

Introduction of Application Technology of Laminated Steel with High Corrosion Resistance and High Coating Adhesion to 18-Liter Can Body[†]

—Development of Laser Irradiation Polishing Method for Welding—

1. Introduction

JFE Steel offers a full lineup of laminated steel sheets for cans suitable for various applications¹⁾. 18 L cans (Fig. 1) are large cans that are widely used in industry, food applications, etc., and application of laminated materials to these cans has expanded in recent years. Laminated cans are free of bisphenol A, which is strongly suspected of being an environmental endocrine disrupter, and also have other advantages, including superior corrosion resistance in comparison with lacquered cans. In particular, however, laminated 18 L cans have received a high evaluation thanks to their scratch-resistant surface and excellent rust resistance. These properties are important in 18 L cans, as these cans are easily scratched during handling due to their heavy weight after filling, and they are frequently used under severe environments, for example, outdoors in coastal areas.

JFE Steel not only supplies laminated steel sheet products, but on occasion also works with the customer to create proposals for can-making technologies that are truly required by the customer. As one such exam-



Fig.1 The appearance of 18 liter cans

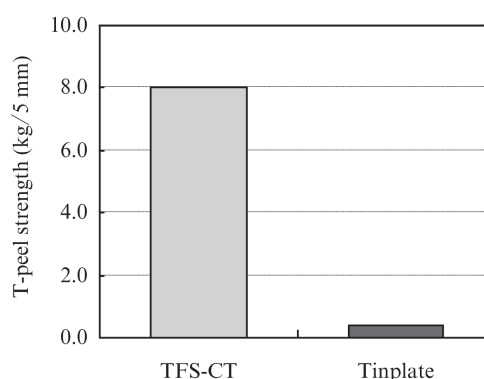


Fig. 2 Lacquer adhesion of TFS-CT and tinplate

ple, this paper introduces a new welding pretreatment technology using laser irradiation polishing which was developed jointly with Dainichi Can Co., Ltd. (hereinafter, Dainichi Can).

2. Plating of Lamination Substrate

When laminated steel sheets are to be applied to can bodies that require welding, lamination is performed in advance except at the weld portion. This means the weldability of the laminated steel sheet depends on the plating of the lamination substrate.

The types of plating used with steel sheets for 18 L cans can be broadly divided into tin-free steel (TFS), in which a chromium plating is applied to a steel substrate, and tinplate, which is plated with tin. TFS has now become the main stream type of plating, as it is more economical than tinplate²⁾.

Moreover, TFS also has dramatically higher lacquer (and film) adhesion than tinplate (Fig. 2), and realizes higher corrosion resistance.

On the other hand, while tinplate has excellent weldability due to its low contact resistance, TFS displays high contact resistance because its surface is coated with an insulating film of chromium oxide, and

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Table 1 Feature comparison of TFS-CT and tinplate

	Lacquer adhesion	Corrosion resistance (After lacquering)	Weldability	Cost performance
Tin free steel	◎	○	×	◎
Tinplate	○	○	○	○

as a result, and welding of TFS is difficult (Table 1). When welding 18 L can bodies, the method of physically polishing of the weld portion in advance is sometimes used to remove the Cr oxide film, but care must be taken to remove the polishing dust so that it does not contaminate the product.

3. Concept of Development of Laser Irradiation Polishing Method

JFE Steel developed a clean welding pretreatment polishing method jointly with Dainichi Can, thereby solving the problem of contamination by polishing dust.

Concretely, this is a revolutionary method in which the surface oxide film is removed by laser irradiation instead of the conventional physical polishing method.

4. Laser Irradiation Polishing Pretreatment for Welding

4.1 Structure of Polishing Section

Conventional physical polishing completely removes the plating film in the area around the weld. In contrast to this, in this laser irradiation polishing treatment, an island-like structure of polished and unpolished areas, as shown in Fig. 3, is created by irradiating the laser beam on a large number of spots.

4.2 Features of Polishing Section

Because the steel substrate is exposed at the weld after welding, the general practice is to repair this area with a dedicated lacquer or film. In the case of the conventional physical polishing method, the repair lacquer or film must be deposited directly on the steel surface because the plating film on the steel surface was completely removed. On the other hand, with the island-

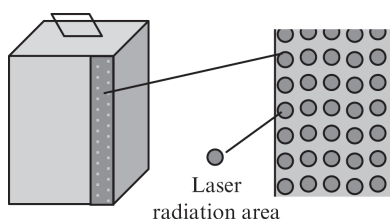


Fig. 3 The structure of the polishing section

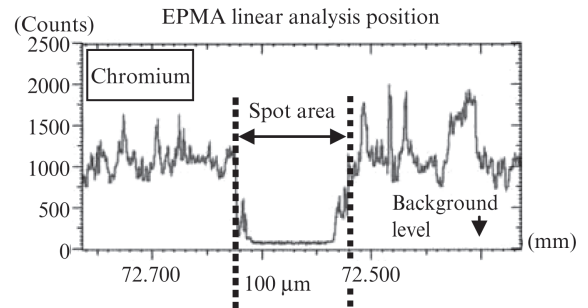
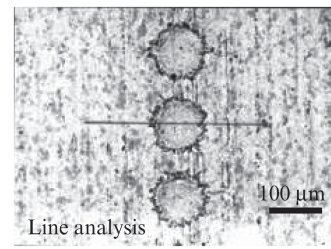


Fig. 4 Distribution of Cr in the spot and around the spot

like structure formed by laser polishing, the substrate steel surface is only exposed at the laser irradiation spots, and a sound plating film remains in the other parts. As a result, the laser polished section has outstanding features, including higher adhesion of the repair lacquer or film and excellent corrosion resistance after welding repair.

Figure 4 shows the results of an analysis of the distribution of the chromium (Cr) coating weight in and around a laser polished spot by the Electron Probe Micro Analyzer (EPMA) method.

In the spot, the amount of Cr which comprises the tin-free coating decreases rapidly and reaches approximately the background level, indicating that the substrate steel surface is exposed. In the area outside the spot, the Cr plating layer remains completely intact.

4.3 Weldability

General seam welding is performed by placing welding electrodes on the two side of overlapped steel sheets and fusing the interface between the two steel sheets by resistance heating. In this process, a satisfactory weld is obtained by reducing the contact resistance between the electrodes and the sheets by cooling the welding electrodes, which results in preferential heating of the interface between the sheets.

The reason why welding of TFS is difficult is the high contact resistance of this material. This high contact resistance increases the necessary voltage for welding, and the contribution of electrode cooling to reduced contact resistance is slight. As a result, fusion between the electrodes and the sheet also occurs easily, and this becomes a cause of splash and expulsion and surface flash. Accordingly, laser polishing enables welding without splash and expulsion and surface flash

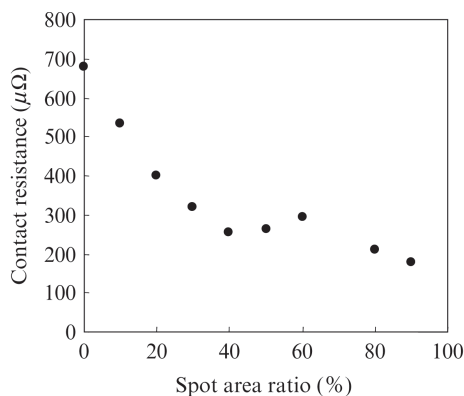


Fig. 5 The area ratio of the laser polishing and the contact resistance

by reducing the resistance between the electrodes and the steel sheets and concentrating resistance heat generation at the interface between the sheets. **Figure 5** shows the relationship between the area ratio of laser polishing and contact resistance. Contact resistance is reduced by one-half or more when the area ratio is 30% or higher. Although the proper area ratio also depends on other welding conditions, satisfactory weldability can generally be obtained with an area ratio of 30% or more.

5. Conclusion

As described in this report, laser irradiation polishing treatment for welding is a revolutionary pretreatment technology which has the effect of substantially reducing contact resistance while retaining a sound Cr plating surface, thereby satisfying both repair paintability (high adhesion of the repair lacquer or film) and stable welding quality, and also has an extremely low risk of contamination by polishing dust.

Reference

- 1) JFE Steel Catalog. JFE UNIVERSAL BRITE, Laminated Steel Sheet for Containers. Cat. no. B1E-009-01.
- 2) Japan Federation of 18Liter Metal cans Manufacture's Trade Unions. Shitte okitai 18-rittoru kan no subete.

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