

Applications of Titanium to Consumers' Products and Their Associated Strategy



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Abstract

For these 10 years, the market of titanium has steadily grown and we now find titanium increasingly used in various application fields. Particularly for consumer products, the increasing number of titanium products has created new repeatable demands. This shift to titanium from other materials in these products for civilian applications could be said that titanium may be used for many applications in other markets as well as that for consumer products. Herein, the market of titanium in consumer products field is outlined and at the same time, this paper presents the problematic issues and their resolution with regard to titanium in its use for the purpose of expanding the use of titanium. Indeed, it is hoped that such discussion will result in customer success in their efforts to develop new products that employ the unique qualities of titanium.

1. Introduction

Japan's titanium market commenced in the early 1950s, and reached about 1,000 tons per year in the late 1960s. By the 1970s, that number grew to approximately 2,000 tons per year. It then evolved to establish titanium in existing applications, mainly chemical plants, electrodes, and electric power plant condensers. In the early 1980s, titanium was used at an annual rate of about 2,000 tons in seawater desalination plants for the Middle East. The resultant steep demand peak caused a shortage of titanium supply and a skyrocketing of titanium prices, which drove users away from this metal. The subsequent participation of new titanium manufacturers and development of new applications stabilized the supply of titanium and expanded the demand for titanium. The end of the cold war in 1989 drastically

reduced the military usage of titanium, but the titanium market scale steadily grew, despite some ups and downs, in step with business cycles in the 1990s, as can be seen in Fig. 1.

As part of the new titanium applications, among the expanding titanium demand in the past decade, the usage of titanium in consumer products like eyeglass frames has become full-fledged in addition to building, civil engineering, and automobile uses. In Japan, where the aircraft industry was slow to warm to any application thereof, titanium was traditionally restricted to use mainly as a corrosion-resistant material for chemical and power plants, and the titanium demand greatly depended on the presence or absence of projects to use titanium. Consumer products as new applications for titanium constitutes a demand sector of high repeatability and contributes to stabilization of the titanium market and acceptance of titanium by

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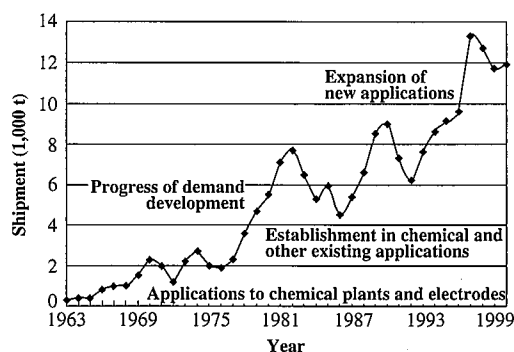


Fig. 1 Change in titanium shipment in Japan

the general public.

2. Overview of Titanium-Made Consumer Product Market

The titanium-made consumer product market continued to expand, albeit slowly, from the middle 1980s and encountered the first peak in 1997 when it reached about 1,400 tons per year and accounted for about 20% of domestic titanium shipment as shown in Fig. 2.

Among the consumer products in which titanium is used are eyeglass frames, wrist watches, golf clubs, bicycles, high-grade cameras, cooking utensils, outdoor goods, ornaments like pierced earrings and kendo face masks and other sporting goods. This fledgling titanium consumer product market is beginning to expand into fire

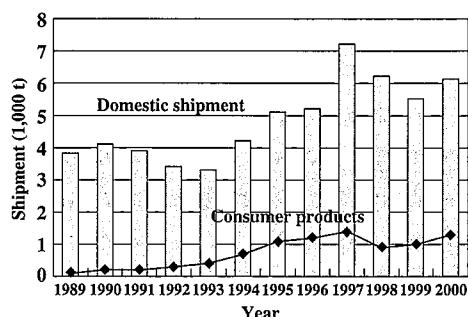


Fig. 2 Domestic titanium shipment and titanium-made consumer products

fighting ladders, wheel chairs and tools. More recently, titanium has begun to be used in the cases of some of information technology (IT)-related products, including mobile gears, cell phones and notebook personal computers. It may be said that the base of titanium applications is steadily enlarging toward the future. Another characteristic of titanium is that the reasons cited for use of titanium in consumer products are varied, such as light weight, high specific strength, non-allergy, color development, and aesthetic surface appearance (see Table 1).

Of the utilization characteristics of titanium used in various demand sectors, high corrosion resistance is an overwhelming utilization characteristic in main applications like chemical plants, electrodes, power plants, and plate heat exchangers (PHEs). In the aircraft and automobile industries, the lightweight and high specific strength of mainly titanium alloys are put to good use. In addition to the utilization characteristics of titanium in consumer products, "an aesthetic surface appearance" is another principal reason for the use of titanium as a relatively new metal in the general markets. In the application of titanium to the cases of IT-related products whose development has advanced recently, recyclability appears to be highlighted as one reason for conversion from plastics, besides traditionally exploited characteristics like lightweight, high specific strength and good surface appearance.

Titanium is more costly than other materials. Unless its functions are properly utilized, titanium cannot be readily adopted or routinely used in consumer products, and titanium-made products cannot become long-selling hit products like eyeglass frames, wrist watches or golf clubs. The next section arranges the essential points to be considered for the development of titanium-made consumer products.

3. Problems with Expansion of Titanium Applications in Consumer Product Sectors

3.1 Quantitative understanding of basic properties of titanium

Light weight, high strength, and high corrosion resistance are the three basic properties of titanium. Among the other properties of titanium are high melting point, low thermal conductivity, low thermal expansion, low Young's modulus, non-magnetism, non-toxicity, low ion dissolution, good biocompatibility, and low electrical conductivity. There are ornaments and other examples in which the non-allergy of titanium is touted by making use of low ion dissolution,

Table 1 Estimated scale of individual titanium-made consumer product markets and reasons for titanium applications

	Scale (t/y)	Material	Corrosion resistance	Light weight	Strength	Flexibility	Thermal conductivity	Non-toxicity	Color development	Surface appearance
Eyeglass frames	450	Wire, plate		○	○	○		○	○	○
Wrist watches	300	Bar, plate	○	○				○		○
Golf clubs	350	Bar, plate	(Alloys)	○	○					○
Cameras	30	Sheet		○	○				○	○
Cooking utensils	40	Sheet	○	○	○		△	○		
Outdoor goods	30	Sheet	○	○	○		△	○	○	○
Fishing gears	10	Wire	○	○	○					○
Mountain climbing goods	10	Plate		○	○					○
Bicycles	20	Tube		○	○	○			○	○
Wheelchairs	10	Tube		○	○	○		○		
Water purifiers	10	Sheet	○					○		
Ornaments	10	Sheet	○	△				○	○	○
Others	30	Various		○	○				○	○
Total	1,300									

good biocompatibility, and non-toxicity.

The consumer product sector has still only a few titanium-made items, so that knowledge of the above-mentioned basic properties of titanium appears to be shallow in the general market. When we study the application of titanium to consumer products, we must have our intended users fully understand the basic properties of titanium. To this goal, it is necessary to quantitatively arrange the basic properties of titanium and compare them with those of other materials. Due to differences in market penetration between titanium and other materials, steel including stainless steel and aluminum, chemical handbook data, for instance, must be relied on for understanding the basic properties of titanium, and all practical data of titanium are not organized properly. One such example is the thermal expansion coefficient of titanium used as material for the back plate of the plasma display panel (PDP).

To produce hit products in consumer product development, it is necessary to develop applications in which the functionality of titanium can be put to effective use. It is thus considered indispensable to quantify the advantages and disadvantages of titanium as compared with various other materials.

3.2 Penetration of titanium utilization and fabrication technology into market

Discussions with fabricators on the general market reveals that many fabricators think that titanium is hard and difficult to process. This perception may be attributed to the limited number of titanium fabricators. Another reason is the small size of the titanium market, resulting in the delay in the development of tools, and lubricants adapted to titanium. To solve this problem, participation of new titanium fabricators and expansion of the market scale are required. To enhance the public awareness of titanium, it is considered very important to accumulate titanium utilization and fabrication technology from a property point of view and to accelerate the application of that technology in the market.

Past experience often tells us that fabricators in the general market have such a wealth of experience with other materials that they only need the explanation of titanium properties (e.g., thermal behavior, n value, r value, and affinity for oxygen). In this market environment, we as titanium manufacturer think it conducive to market expansion to continue our steadfast activities to inform titanium fabricators and tool, die, and lubricant manufacturers of the titanium properties.

3.3 Augmentation of menu of titanium materials

The base of titanium materials used in consumer products is commercially pure titanium. Titanium alloys are used in golf clubs and some eyeglass frames to meet strength requirements. Each titanium manufacturer provides its original menu of titanium alloys. Since cold workability is chiefly demanded, beta alloys are main titanium materials to be used. Sheets and round bars of commercially pure titanium are mainly used to make wrist watches, but some wrist watches require hard titanium like as Grade 4 to reduce surface scratches. Cameras, outdoor goods, and cooking utensils are often press formed from titanium sheets, so that soft grades of commercially pure titanium is used in many cases. Hard grades of commercially pure titanium or titanium alloys like half alloys are used in bicycles and wheelchairs, because they need the strength of welded frame structures by tubes.

To summarize these conditions, titanium materials to be used in consumer products must be available in a variety of shapes, including sheet, wire, bar, and tube. In terms of properties, Grade 1, 2 or 4 of commercially pure titanium, and many titanium alloys are required

for specific product items. The development of new titanium-made consumer products makes it essential not only to augment the menu of titanium materials but also to meticulously meet the market needs. In the initial stage of development, the required quantity will be probably extremely small, and the size, specifications and other details will be often indeterminate. Flexible response, such as outsourcing, will be thus essential.

One of the recent trends is the active application of titanium to IT-related products. The material functions required in this application are good press formability (rectangular formability) and good surface quality like less surface roughening for less post treatment. These IT-related products represent very severe material requirements. If titanium materials can be developed to meet such rigorous formability and surface quality requirements, they will help titanium fabricators to reduce production costs by achieving volume production and lowering reject rates. Thus, the commercialization of consumer products will make steps forward.

3.4 Improvement in availability of titanium materials

In the past few years, Japan's titanium market has hovered around 5,000 to 7,000 tons per year. Of this total quantity, about 50 to 60% is accounted for by titanium directly supplied by manufacturers to specific users. The titanium materials distributed in the titanium market are estimated at a total of about 2,000 to 2,500 tons per year, combining 1,000 to 1,500 tons per year handled by distributors and those intended for consumer products. Most of the titanium materials handled by distributors are plates, sheets, and bars of commercially pure titanium. Cold-rolled sheets and tubes of commercially pure titanium and titanium alloys, mainly used for consumer products, are considered to be very difficult to obtain.

Development of new titanium-made consumer products calls for flexible and quick response to various samples (as to standards, thickness, size and surface finish, among other things). These requirements may be best met by individual titanium manufacturers with an inventory of their own. Since customer requirements are expected to be extremely small in lot size, short in delivery lead-time and varied in specifications, the titanium manufacturers will be faced with an enormous clerical workload to handle orders from their customers. To expand titanium applications to consumer products, it will become necessary to build a system to quickly meet customer requirements for samples and to improve the availability of titanium materials to customers.

4. Conclusions

The titanium market has certainly expanded, but its scale is still about 13,000 tons per year and estimated at about 30 to 40 billion yen per year. In the past decade, the titanium market has achieved a steady growth and is believed to be entering a new stage with a scale of 30,000 tons or 100 million yen per year sooner or later in a few years' time as predicted by the Japan Titanium Society.

Increasing the titanium applications to consumer products is an important factor for expanding the overall titanium market. Since consumer products constitute a demand sector of relatively high repeatability, they are said to be capable of contributing to stabilization of the titanium market. From the standpoint of titanium manufacturers, compliance with a diversity of customer needs leads to enhancement of comprehensive technology capability, including manufacturing technology. We intend to continue our titanium application development, convinced that steady compliance with individual items, though small in demand, will eventually contribute to expansion of the overall titanium market.