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Future Outlook on Steel Sheets for Container Use

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Abstract

This paper describes the current situation of steel sheets used for food and drink containers, namely, tinplates and tin-free steel as well as nickel-plated sheets, which are used for battery casings, and presents the future prospects on the products.

1. Introduction

Tinplates and tin-free steel (TFS) (unless clearly distinguished, hereinafter collectively referred to as tinplates) are typical steel materials for container use. The estimated demand of tinplates in the world as of 2010 was 16.41 million tons (all the units used herein are metric). While their consumption is decreasing in developed countries and regions (Japan, Korea, Taiwan, EU, USA, Canada, and Oceania) owing to gauge reduction and competition with other materials, the increase in consumption in developing economies more than compensates for the decrease; for the time being, the total worldwide consumption is expected to grow at an annual rate of 2%. The production capacity of the product, on the other hand, is estimated at about 23 million tons as of 2010; however, since a capacity increase exceeding the domestic demand growth is planned in China, it is feared that the supply–demand gap will increase further. The demand for tinplates in Japan is estimated at about 0.9 million tons per year at present, which is roughly half of that in the peak year, 1991.

Against the above background, it is essential for Japanese tinplates' manufacturers to maintain the competitiveness of the product against other container materials, such as polyethylene terephthalate (PET) and aluminum, in the domestic market, and for this end, it is necessary to enhance the performance of steel cans and reduce costs in a vertically integrated manner through close cooperation with can makers. In the overseas market, on the other hand, it is important to differentiate the product from that of competitors taking advantage of high technology accumulated and fostered in the domestic market, and sharpen the competitive edge through vertical cooperation with can makers, as has been implemented in the domestic market.

On the other hand, nickel-coated steel sheets are used for battery casings. In this field, it is also important to precisely respond to user requirements. This will surely be achieved by adequately exercising the technology accumulated in the field of tinplates over the years.

This paper overviews the characteristics of the market of container materials in and outside Japan, and tries to clarify what has to be accomplished from the technical perspective.

2. Characteristics of Tinplate Market

2.1 Market characteristics in Japan

Tinplates are primarily used for food cans, milk cans, and bottle crown caps outside Japan, but in Japan, the use for food cans is very limited, and is primarily used for beverage cans. As a result of the increase of aluminum cans, and especially after the ban on small PET bottles (500 ml or less) was lifted in 1996, tinplates are primarily used for coffee beverage cans in Japan. Tinplates are still predominantly used in coffee cans for safety reasons, since many types of coffee beverages contain milk.

From the viewpoint of aluminum cans and PET bottles, however, coffee beverage cans are the last remaining area of attack, and the competition is increasingly becoming tougher. The strongest advantage of steel cans is safety: sound inspection (the method of detecting the decomposition of contents by striking the can bottom and detecting the change in the internal pressure from the sound) is possible only with steel cans, and not with aluminum cans, the strength of which is maintained by keeping the internal pressure higher than that of the atmosphere. If steelmakers continue to rely only on this last remaining fort, however, some other materials will eventually take over. Hence, it is imperative for the steel industry to develop a new type of steel can that is capable of maintaining its advantage over aluminum cans, besides the practicability of sound inspection, and that has attractive properties capable of recapturing the market sectors that have been captured by PET bottles and aluminum cans.

2.1.1 Past development of beverage cans and their materials

Before prospecting the future of beverage cans, let us briefly look into the history of the development of beverage cans and their materials.

The development of TFS, steel sheets coated with films of metallic chromium and hydrated chromium oxide, in 1961 was the most sensational event in this field in Japan. Before that, tinplates constituted the basis of Japan's can industry and the technology of container materials, but all the technologies related to them had been imported from the Western countries. TFS was, in contrast, the first major container material developed in Japan, and the product as well

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as its manufacturing technology was exported to Western countries. TFS was developed considering the worldwide depletion of tin resources, which became widely known at that time. Bonded cans for cold packing were developed using TFS as the material. This decelerated the marketing of aluminum drawing and ironing (DI) cans, which were introduced from the USA at that time, and as a result, steel cans took the lead in the subsequent expansion of Japan's beverage can market. Thereafter, in consequence to the development of the Super WIMA method by Soudronic AG, Switzerland, development races of materials for welded cans took place among steelmakers. A recent example of such an event would be the development of laminated steel sheets coated with plastic films for application to two- and three-piece cans.

2.1.2 Future prospects of Japan market

As the development of TFS demonstrates, a technical breakthrough requires a strong need and technology to respond to it. At present, there is no imminent problem comparable to the depletion of tin resources bringing impending threats to the tinplate business in Japan. As was seen at the troubles of nuclear power plants after the big earthquake in 2011, "safety and reliability" is the key word for everything that surrounds our daily life and has to be uninterruptedly maintained in the future. With regard to food and drink containers, for instance, different countries cope with bis-phenol-A (BPA), an environmental endocrine disrupter, in different ways, whereas some do not cope at all. So far, the measures taken against it in Japan are insufficient from the "safety and reliability" perspective for the foreseeable future. The responsibility of the can and steel industries is to offer environment-friendly and resource- and energy-saving containers and container materials.

As is understood from history, the development of a new type of can and that of a new can material take place in close relation to each other. In terms of technology, Japanese can makers are in the world's highest tier, and it is adequate for the Japanese steel industry to continue developing new materials and technology, and spread them to the world through close cooperation with other countries.

2.2 Characteristics of can markets outside Japan

As mentioned earlier, the can markets outside Japan are characterized as follows:

1) The demand for steel cans is increasing.
2) Food cans account for major market portions.
3) Container materials are in oversupply, especially in China.
4) Tinplate manufacturers of the world are competing with each other in terms of price and quality.

Of the above, note that the rapid increase in supply capacity is primarily in China. The can material production capacity of the country is expected to increase by about four million tons from 2010 to 2015. However, tinplates of middle to low grades using cold-rolled steel sheets of so-called commercial grades as the base metal account for about 90% of the increase. As is defined in JIS and other internationally accepted standards, tinplates in developed countries are manufactured through precise steel chemistry control at melt shops into MR, D, or L type steel (according to JIS G 3303) suitable as the base metal, the contents of non-metallic inclusions being regulated according to final application, and under meticulous process control at hot and cold rolling, annealing, and temper rolling to instill the properties required for tinplate substrates. It is true, however, that tinplates of base grades are accepted in certain market sectors. It is our fault for letting it happen; our tinplates should have been of such high quality that there was no room for base grade products.

2.2.1 What has to be done in international market at present and in the future

The technical level of Japan in the fields of can making and manufacturing of steel sheets for containers is acceptedly one of the world's highest. The characteristics of the market, however, are such that it is not easy to diffuse the technologies that have proved effective in Japan to other countries. While globalization has become a daily word, and although Nippon Steel & Sumitomo Metal Corporation has pursued globalization in terms of industrial structure by building tinplate production plants based on Japanese technology outside Japan, after the transfer of the TFS technology to overseas partners some 50

Principal development events of beverage cans and can materials (for reference)

Can and can-making		Steel materials for beverage cans	
		1923	Tinplate production started in Japan
		1955	Electrolytic tinning process was introduced
1958	First canned beer was marketed in Japan		
		1961	TFS was developed
1963	Reynolds Metals (USA) launched aluminum DI (ADI) cans for beer and carbonated beverage		- Cansuper by Fuji Iron & Steel *
			- Supercoat by Yawata Iron & Steel *
			- Similar products by other steelmakers
1966	Miraseam method ** was developed (American Can Company)		
1967	Conoweld method ** was developed (CCC)		
1969	Showa Aluminum Can KK manufactured Japan's first ADI cans		
1970	Toyo-seam cans (for cold packing) were launched to the market		
1973	Steel DI (SDI) cans were developed		
1975	Toyo-seam cans (for hot packing) were launched to the market	1975	TFS for hot packing was developed
1978	Welded can production for beverages started		
1980	Super WIMA method *** was developed by Soudronic AG	1980	Lightly tinned steel (LTS) was developed
		1980	Ni-coated sheets for cans (CANWELL®) were developed
		1984	Ni-Sn-coated sheets for cans (tin nickel steel—TNS) were developed
1992	Toyo Ultimate Cans (TULC, stretch-draw- ironing cans) were developed	1992	Plastic-laminated sheets for TULC were developed
1993	3-piece cans of plastic-laminated sheets were developed		

* Both Fuji and Yawata are now part of Nippon Steel & Sumitomo Metal.
** For use of TFS.
*** A welding method whereby the weld lap is narrow and the joint thickness is reduced by pressing.

years ago, the expansion of technical partnership across the border has been reined for a long period. To make its position firmly differentiated in this market, the Japanese steel industry needs to globalize the technology developed and fostered in Japan.

As was stated in the overview of the technical development history in Japan, significant technical developments resulted from the close ties between steel and can makers. When tinplate products were sold to overseas users, attention was focused only on the manufacture of the products, and it did not go beyond the supply of tinplates of stable quality. What is important from now on for the Japanese tinplate producers is to differentiate their products through vertically integrated support capacity covering packers as well as can makers. Let us consider a little more about what can be done for the integrated differentiation.

(1) Can cost reduction

The biggest concern of can makers must be can manufacturing costs, the basis of their competitiveness, but the cost competitiveness should depend not only on the price of the steel materials but also on the productivity and unit consumption during the can making processes. An example of the measures to reduce costs through such approach is the change from batch annealing to continuous annealing. Nippon Steel & Sumitomo Metal developed continuously annealed tinplates that could replace the batch-annealed ones, and proposed the use of the new material to can makers. The reject rate before the shipment from works is lower with continuously annealed sheets, and in addition, the product quality is more homogeneous within each coil, which enables higher processing speeds and decreases manufacturing troubles, a win–win situation. The proposal of the replacement has a long history, and now continuously annealed tinplates account for most of the orders.

Next, let us look into reduction of unit consumption. For the body of three-piece food cans, for example, single-reduced (SR, cold rolled only once before annealing) products 0.20–0.25 mm in thickness used to be widely used. Steelmakers proposed to replace them with stronger double-reduced (DR) products, 0.20 mm or less in thickness; by this, the unit consumption of the material is decreased by the thickness difference, and the cost decreases in proportion. The steel chemistry of the material sheets of tinplates is strictly controlled as stated earlier, and their thickness is close to the lower limit of industrial cold steel rolling; for this reason, double reduction is effective for decreasing the product thickness.

Since, by the DR method, the thickness of the base metal is reduced for a second time on a temper mill after annealing, the material strength increases while the elongation decreases. This sometimes leads to flange cracks near weld joints during can making, or waviness during the formation of can ends or in two-piece cans. Based on past experiences, Nippon Steel & Sumitomo Metal has established solution measures against problems arising from the use of thinner DR tinplates, and has proposed can materials best suitable for the can types and the manufacturing methods of each user to reduce can-making costs.

The strength of a can, on the other hand, depends significantly on the can shape as well as on the material strength, and the performance of a can has to be evaluated based not on the material but on the product can. Trial and error is, however, a costly and time-consuming approach. Hence, to propose suitable materials and adequate can design, the company has created and commissioned the “Virtual Can-making Factory”, a simulation system capable of estimating can strength following the changes of material and can shape.

It is important to support users in their efforts to strengthen their competitiveness by proposing overall solutions through effective use of such technologies.

(2) “Safety and reliability” for the future

Since tinplates are used for containers for food and drink, steelmakers are responsible for proposing and supplying safe and reliable materials to users in and outside the country, and BPA-free steel sheets are one such material. Nippon Steel & Sumitomo Metal is determined to continue being a world leader of safe and reliable container materials by developing and supplying environment-friendly steel sheets for container use, focusing on environmental regulations of the world.

3. Future Prospects of Steel Sheets for Containers (summery)

Steel cans are the best type of container either in the historical sense or in the view of future. To expand the use of steel cans, it is necessary to enhance the competitiveness of steel cans not simply as a material supplier but in a manner closely tied with the users. For this, it is essential to pursue the economy of energy and resource in close cooperation with users to develop and offer environment-friendly materials. While there are many suppliers of steel sheets for containers in the world, who are eagerly increasing their production capacities, especially in developing countries, it is imperative for Nippon Steel & Sumitomo Metal to keep the position as the front runner.

4. Other Sheet Products for Container Use (Ni-coated Sheets for Batteries)

Food and drink cans and steel sheets for this application have been overviewed in the preceding sections. Nickel-coated sheets are another container material of Nippon Steel & Sumitomo Metal; they are mainly used for batteries. The outer casings for primary batteries, such as alkali-manganese dry cells, and those for secondary batteries, such as lithium ion, nickel hydrogen, and nickel cadmium batteries, are made of nickel-coated sheets.

The nickel coating, which secures good resistance to corrosion by the chemicals of the batteries, is applied either after forming the sheets into final shapes (post-coating) or before the forming work at steelworks (pre-coating). The total market size of Ni-coated sheets in the world is roughly 250,000 tons per annum, and the pre-coating accounts for about a half. Because of the homogeneous coating, pre-coated sheets are used in Japan and Western countries for primary and high-capacity secondary batteries. The market characteristics and future prospects of pre-coated Ni-coated sheets are presented in the following sub-sections.

4.1 Market characteristics of nickel-coated sheets and requirements

The market size of Ni-coated sheets is far smaller than that of tinplates, and the number of suppliers is limited. The principal suppliers are TATA Group, India (holding a market share of about 40%), Toyo Kohan Co., Ltd., Japan (about 30%), and Nippon Steel & Sumitomo Metal (about 10%).

There are two types of Ni-pre-coated sheets: as-Ni-coated sheets and thermally diffused sheets with the Ni layers diffused into the steel substrate by heating after coating. Since no additional treatment is required in addition to the Ni coating and the heating for diffusion, it is difficult for a supplier to differentiate its products from competitors’.

Since the outer dimensions of batteries are standardized, battery makers compete with each other in terms of battery performance, which depends on the internal capacity; this means thinner sheets are required.

To increase the market share and contribute to the growth of the

battery industry, it is necessary for Nippon Steel & Sumitomo Metal to accurately respond to the requirements of battery makers, taking advantage of its wide-ranged strength in vertically integrated manufacturing processes.

4.2 Future prospects for nickel-coated sheets

The market of batteries other than those for automobiles is expected to grow steadily, and there is a good opportunity for Nippon Steel & Sumitomo Metal to take the lead in the market by correctly responding to the requirements of battery makers. The technology of thickness decrease is what has been accumulated and fostered for decades in the field of tinplate manufacturing, and it will surely be effective in meeting the market requirements of Ni-coated sheets for batteries.

The outer casings for secondary batteries for automobiles are primarily made of aluminum or laminated sheets of aluminum foils and plastic films. For the company, the study and development of practical measures for the use of steel for the application is important.

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