing yield by making handling scratches less visible
  - Its workability, chemical resistance, and other basic properties are the same as conventional VIEWKOTE

Self-Cleaning Type VIEWKOTE

- Hydrophilic coating vastly improves resistance against rain drop stains
- Offers high workability thanks to optimal substrate design
- Also offers excellent weatherability and stain resistance in processed areas
- A wide range of color variations, including metallic tones
- Chromate-free and eco-friendly

Deep Drawable Metallic VIEWKOTE

- Offers attractive appearances
- Suitable for processing applications that require bending or drawing
- Add functions by selecting the appropriate back coating
- Example: To discharge internal heat, select high heat absorption type coating

Chromate-free and eco-friendly

Processing Examples of Deep Drawable Metallic Type

- Example: Comparison of charged voltage

- Example: Appearance after embossing 1mm

High Reflectivity VIEWKOTE

- Diffuse reflectivity of 92-98%
- Can be deep drawn
- Has excellent basic properties including corrosion and chemical resistance
- Both electromagnetic shielding and temperature control can be achieved by selecting heat absorption types with good electroconductivity in the back coating

Chromate-free and eco-friendly

- Measurement of diffuse reflection factor (example)

Chromate-free and eco-friendly

- Orange-Peel-Surfaced VIEWKOTE

- A pebbled surface like that of an orange peel is achieved by special beads in the coating. These beads then melt during heating when the coating is enamelled
- This coating improves processing yield by making handling scratches less visible
- Its workability, chemical resistance, and other basic properties are the same as conventional VIEWKOTE
- Can also include antistatic property

Chromate-free and eco-friendly

- Coating structure (representative example)