

# Properties of Chromium-free Coated Steel Sheet “GEO-FRONTIER-COAT”

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## 1. Introduction

Chromate treatment is widely used as an inexpensive method to control white rust from zinc on galvanized steel sheets. As corrosion prevention technology advances and the demand for higher performance has increased, the chromate treatment process has been increasingly employed for coated steel sheets for household electrical appliances<sup>1)</sup>.

Chromate treatment uses a solution containing hexavalent chromium. Completely closed systems for treating waste water from manufacturing processes have been implemented as measures for environmental conservation, along with the development of dry-in-place chromate coating technologies that do not require water washing<sup>1,2)</sup>. Some researches for making dry-in-place chromate coatings even less soluble have been carried out<sup>4)</sup>. In addition, organic composite coated steel sheets have been developed that consist

of chromate coating and thin organic composite coating. The thin organic coating prevents elution of the trace hexavalent chromium contained in the chromate coating<sup>3)</sup>.

Recently, however, the concept of environmental conservation has gone beyond mere pollution control as represented by such terms as air pollution control or water pollution control. The concept of environmental control being accepted today is elimination or containment to the extent possible of potential dangers or environmental risks that could emerge in one way or another in the future<sup>5)</sup>. This new concept of environmental control finds expression in the PRTR (Pollutant Release and Transfer Register) system and in the practice of green procurement that is increasingly adopted by the household appliance manufacturing industry.

Under these circumstances and in anticipation of the growing need for environment-friendly products,

NKK has developed chromium-free coated steel sheets to completely free of to completely conform to the requirements of global environmental conservation. As a result of this endeavor, NKK successfully commercialized its proprietary, high-performance, chromium-free coated steel sheet, or “GEO-FRONTIER COAT” (GF). Along with GF, NKK also commercialized “GEO-FRONTIER COAT type-L” (GFL), a chromium-free coated steel sheet with excellent lubricating prop-

**Table 1 Test specimens**

GF	
Thinner coating	Thinner inorganic-organic composite coating
A	Chromate coating(Cr 20mg/m <sup>2</sup> ) +organic composite coating(1 μ m)
B	Dry-in-place chromate coating(Cr 30mg/m <sup>2</sup> )
C	Conventional chromate coating(Cr 20mg/m <sup>2</sup> )

line degreasing (10 g/liter, 60 °C, 2 min. spraying) using CL-N364S by NIHON PARKERIZING CO., LTD.

(2) Anti-fingerprint property

The specimens were immersed in an artificial sweat solution, dried and compared for color difference, E, before and after the treatment.

(3) Electrical conductivity

The JIS C2550 method was used to measure the inter-layer resistance of the coating. A four-pin-probe Lolesta AP (Mitsubishi Chemical Co., Ltd.) with ASP probe measuring terminals was used to measure the surface resistance.

(4) Spot weldability

Determination of the optimum range of welding current was done using Cu-Cr electrodes under a welding force of 300 kgf, and continuous spot welding tests were done on 1.2 mm thick sheets. The results of continuous spot welding tests were evaluated in terms of the weld nugget diameters.

(5) Paint adhesion

After alkaline degreasing using CL-N364S of NIHON PARKERIZING CO., LTD. (60 °C, 2 min. spraying), the specimens were painted with thermo-

setting paint consisting of a melamine alkyd resin, Delicon #700 of Dai Nippon Toryo Co., Ltd. to a film thickness of 30 μ m. The specimens were tested for paint and wet adhesion, the latter after immersion in boiling water for two hours. The paint adhesion performance was evaluated by the Erichsen method. In this method a cross cut portion was tested first for the degree of peeling of the paint when a pressed tape was detached; and second by the degree of paint peeling by pulling a pressed tape after the cross cut area had been extruded to a length of 5 mm.

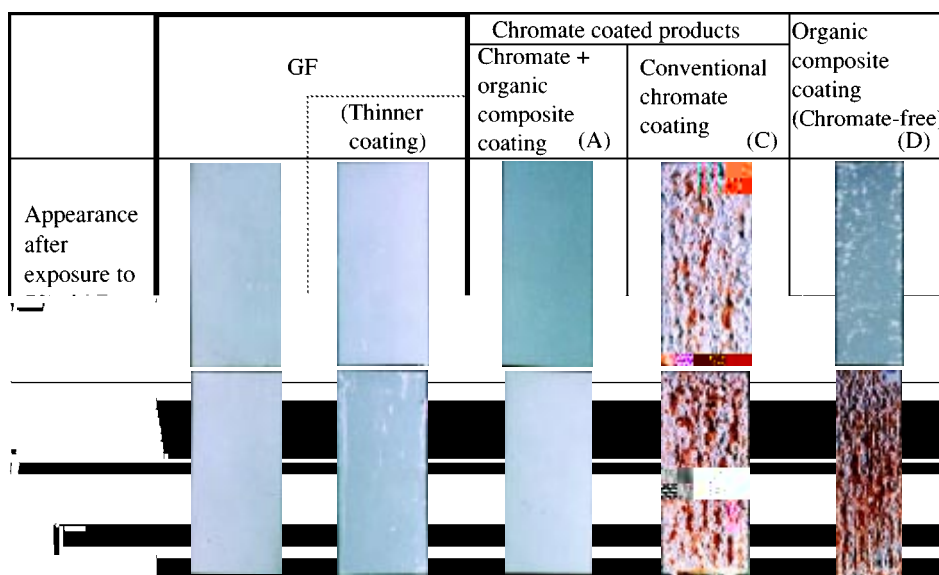
(6) Coefficient of friction

Coefficient of dynamic friction was measured by using a bead, which was made of SKD11 and measured 1 mm by 12 mm on the flat portion of the tip, under a pressure of 80 N/mm<sup>2</sup> at a drawing speed of 500 mm/min.

**5. Characteristics of GEO-FRONTIER-COAT**

**5.1 Corrosion resistance, corrosion resistance after alkaline degreasing**

Photo 1 shows the appearance of specimens after the salt spray test. One specimen was subjected to the salt spray test only, while the other was subjected to alkali degreasing before the salt spray test. The evaluation was based on conditions after a 72 hour salt spray. GF exhibited excellent corrosion resistance without growing white rust on its flat portion, as was the case for the organic composite coated sheet (A). GF showed virtually no decline in corrosion resistance, even after alkali degreasing. Specimen (D), a sheet coated with an organic resin without a chromate coating, exhibited



**Photo 1 Corrosion resistance of various coated steel sheets**





## 8. Conclusion

The increasing tendency toward green procurement in the household electrical appliance industry prompted the development of the high-performance, chromium-free coated steel sheet, "GEO-FRONTIER-COAT." The GEO-FRONTIER-COAT has achieved a high level of corrosion resistance that was conventional unachievable with conventional chromium-free products, by virtue of its proprietary special organic composite coating. Actually, GEO-FRONTIER-COAT is endowed with excellent qualities such as corrosion resistance, anti-fingerprint property, electrical conductivity and paint adhesion that are equal to those of cur-

## References

- 1) Yamashita, M. Material for Nos. 167 and 168 Nishiyama Memorial Technical Symposiums. Iron and Steel Insti-