Technologies that Contribute to Sustainability

R&D Enhancing the Value of Titanium, the Metal of the Future

The Toho Titanium Group have expanded its business areas by readily responding to the emerging needs of our customers, and steadily accumulating technological development that increases the value of titanium, which has various properties such as it being lightweight, strong, and gentle to the human body. Furthermore, we are now promoting the development of new products that contribute to resource utilization, the spread of clean energy, and reduction of environmental impact, thereby contributing to the development of a sustainable society.

Advantages of Titanium

Titanium Challenges

High manufacturing costs and environmental impact

The current titanium smelting technique (Kroll method) uses batch production, a complex process that consumes large amounts of electricity, resulting in high production costs. In addition, the burning of coke produces large amounts of CO_2.

Difficult to process

Titanium has high strength, which makes it difficult to cut, press, and weld. In addition, because its thermal conductivity is low, heat does not escape during machining, causing cutting heat to build up, thus making tools more prone to wear, and metal fires more likely to occur. Processing methods and advanced technologies suited to the characteristics of the material are therefore required.

Toho Titanium Takes Pride in Sustainable Technology

Reduction of CO_2 emissions

- New energy-saving titanium production process enabled by introducing new technology
- Reduce CO_2 emissions in our customers' value chains by providing titanium and products using related technologies

Effective resource utilization

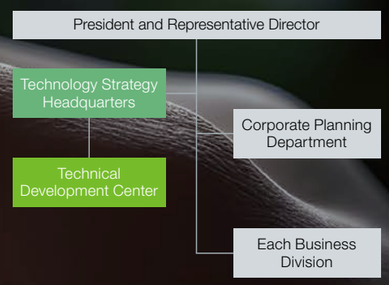
- Reduction of material loss through improvement of existing processes and products, and development of new processes and products
- Promote reuse of titanium scrap

New energy creation

- Support the creation of next-generation energy sources such as renewable energy and hydrogen energy

R&D Organization

We conduct our research and development work under a policy of strengthening and building a management foundation through the pursuit of quality. In collaboration with engineers from each Business Division, the Technology Strategy Headquarters leads the development of new technologies and products in line with business strategies.



FOCUS
Achieving a Carbon-neutral Society with the Power of WEBTi Materials → p.23

R&D Case Studies

CASE 1

Reduction of CO_2 emissions

Establishing a new smelting technology with low energy and high efficiency

New titanium smelting method

Use of titanium, a metal characterized by its light weight, high strength, and high corrosion resistance, is expanding and getting more diversified year by year. Titanium feedstock is widely available around the world, but the smelting process currently being used to convert it into titanium metal is a complex technique based on a particular method called the Kroll method.

However, since this method consumes a large amount of electricity, combining the CO_2 emitted from the process and the CO_2 derived from electricity emits approximately 9 tons of CO_2 to produce 1 ton of titanium. Various alternatives to the Kroll smelting method have been studied, but none has yet been put into use. In order to build a low-carbon society, there is an urgent need to reduce CO_2 emissions from the smelting process.

The new smelting technology that Toho Titanium is developing in collaboration with Universal Achemetal Titanium, LLC (UAT, LLC.) of the United States is a smelting process that has the potential to reduce CO_2 emissions virtually to zero. We also aim at reducing electric power consumption by approximately 75%.

In this development, it is necessary to utilize knowledge of basis sciences such as thermodynamics, electrochemistry, mechanical engineering, and electrical engineering to solve highly challenging technical issues of high-temperature smelting reactions and molten salt electrolysis, and to design processes and facilities suitable for actual implementation. We aim to implement the new smelting technology by the end of FY2025 by making full use of our advanced technologies and putting all our efforts into development. Furthermore, through measures centered on the new smelting technology, the Group as a whole aims to reduce CO_2 emissions by 40% from 2018 levels by 2030, and to achieve carbon neutrality (net zero CO_2 emissions) by 2050.

Anticipated Results

- We will reduce direct CO_2 emissions from the titanium smelting process to zero.
- A major energy conservation effect is anticipated, as the introduction of this new smelting method has the potential to reduce the domestic power consumption required for the production of metallic titanium by up to 75%.
- Titanium products manufactured with this newly developed technology can help create products with low environmental impact in both name and reality, including the materials used.

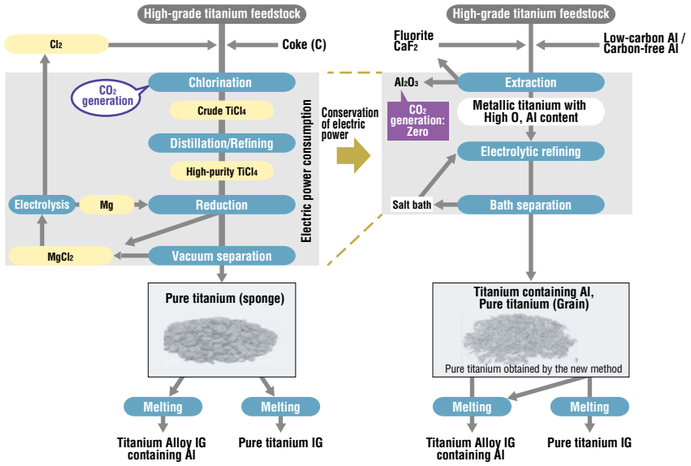
Technical details of the new process

This process is expected to be an excellent smelting method since it is a simpler process than the current method, uses almost no hazardous materials, consumes about a fourth of the electricity, and produces no CO_2.

This technology consists of two major processes: In the first process, titanium feedstock is converted into an electrically conductive material, and in the second process, it is electrolytically purified. Finally, residual salt is removed to finish the product.

1. As an example, by first mixing granular titanium ore, calcium fluoride (fluorite), and metallic aluminum and reacting at high temperatures, a conductive titanium alloy containing oxygen and aluminum is produced. Slag consisting of the byproducts aluminum oxide and calcium fluoride is separated by flotation, so the titanium alloy can be easily recovered in isolation.
2. We use a proprietary electro-refining process, in which titanium ions are mainly dissolved from the titanium alloy into the salt bath, and deposited as dendritic solid metal titanium on the cathode. After vacuum separation or rinsing, we obtain metallic titanium with few impurities, equivalent to current commercially pure titanium sponge.

	Current process based on Kroll method	→	New process
Number of steps	6	→	4
Electricity consumption	High	→	1/5 to 1/4 of the current process (Note: electric power used to produce ore, aluminum, salt baths and other substances is not taken into account.)
Use of hazardous substances	Yes (Cl_2 gas, molten Mg, $TiCl_4$, etc.)	→	No
CO_2 generation	Yes	→	Zero



CASE 2

Reduction of CO_2 emissions

Effective resource utilization

Greatly Simplified Titanium Foil Manufacturing Process

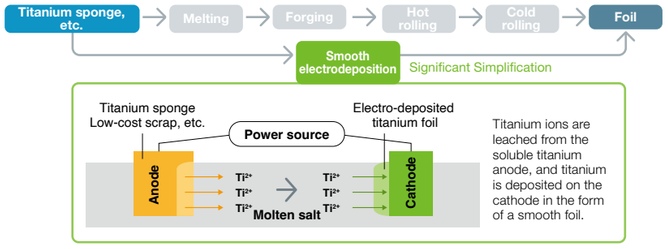
Direct Titanium Foil Production with Smooth Electrodeposition

In general, titanium foil is manufactured by melting and forging raw materials such as titanium sponge, followed by a number of processing steps such as hot and cold rolling.

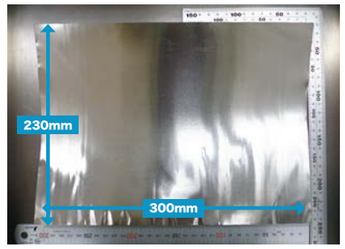
The smooth electrodeposition method that we are currently developing is a manufacturing process that can significantly eliminate steps of fabrication by electrodepositing the raw material in foil form through molten salt electrolysis. As a result, reduction in CO_2 emissions can be expected through energy-saving manufacturing process. Furthermore, since the electrodeposition also has a refining effect, low-cost titanium scrap can be used as raw material, leading to resource conservation.

We have established the technology for manufacturing titanium foil of A4 paper size and approximately 100 μm thickness using this process, and will continue to develop the technology with the aim of commercializing it. Taking advantage of titanium's high corrosion resistance, it is expected to be used in bipolar plates for PEM water electrolysis hydrogen production equipment and anti-corrosion films for steel structural buildings, thereby contributing to the maintenance and preservation of social infrastructure.

Smooth Electrodeposition Significantly Simplifies Titanium Foil Manufacturing Process



Electro-deposited titanium foil with A4 dimensions



CASE 3

Reduction of CO_2 emissions

New energy creation

All-Solid-State Batteries Promote Clean Energy

LLTO™ Technology Improves Performance of Lithium-ion Batteries

High-capacity, high-performance, safe batteries are essential in expanding the deployment of clean energy, electricity generated from renewable energy sources, as called for in SDG No. 7: "Affordable and Clean Energy." The lithium-ion batteries that have been widely used in the past have used liquid as the electrolyte, which has presented challenges in terms of capacity and safety. All-solid-state batteries using solid electrolyte are attracting the most attention as the next-generation battery.

We have focused our development work on lanthanum lithium titanate (LLTO™), an oxide-based solid-state electrolyte. It is chemically very stable, and is expected to be used in multilayer (chip-type) all-solid-state batteries and large batteries for automotive use in the future.

LLTO™, currently achieves ionic conductivity of $5\times10^{-4}Scm^{-1}$ at 27°C in plate form, demonstrating the characteristics of high ionic conductivity among oxide-based solid electrolytes. We will continue to develop all-solid-state batteries for practical use.

Structure of an all-solid-state battery with LLTO™

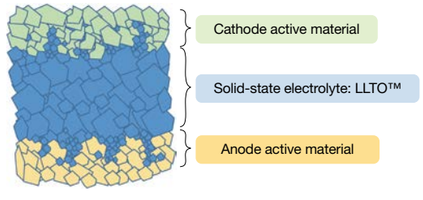
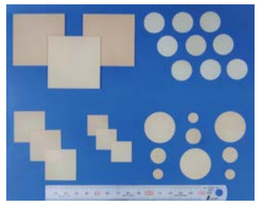


Plate LLTO™ (LLTO™ in plate form)



INTELLECTUAL PROPERTY STRATEGY

IP Strategy

We aim to be aggressive with our intellectual property, which is the core of our competitive strength.

Masakatsu Ikisawa

General Manager,
Intellectual Property Department,
Technology Strategy Headquarters

For our company, whose core competency is advanced titanium-related technology, securing and utilizing intellectual property is an important initiative that can be called the core of our competitiveness. The Intellectual Property Department continuously files strategic patent applications, provides IP education for engineers, and steadily performs invention discovery activities.

There are two main roles that the Intellectual Property Department plays. The first is establishing an appropriate patent network for the inventions we have developed to ensure our business dominance. The second is making full use of the IP landscape to contribute to the exploration and planning of new businesses from promising business areas. In these cases, it is also extremely important to consider sustainable materials and their manufacturing methods that contribute to reducing environmental impact. In order to turn the results of research and development into a competitive advantage for our company, we will lead the strategic use of intellectual property, with an emphasis on medium- to long-term business growth.

Setting quantitative and qualitative goals

With regard to patent applications, we set annual targets for the number of applications and for acquisition of know-how based on the progress of our business strategy and development themes. In FY2022, we acquired 42 patents in Japan. When determining whether or not to obtain patents internationally, we use a checklist to check whether competitors have manufacturing and sales bases in a particular country, as well as the level of competition, and make comprehensive decisions from the perspective of cost performance.

Leveraging the IP landscape

For existing products, we use the IP landscape to compare the intellectual property capabilities of our competitors and to specify the content of patents that should be obtained in the future.

We also share information about the current status of our IP capabilities and changes in our IP capabilities over time during monthly reporting meetings of the Technology Strategy Headquarters as well as in the reporting meetings with management. With our enthusiasm to "create business with intellectual property", we will contribute to management by proactively making proposals to our business divisions regarding patent acquisition and the exploration and narrowing down of new businesses.

Promoting open innovation

When it comes to technology development, we place the highest priority on promoting development and early commercialization of the results. To this end, we are proactively considering and introducing external technologies that we lack, rather than relying on in-house development. For example, we not only exchange technology with our parent company, JX Metals, through technology presentations, but also conduct joint research on multiple individual themes. In addition, we are collaborating with an overseas start-up company to develop metallic materials, and joint research with several universities is underway.

IP education

In FY2022, we conducted four IP training sessions for engineers. Until now, the only people eligible for in-house IP training were engineers who could become inventors. However, starting in FY2023, we will begin providing IP training to sales personnel.

In addition to basic knowledge of patent law and copyright law, the training content is related to situations that frequently occur in sales activities, such as during sample shipping, sales promotion operations, and signing patent guarantee contracts. We also provide explanations of related knowledge along with hypothetical examples.


営業部員への知財教育
～Part2：知財契約の留意点～
内容
1. 御質問への回答
2. 前回説明の補足
3. 事例問題2件
2023.6.22 知的財産部 生澤

IP education materials for sales staff

Digital utilization in research and development

We aim to speed up R&D and improve the quality of R&D results by introducing appropriate digital tools that match the content and stages of our R&D. Specifically, we are actively introducing various simulation software, through which we have achieved results such as narrowing down the appropriate experimental conditions and clarifying the causal relationship between conditions and characteristics.

We are working to further achieve labor saving, speed improvement, and functionality enhancement in intellectual property work. For example, when searching for past papers and documents, it used to take time and effort to check a huge amount of documents, one by one. Therefore, by introducing an AI tool that collects and displays articles in the order of their relevance to the target keyword being searched, we are now able to obtain the necessary documents extremely quickly, significantly reducing work time, and improving the quality of our staff's work.