New Products & Technologies

New Tin Free Steel for Cans Weldable without Edge Grinding*

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1 Introduction

The shells of 18-liter metal cans, pails, and similar containers for paints, chemicals, and other products are commonly manufactured by welding chromium plated tin free steel (JIS G 3315) using a copper wire type electric resistance seam welder. In comparison with tinplate, tin free steel is superior in paint coating adhesion and is economically advantageous, but the welding of conventional tin free steel is difficult due to the large electric resistance of its hydrated chromium oxide coated layer. The narrow available welding current range (ACR, defined as the range between the lower limit current for securing sufficient bonding strength and the upper limit current for small splash formation) has made it impossible to weld the finished tin free steel surface, and it has therefore been necessary to remove the coating from the weld area by grinding immediately before welding. Consequently, the composition of the can making line is complicated with tin free steel, involving a grinder and suction pick-up device for the grinding scrap, and the productivity of the can making process is poor. Finally, where edge grinding is concerned, paint coating adhesion is deteriorated at the ground surface by the loss of the coated layer, and it has been pointed out that welding is unstable because uniform removal of the chromium layer is difficult.

Thus, a tin free steel which makes stable welding possible without grinding before welding had been desired. Kawasaki Steel developed and commercialized such a product by adopting a plating of metallic chromium in a granular metallic chromium-type tin free steel sheet "tin free steel for welded cans" which enables stable welding with a wide ACR even when the strip is welded without grinding.[1-5] An outline of this product is presented below.

2 Features of Tin Free Steel Sheet for Welded Cans

(1) Because granular metallic chromium is used in the chromium-plated layer, splash formation is minimized and a wider ACR is available with continuous nuggets without preliminary grinding of the welding area, making stable welding possible.[1,2,4,5]
(2) Canning line cleanliness is substantially improved because there is no grinding metal powder contamination with this product.
(3) To prevent darkening of the steel sheet due to an excessive amount of metallic chromium, the number of chromium granules is controlled within a range compatible with both weldability and good surface color tone by strict control of plating conditions, securing the same color quality as with conventional material.[4,6]
(4) The corrosion and rust resistance of the new steel sheet is equal to that of the conventional material.[1-7]
(5) Temper designations are the same as those of conventional material because the same substrate material is used.[1-5]

3 Applications

Sheets of the new material are suitable for use in the shells of large containers such as 18-liter metal cans and pails which are subjected to flanging after welding because containers of these types require increased weld strength.

4 Surface Microstructure of Steel Sheet and its Role

Photo 1 is an atomic force microscopic (AFM) image of the surface of the new tin free steel sheet, and shows partial granulation to a height of approximately 100 nm.

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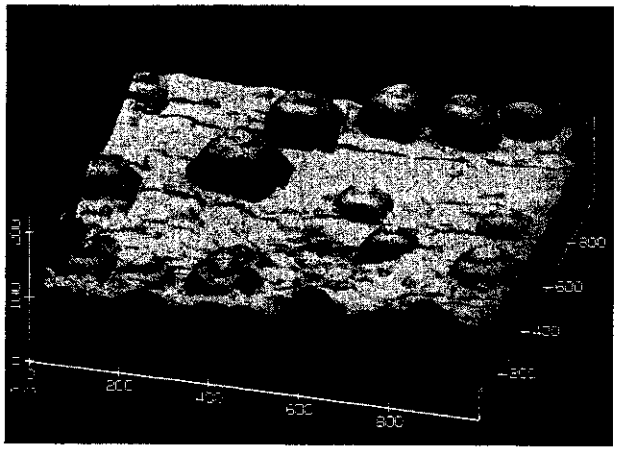

Photo 1 Atomic force microscopic image of weldable tin free steel

When welding force is applied, the granular metallic chromium mechanically destroys the approximately 10-nm-thick layer of hydrated chromium oxide coated on the surface of metallic chromium. As a result, an electric circuit is formed by contact between pairs of metallic chromium granules, and the contact resistance at the pressure-welded area immediately below the electrode is reduced. These changes in the surface conditions of the sheet result in improving weldability.[8-10]

5 Available Current Range

Figure 1 shows a comparison of the available welding current range (ACR) with the new tin free steel for welded cans and conventional material. Welding was conducted with a commercial can body welder of the copper wire type (manufactured by N.P.W. Giken Co., Ltd.) at a welding speed of 21 m/min, sheet overlap of 0.8 mm, and range of power supply frequencies of 180 to 300 Hz. The material specimens were tin free steel sheets prepared by performing either conventional or granular metallic chromium plating on a low-carbon Al-killed steel substrate with a temper grade of T4CA, sheet thickness of 0.32 mm, and bright finish surface roughness.

At all frequencies, the tin free steel for welded cans showed a wider ACR than the conventional tin free steel, which has a flat metallic chromium layer. This is considered to be a composite effect of the destruction of the hydrated chromium oxide layer by the granular metallic chromium and the suppression of the hydrated

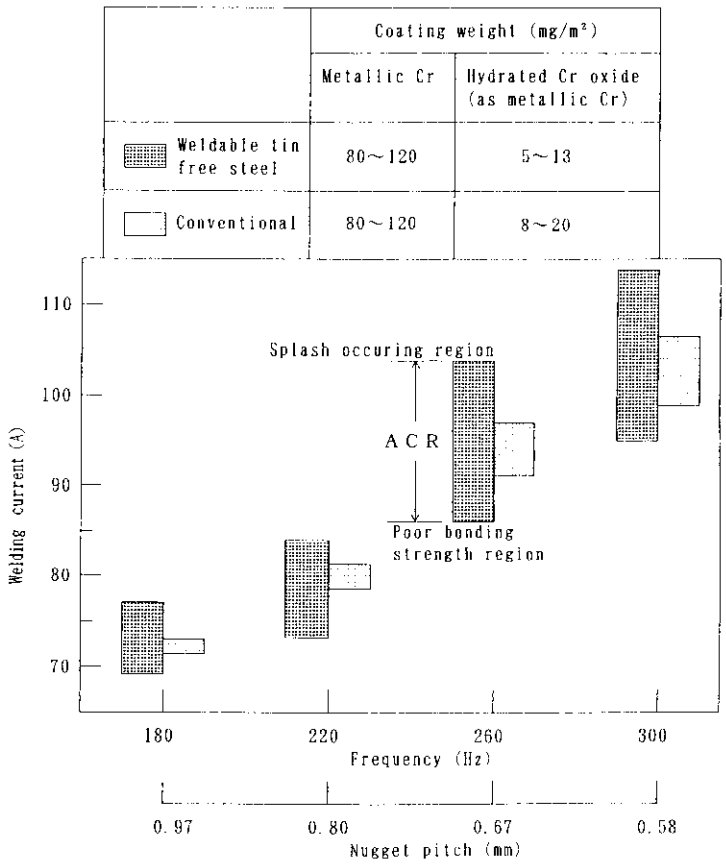

Fig. 1 Comparison of available welding current range (ACR) between weldable tin free steel and conventional one

Table 1 Results of packing test

Can type	Contents	Treatment of inside surface	Corrosion resistace of inside surface (after 12 months)	
			Weldable tin free steel	Conventional
18 liter can	Water paint	Coating	Good	Good
	Oil paint	Plain	Good	Good
	Lacqure solvent (toluene)	Plain	Good	Good
	1, 1, 1-trichloroethane	Plain	Good	Good
	Cleaner (neutral)	Coating	Good	Good
	Cleaner (alkaline)	Coating	Good	Good
	Petrolic agricultural chemicals	Coating	Good	Good
	Soup	Coating	Good	Good
	Soy sauce	Coating	Good	Good
	Soybeen paste	Coating	Good	Good
Pail can	Motor oil	Coating	Good	Good

chromium oxide coating weight. The ACR increased at higher frequencies, but this increase may be attributable to the fact that the nugget pitch is smaller at higher frequencies.

6 Pack Life Test

Table 1 shows the results of a test in which actual cans were evaluated by observing the changes in the inside and outside surfaces of cans of the tin free steel sheet for welded cans and conventional material, which was used for comparison purposes. The cans of the new material were welded without grinding, and the inside seam was spray lacquered and heat dried (cured). The surfaces of both types of cans were observed one, three, six, and twelve months after packing with various contents. In the tin free steel for welded cans, the hydrated chromium oxide coating weight was controlled to a low level, but the new material nevertheless showed satisfactory corrosion resistance equal to that of the conventional material. It should also be noted that the dissolution metallic weight of Fe, Cr, Pb, Sn, and Ni was compared and evaluated using cans containing cooking oil after twelve months of storage, but no difference was found between the two types of tin free steel in this investigation.

7 Concluding Remarks

A new type of tin free steel having the following characteristics was developed for use in welded cans:

(1) The use of granular metallic chromium layer in tin free steel sheets and reduction of the amount of hydrated chromium oxide to a appropriate level makes it possible to weld the new tin free steel without edge grinding.

(2) Because the number of chromium granules is controlled within a range in which stable welding is possible (as the lower limit) and the color tone does not change (as the upper limit), both stable welding and a color tone equivalent to that of conventional tin free steel are possible in the new tin free steel.

(3) Although the chromium plated layer was reformed to improve weldability, the corrosion resistance of the new product is equal to that of the conventional material.

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