

# Chromium-free Coated Steel Sheet “GEO-FRONTIER COAT” and Chromium-free Prepainted Steel Sheet “GEO-FRONTIER EXCEL COAT” for Electrical Appliances

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*The centerpieces of NKK’s new series of environmentally friendly steel sheets, a new chromium-free coated steel sheet “GEO-FRONTIER COAT” and a new chromium-free prepainted steel sheet “GEO-FRONTIER EXCEL COAT”, have been developed. The major advantage of “GEO-FRONTIER COAT” is that it has excellent corrosion resistance comparable to conventional chromate coated steel sheets even after alkaline degreasing. This property is due to a proprietary organic composite coating. It is a new product with a good balance of corrosion resistance, electrical grounding properties, and is easy to weld. While developing “GEO-FRONTIER EXCEL COAT”, a new type of primer coating was designed in order to achieve excellent corrosion resistance comparable to that provided by the conventional chromate-based prepainted steel sheet.*

## 1. Introduction

Chromate coating of galvanized steel sheets is effective at suppressing the formation of white rust on the zinc coating layer. This technique is widely applied as an economical method of corrosion prevention. In line with advances in corrosion prevention technology and the increasing demand for high-quality materials, various coated steel sheets and prepainted steel sheets with excellent properties are increasingly being used for producing electrical appliances<sup>1),2)</sup>.

reported include: (1) molybdate coating<sup>9)</sup>, which was expected to have a passivation effect comparable to Cr; (2) tannic acid coating<sup>10)</sup>, which was expected to have a chelate effect with zinc through the OH radical; (3) silicate<sup>11)</sup> and electrolytic phosphate coatings<sup>12)</sup>, which were expected to exhibit barrier effects using inorganic polymer compounds, and (4) organic coating<sup>13)</sup> such as polyolefin and acrylic resin. However, the level of corrosion resistance achievable with these technologies is generally inferior to that of chromate coating. In order to secure sufficient levels of corrosion resistance, it is necessary to apply a thick coating of more than 3 $\mu$  m, which inevitably degrades the electrical grounding properties and weldability<sup>13)</sup>. To date these shortcomings have hindered the wide use of these chromium-free technologies.

## **2.2 Developing "GEO-FRONTIER COAT"**

### **2.2.1 Coating design concept**

Generally, corrosion resistance increases with increasing thickness of the organic composite coating, as a result the electrical grounding properties and weldability suffer. In order to secure good electrical grounding properties, the coating thickness needs to be less than 1 to 2 $\mu$  m. Conventional chromium-free technologies apply a thick coating of more than 3 $\mu$  m to ensure corrosion resistance.

While developing GF, the following two unique new

**Fig.3 Corrosion resistance of various coated steel sheets**

(2) Spot weldability

GF has a very thin surface coating, which assures excellent electrical grounding properties and weldability. Ricoh Company, LTD., a major Japanese copying machine manufacturer, evaluated spot weldability of chromium-free steel sheets produced by four major Japanese steel manufacturers. The result was reported in the magazine, Nikkei Mechanical. **Fig.4** is a quote from this magazine. GF was judged No.1 in terms of quality performance<sup>15)</sup>.

(3) Anti-fingerprint properties

Due to the effect of the organic composite coating, GF has excellent anti-fingerprint properties, making fingerprints



corrosion-inhibiting effect, are used in combination to achieve high corrosion resistance. The resin used in the primer coating is highly ductile, and its degree of cross-linking is adjusted to obtain formability and corrosion resistance of the highest degree when applied in combination with corrosion-inhibiting additives. **Photo 3** shows the results of SST on prepainted steel sheets designed for use in electrical appliances. GF-E demonstrated a superior level of corrosion resistance to that of the conventional chromate coated steel sheet that was also designed for use in electrical appliances. Formability and other properties are equivalent to those of the conventional product (**Table 1**).

**Photo 3 Corrosion resistance (SST, 240 hrs)**

#### 4. Conclusions

The highly functional chromium-free coated steel sheet "GEO-FRONTIER COAT" was developed in response to expanding environmental needs. In developing this product, a specially modified epoxy resin with the highest barrier effect was combined with unique silica-based corrosion-inhibiting additives that exhibit a self-healing effect. As a result, excellent corrosion resistance was achieved using a thin coating layer while at the same time securing other conflicting properties of excellent electrical grounding properties and weldability. The Surface Finishing Society of Japan recognized the innovativeness, uniqueness, and commercial performance of this product and awarded it the Technology Award in 2002.

For use in electrical appliances, a highly corrosion-resistant primer coating was developed and the chromium-free prepainted steel sheet "GEO-FRONTIER EXCEL COAT" was developed and marketed.

These unique chromium-free coated steel sheets are gathering attention as world-leading products that contribute to the reduced use of environmentally harmful substances that were hitherto difficult to replace.

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Chromium-free Coated Steel Sheet "GEO-FRONTIER COAT" and  
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