

new, coated steel sheets
in bodies, electrical appliances, construction, and can-
satisfying ecological requirements are also introduced.

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2.1.1 Electroplated zinc-coated steel sheets: NKFZ,

Advanced Coated Steel Sheets with Excellent F

eration made it possible to consistently produce products that would satisfy the surface quality requirements when used as exposed panels⁷⁾. These technologies were also applied to Fukuyama No.3 CGL and Keihin No.4 CGL. These lines started production in 1992 and 1993 respectively. Customers in various fields hold the product from these lines in high regard.

Increased coating weight brought another problem in terms of the quality of the coating layer, which readily exfoliated and powdered at the press forming stage. It was also found that the sliding property, also at this stage, was degraded due to the structure of the coating layer.

NKK carried out basic research on the Fe-Zn alloying reaction that takes place during the process of forming the coating layer in the CGL⁸⁾

An anti-fingerprint steel, marketed in 1984, effectively suppresses the adhesion of assembly workers' fingerprints to VTRs and other AV products that would otherwise lower the market value of these products. UZ-C2 was first used in the fabrication of VTR and stereo unit rear panels. t

This means that this product can be used in a wide variety of applications¹⁶⁾. This unique property was achieved by applying a special denatured ethylene resin that can increase the surface density of the polar group, thus significantly improving paint adhesion, which had previously been lowered by the lubricating agent contained in the surface layer of the conventional lubricating steel sheet¹⁶⁾. UZ-C3 won the 1997 New Technology Development Award (Machinery Material & Material Processing Section) of the Japan Society of Mechanical Engineers.

(2) Corrosion control mechanism using silica

In parallel with the development of these new products, NKK carried out basic research in the field of chemically treating steel sheets. In order to improve corrosion resistance, ultra-fine silica (colloidal silica), fumed silica, or silica sol was added to the upper layer of organic resin coating of anti-fingerprint coated steel sheets and highly corrosion resistant steel sheets. Silica exhibits a corrosion resisting effect in a corrosive environment where chloride ions are present. Its corrosion resisting effect is particularly significant in a corrosive environment where dry and wet conditions are repeated cyclically¹⁷⁾. This effect is considered to be attributable mainly to the phenomenon that silica promotes the generation of zinc hydroxide chloride, a substance that effectively suppresses corrosion¹⁸⁾. In addition, a small amount of silica dissolves in a corrosive environment as orthosilicate, forming silicate ions and Zn^{2+} ion, the latter dissolves out of the Zn-coating layer, into an insoluble salt. This acts as a barrier that contributes to the suppression of corrosion¹⁸⁾.

2.2.2 Prepainted steel sheets

Prepainted steel sheets, when used in electrical appliance manufacture, eliminate the painting process for appliance manufacturers. Its significance is also increasing in terms of environmental protection. In 1988, NKK constructed a new CCL dedicated to the production of prepainted steel sheets for electrical appliances. NKK also began marketing a high quality prepainted steel sheet for electrical appliances, NKK Excel Coat. In 1998, NKK marketed another new prepainted steel sheet, Geo-Flex. This product has a new coating that combines adequate hardness with excellent formability. The new coating was achieved by introducing a special liquid crystal compound into polyester resin. This was a world-first in combining the two conflicting properties of excellent formability and surface scratch resistance at the same time¹⁹⁾. Geo-Flex was awarded the 1999 Technology Award by the Japan Coating Technology Association. NKK further success-

fully marketed a number of new types of prepainted steel sheets, each having a unique function. Lubi-Coat, for example, is highly heat resistant while at the same time having a non-adhesive surface. Another is the anti-bacterial prepainted steel sheet.

Generally, hexavalent chromium compound is used in primer chemical treatment and primer paint coating for prepainted steel sheets in order to increase corrosion resistance. Recently however, requests for prepainted steel sheets produced without using chromate are increasing, and chromium-free products have been marketed for applications where the corrosion resistance levels are not especially high. By applying unique chromium-free coating design, NKK developed the Chromium-free Excel Coat.

Photo 3 Scanning electron micrograph of Litewel-N**(2) TFS for welded cans: Britewel**

A new TFS product for welded cans was developed by NKK and is being marketed under the trade name Britewel³¹⁾. The production of this product involves accurate control of the electrolytic condition to deposit metallic chromium on the steel sheet in either granular or plate shapes. This is then covered by a hydrated oxide layer that is extremely thin compared with conventional products. When this TFS³²⁾ product is pressurized during welding, the hydrated oxide top layer can be destroyed easily. Welding current paths are evenly formed inside the pressurized area thus suppressing the generation of whisker-like iron splash that is the cause of dust generally seen when welding a conventional TFS. This new product enabled polish-free welding of TFS for the first time in the world. It has paint adhesion and corrosion resistance levels equal to a conventional TFS, and yet can be produced at a cost lower than LTS and TNS. Its use is expanding in applications such as 18-liter cans widely used in Japan.

2.4.2 Plastic film laminated steel sheets

A plastic film laminated TFS was first applied to two-piece beverage cans³³⁾. In an effort to expand its use, it was next applied to three-piece beverage cans^{34),35)}. In line with increasing concern about environmental problems, its use is rapidly increasing. NKK has been developing unique laminated steel sheets that can be produced economically, thus expanding this product's use to applications other than beverage cans.

(1) Laminated steel sheet for food cans: Universal Brite

A new BPA-free can-making material that eliminates a

The film structure is shown in **Fig.9**. The surface of the PET film in contact with the content has a thin layer that contains a minute amount of vegetable oil. This oil acts as a surfactant. Since this product was first marketed in the U.S., its use is expanding all over the world.

Fig.9 Schematic cross-section diagram of Universal Brite

(2) Laminated steel sheet for general-line cans³⁸⁾

sheet surface. Stage 2 (2) is when part of the substrate steel sheet is exposed and galvanic corrosion progresses due to the contact between two different metals. Stage 3 (

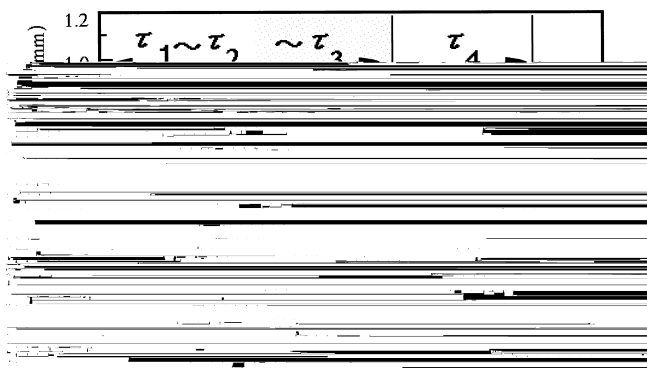


Fig.12 Schematic progress of corrosion in automobile lapped panel crevices

tact pressure in press forming is low, lubrication is a mixture of fluid and boundary lubrication with a higher amount of fluid lubrication. With increasing contact pressure, the region of boundary lubrication increases, leading to direct contact between metals. Once micro adhesion results from direct contact between metals, friction resistance increases significantly.

When developing the PZA-N coating design, the following five points were set as objectives:

sion resistance by applying a thin layer of a newly developed unique organic composite coating as described below (also see **Fig.15**)⁴⁸⁾.

(1) Geo-Frontier Coat uses a special chelate-modified epoxy resin that has an excellent barrier effect.

(2) It uses unique inorganic corrosion inhibitors that result in a self-healing effect.

4.2 Features of the new product

- 47) T. Sakurai et al. "Development of Highly Lubricating Galvannealed Steel Sheet for Automobiles: PZA-N". MASTERIA. Vol.40, No.2, pp.190-192(2001).
- 48) N. Yoshimi et al. "Newly Developed Chromium-free Thin Organic Composite Coated Steel Sheets with Excellent Corrosion Resistance". GALVATECH-2001, pp.655-662.
- 49) N. Yoshimi et al. "Chromium-free Chemical Treated Steel Sheet: Geo-Frontier Coat". NKK Giho. No.170, pp.29-33(2000).
- 50) M. Yamashita et al. "Development of Environmentally Friendly, Highly Functional, Chromium-free Chemical Treated Steel Sheet". Collection of Synopses of The 105th National Conference of The Surface Finishing Society Of Japan, Speech for Commemorating the 2002 Technology Award, pp.461-464(2002).
- 51) Nikkei Mechanical. No.551, pp.33-36(2002).