TTC 2022 meeting

Screen Only

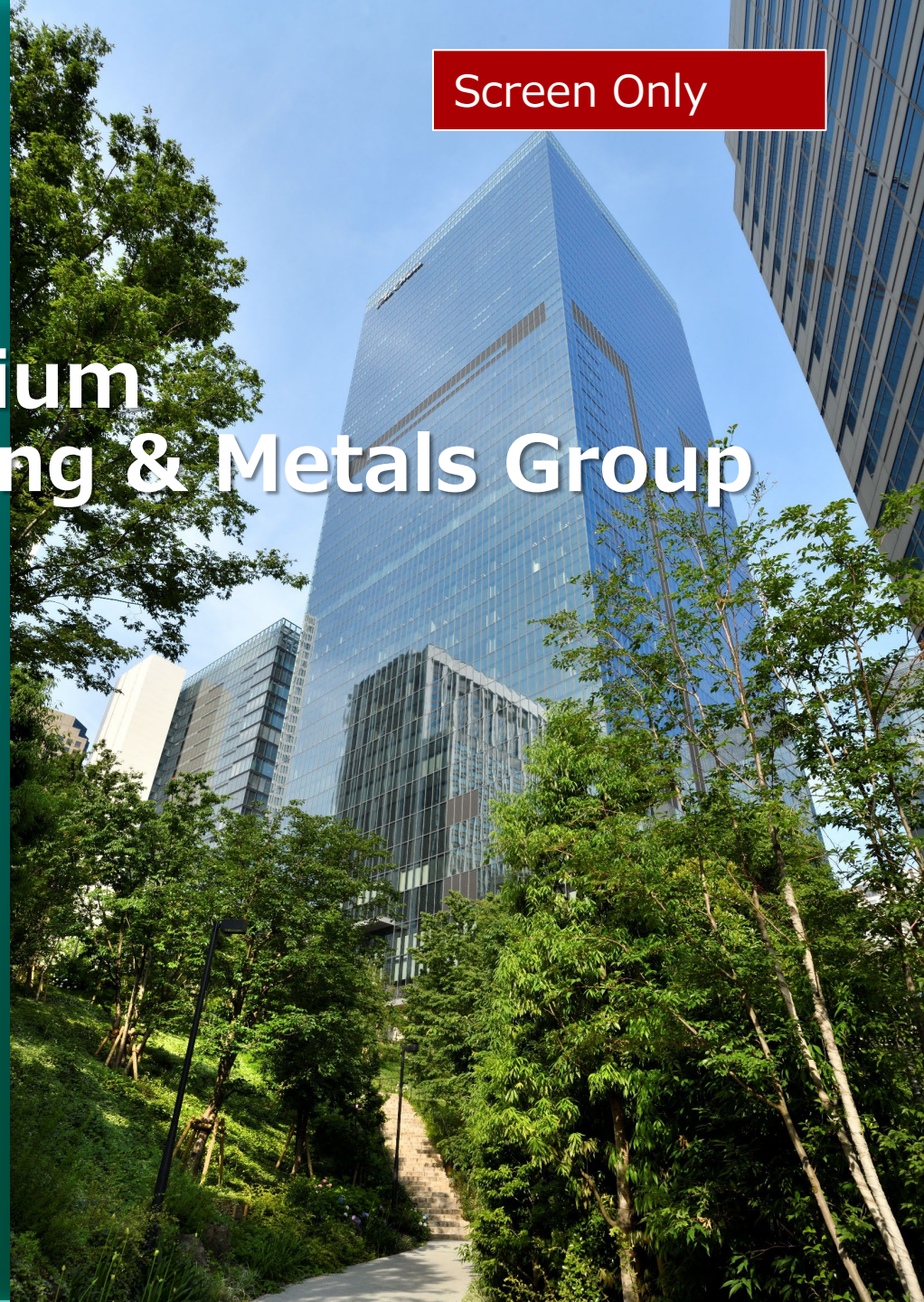
High purity Tantalum and Niobium of JX Nippon Mining & Metals Group

IRUMATA Shuichi,

General Manager

Technology Dept. Tantalum and Niobium Div.

Oct. 14th., 2022



JX Nippon Mining & Metals

Contents

1. Introduction of JX Nippon Mining & Metal Corporation
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3. Technologies of Ta and Nb production in TANIOBIS and Tokyo Denkai
4. Future Business Plan of Ta and Nb
5. To meet expectations for SRF Community and Projects

1. Introduction of JX Nippon Mining & Metal Corporation

ENEOS Group

ENEOS Holdings, Inc

ENEOS Corporation

Energy Business

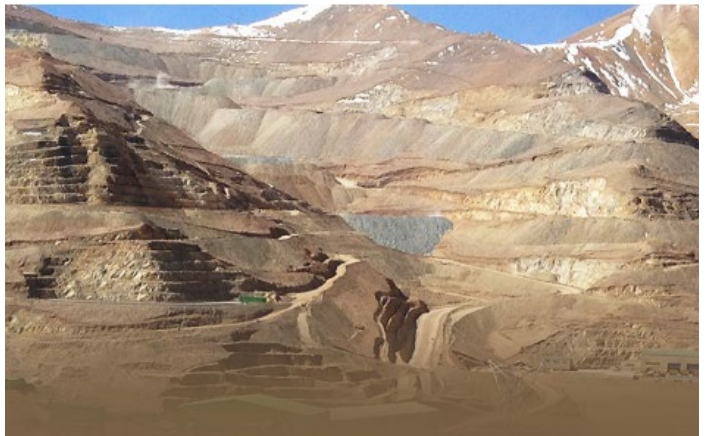
ENEOS Corporation, As one of the most prominent and internationally-competitive energy and materials company groups in Asia, contributes to the development of a sustainable economy and society through the stable supply and effective use of energy.

JX Nippon Oil & Gas Exploration Corporation

Oil and Natural Gas Exploration and Production Business

JX Nippon Oil & Gas Exploration Corporation is moving ahead with the development of petroleum and natural gas resources, with the utmost attention to safety and the environment.

JX Nippon Mining & Metals Corporation



Metals Business

JX Nippon Mining & Metals Corporation contributes to the sustainable development of society on a global scale through the stable supply and effective use of non-ferrous metal resources and products.

Overview of ENEOS Holding

Name	ENEOS Holdings, Inc.
Representative	Ota Katsuyuki, Director / Chairman of the Board SAITO Takeshi, Representative Director / President
Capital	¥ 100 billion
Employees	40,753 *As of March 31, 2021
Business	Management of Group companies and subsidiaries engaged in the energy business; oil and natural gas exploration, development, and production business; and metals business; and operations incidental to said businesses
Head Office	1-1-2 Otemachi, Chiyoda-ku, Tokyo 100-8162, Japan

Overview of JX Nippon Mining & Metals

Name	JX Nippon Mining & Metals Corporation
Representative	MURAYAMA　Seiichi, President & Chief Executive Officer
Paid-in Capital	¥ 75 billion (wholly owned by ENEOS Holdings, Inc.)
Employees	3,133 (nonconsolidated) / 9,622 (consolidated) *As of March 31, 2022
Business Activities	■ Manufacture and sale of materials for electronic devices ■ Manufacture and sale of non-ferrous metal powders ■ Smelting and refining and sale of non-ferrous metals ■ Recycling and industrial waste treatment ■ Developing and mining of non-ferrous metal resources
Head Office	10-4, Toranomon 2-chome, Minato-ku,Tokyo 105-8417, Japan

The JX Nippon Mining & Metals (JXNMM) Group : a global player in the non-ferrous metals market

Providing value to society as a technology-based firm

Global supply chain to support this goal

JXNMM Group Strengths: Robust Supply Chains

Building **strong** upstream, midstream, and downstream **supply chains**

Edit_JXcorp_20200824_eng.mp4

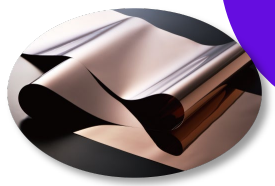
Video of JX NMM

8 minute Video of JX NMM

Key Business Figures

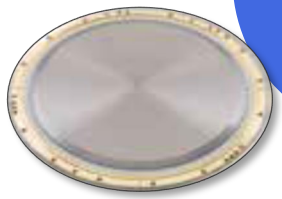
Treated Rolled copper foil for flexible printed circuits (global share)

approx. 80% No.1



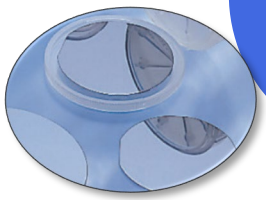
Sputtering Targets for semiconductors (global share)

approx. 60% No.1



InP wafers (global share)

approx. 50% No.1



High-purity tantalum powder for electronic materials (global share)

approx. 50% No.1

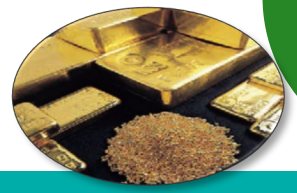
Copper production

Note: Saganoseki Smelter & Refinery annual copper anode production capacity

approx. 450K tons

Gold recovered from recycling (annual)

approx. 7 tons



Equity entitled copper mine production (annual)

approx. 200K tons

Business Segments: Focus Businesses

Focus Businesses

Businesses where differentiation through technology can achieve a global competitive advantage (core of growth strategy).

Functional Materials Business

Global production of copper foil and precision rolled products essential to the advanced electronics industry, as well as precious metal plating and press processing.

Thin Film Materials Business

Development and production of materials for highly functional devices fitted to state-of-the-art IT equipment and electric vehicles, etc., including a range of sputtering targets and compound semiconductor materials.

Tantalum and Niobium Business

TANIOBIS supplies tantalum and niobium powders for capacitors, semiconductor materials, and SAW devices, as well as AMtrinsic® powders for metal 3D printers. Tokyo Denkai supplies tantalum and niobium ingots/sheets for sputtering targets, SRFC, etc.

Other Functional Materials Business

Toho Titanium: Titanium metals, nickel powder for MLCCs, etc.
Tatsuta Electric Wire & Cable: Wire and cable, electronic materials focusing on electromagnetic shielding, etc.

Business Segments: Base Businesses

Base Businesses

Businesses that keep the organization robust and resilient, through never-ending efforts to boost competitiveness.

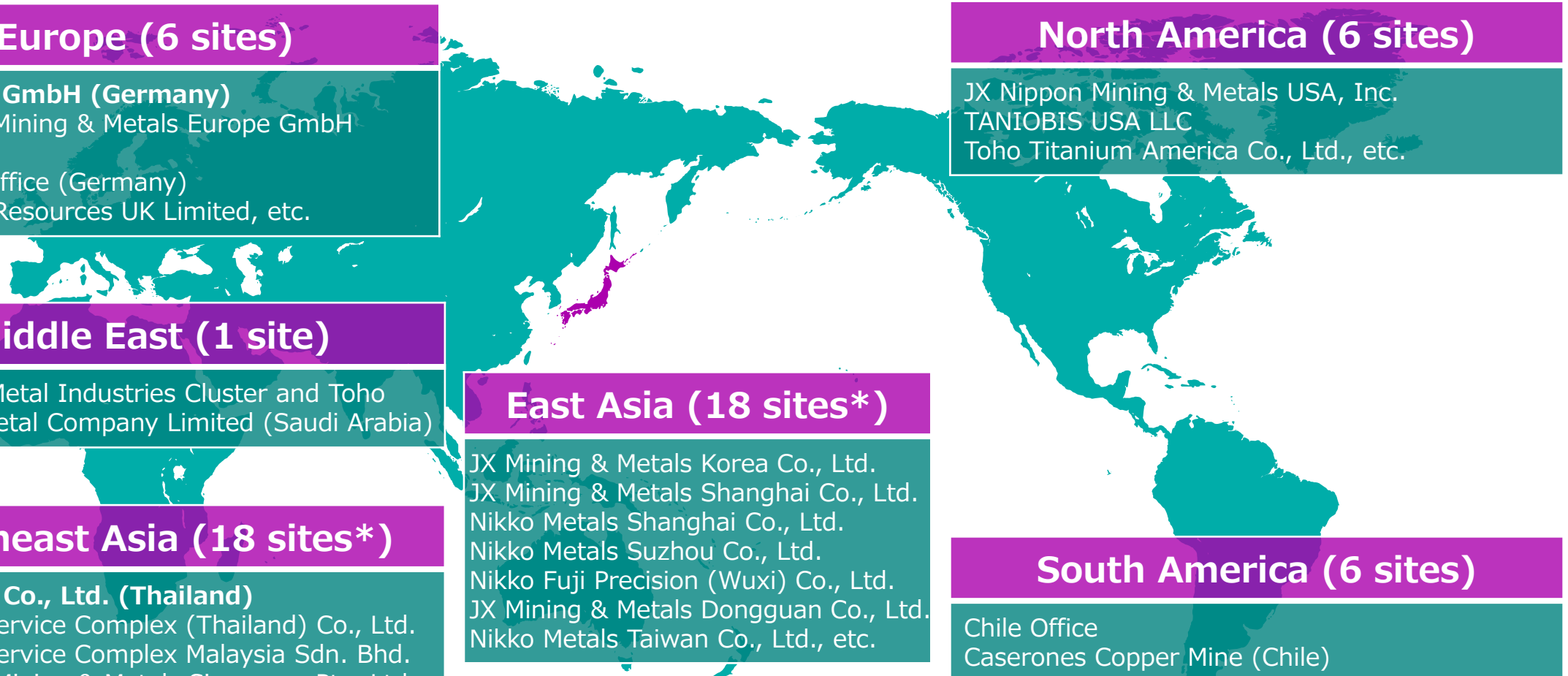
Mineral Resources Business

Focusing on the Caserones Copper Mine (Chile), in which the JX Nippon Mining & Metals Group owns all interests, we are striving for stable operation and further productivity improvement of copper mines. We are also actively researching and developing rare metal mines, where demand for advanced materials is expected to grow in the future.

Metals and Recycling Business

Through the smelting process from copper concentrates and recycled raw materials, we efficiently produce high-quality metal ingots such as copper and precious metals, and provide them as materials for our advanced materials, as well as stably supplying them to Japan and the Asian region. In recent years, we have been contributing to the creation of a recycling-oriented society, especially by increasing the processing volume of recycled materials.

Main Overseas Operating Sites (JX NMM Gr.)



Europe (6 sites)

TANIOBIS GmbH (Germany)
JX Nippon Mining & Metals Europe GmbH (Germany)
Frankfurt Office (Germany)
Nippon LP Resources UK Limited, etc.

North America (6 sites)

JX Nippon Mining & Metals USA, Inc.
TANIOBIS USA LLC
Toho Titanium America Co., Ltd., etc.

Middle East (1 site)

Advanced Metal Industries Cluster and Toho Titanium Metal Company Limited (Saudi Arabia)

East Asia (18 sites*)

JX Mining & Metals Korea Co., Ltd.
JX Mining & Metals Shanghai Co., Ltd.
Nikko Metals Shanghai Co., Ltd.
Nikko Metals Suzhou Co., Ltd.
Nikko Fuji Precision (Wuxi) Co., Ltd.
JX Mining & Metals Dongguan Co., Ltd.
Nikko Metals Taiwan Co., Ltd., etc.

*Total of 18 sites in East and Southeast Asia

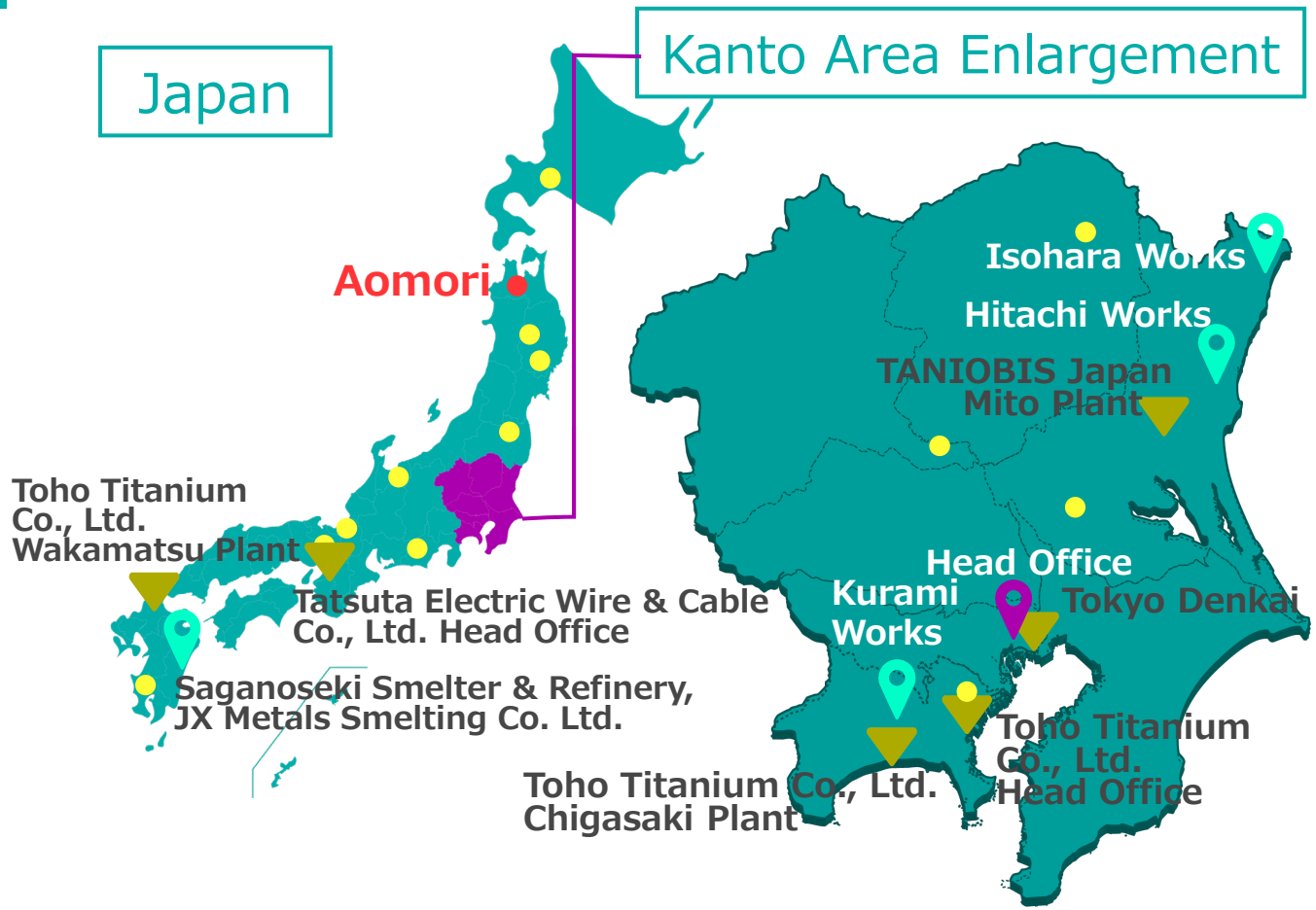
Southeast Asia (18 sites*)

TANIOBIS Co., Ltd. (Thailand)
Materials Service Complex (Thailand) Co., Ltd.
Materials Service Complex Malaysia Sdn. Bhd.
JX Nippon Mining & Metals Singapore Pte. Ltd.
JX Nippon Mining & Metals Philippines, Inc., etc.

South America (6 sites)

Chile Office
Caserones Copper Mine (Chile)
Escondida Mine (Chile)
Los Pelambres Mine (Chile), etc.

Main Operating Sites in Japan (JX NMM Gr.)



● Group Operating Sites
For details, please see our website: https://www.nmm.jx-group.co.jp/

Main Sites and Group Companies

Isohara Works (Ibaraki Prefecture)	Film materials (sputtering targets, InP wafers, etc.)
Hitachi Works (Ibaraki Prefecture)	Smelting and refining (electrorefining), functional materials (copper foils), recycling and environmental services, Technology Development Center, etc.
Kurami Works (Kanagawa Prefecture)	Functional materials (copper alloy strips, Treated rolled copper foils, etc.)
Saganoseki Smelter & Refinery (Oita Prefecture)	Smelting and refining (from smelting to electrorefining), recycling and environmental services, functional materials (casting)
Major group companies	・TANIOBIS Japan Co., Ltd. (tantalum and niobium powders, etc.) ・Tokyo Denkai Co., Ltd. (tantalum and niobium ingot/plate, etc.) ・Toho Titanium Co., Ltd. (titanium, functional chemicals, catalysts, etc.) ・Tatsuta Electric Wire & Cable Co., Ltd. (wire and cable, electronic materials, etc.)

History of JX Nippon Mining & Metals

Year	JX Nippon Mining & Metals
1905	Hitachi Mine was founded and JX NMM Group is originated from it.
1916	Start of operation at Saganoseki Smelter & Refinery.
1928	renamed to Nippon Sangyo
1929	Mining and smelting division of Nippon Sangyo spun off to form Nippon Mining
-	
1964	Kurami Works established.
1985	Start of operations at Isohara Works
1997	(JX started to produce Ta sputtering targets for Cu interconnects of Semiconductor)
1999	Nikko Materials established
2002	Nippon Mining Holdings established as joint holding company of Nikko Metals and Japan Energy
2010	Holding company, JX Holdings, established with the merger of Nippon Mining Holdings and Nippon Oil. Nikko Metals renamed as JX Nippon Mining & Metals
2016	Japanese name of JX Nippon Mining & Metals changed
2017	JXTG Holdings established with the merger of JX Holdings and Tonen General Sekiyu
2020	JXTG Holdings renamed as ENEOS Holdings

Business Portfolio: Revenue Structure

Metals Business/
Recycling Business
(disclosed as
Smelting and Recycling segment)

¥ 41.0 billion

Functional Materials Business/
Thin Film Materials Business/
Others
(disclosed as Functional Materials, Thin Film Materials and Others segment)

¥54.5 billion

Mineral Resources Business
(disclosed as Mineral Resources segment)

¥72.1 billion

Notes:
1. JXNMM discloses financial information via the holding company ENEOS Holdings, Inc.
2. ENEOS Holdings has applied International Financial Reporting Standards since FY2017.

2. Business of Ta and Nb Division in JX Group

Tantalum and Niobium Business in JXNMM

JX Nippon Mining & Metals Corporation

Tantalum and Niobium Division

Operating company

TANiOBIS

Powders of metals, alloys and compounds of Ta and Nb

ULTRA HIGH PURITY RARE METAL TOKYO DENKAI

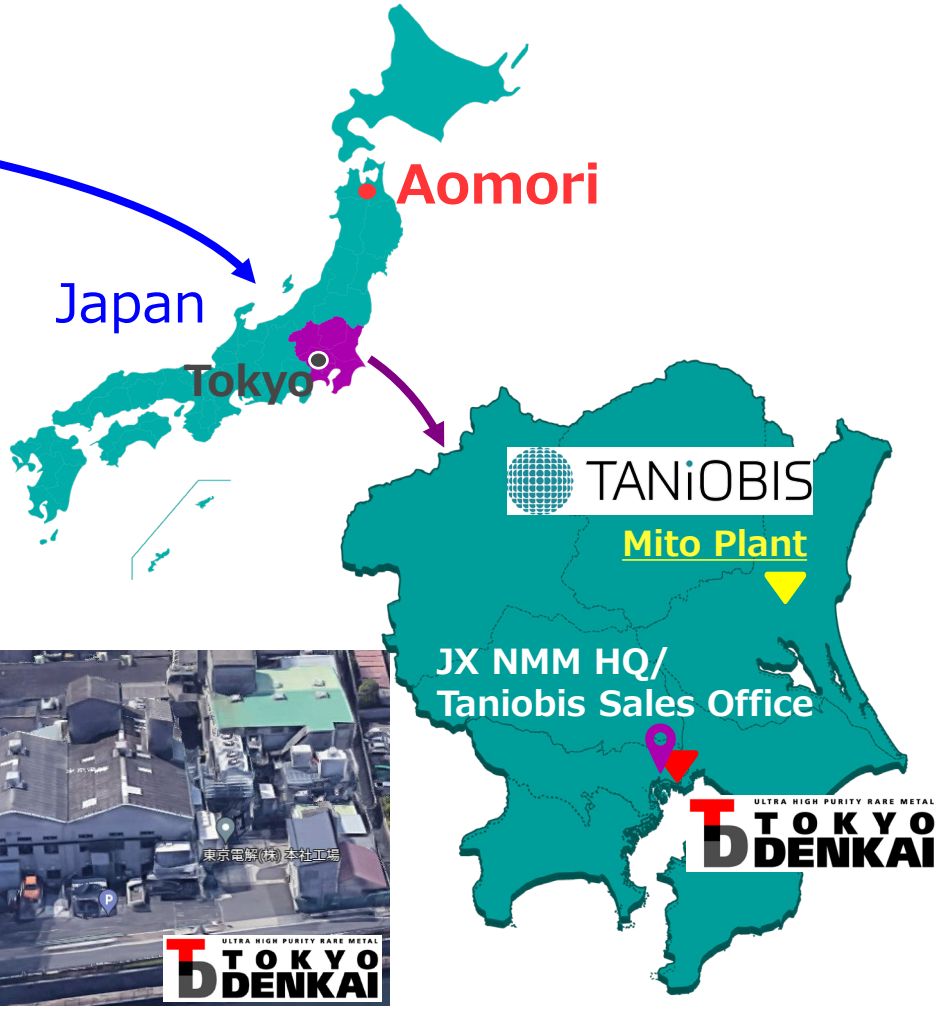
Ingots and sheets of Ta and Nb

(New Business)

Operation sites of Ta and Nb Div. of JX NMM

Tokyo, Japan（Sales Office）

Newton, MA US（Sales Office）



History Ta and Nb Business in JX Metal Group 1

Year	JX Nippon Mining & Metals	TANIOBIS	Tokyo Denkai
1905	Hitachi Mine was founded, and the Group is originated from it.		
1920		H.C. Starck was funded in Berlin.	
1926			Founded by recovering Sn from tin cans
1934			Reorganized to Takeuchi Shoten
1935		Acquisition of Gebr. Brochers AG (Goslar, Germany). The company was founded in Goslar in 1807.	
1936			Factory moved to Higashisuna, Koto-ku
1950			Established Tokyo Denki Co., Ltd., inheriting facilities and operations from Takeuchi Shoten
1959			Entered the Ta business
1962			The first EB furnace installed.
1963			Developed Ta foil, seamless Ta tube, and Ta clad
1968			Entered the Nb business.
1985	Start of operations at Isohara Works.		

History Ta and Nb Business in JX Metal Group 2

Year	JX Nippon Mining & Metals	TANIOBIS	Tokyo Denkai
1985	Start of operations at Isohara Works		
1990		Acquired V-Tech Fansteel (Mito, Japan), which was established in 1986	
1992	Start of operations by Nikko Metals		Operation of a rolling mill achieves integrated production of plates, strips, wires, bars, and tubes, except for the forging process.
1993			Consolidate the business entity into the Ta, Nb business
1996		Acquired TTA (Thailand Tantalum Co. in Map Ta Phut). TTA was established in Phuket in 1979 and moved to Map Ta Phut in 1990.	
1997	(JX started to produce Ta targets for Cu interconnects of microchip at Isohara Works)		
2018		**JX NMM acquired** H.C. Starck Tantalum & Niobium GmbH (current TANIOBIS GmbH)	
2020		Company name changed to TANIOBIS	
2021			Received investment from Mercuria Investment Co., Ltd. and JX NMM
2022			**JX NMM acquired** all shares of Tokyo Denki and made it a wholly owned subsidiary.

Major Products of TANIOBIS

TANiOBIS

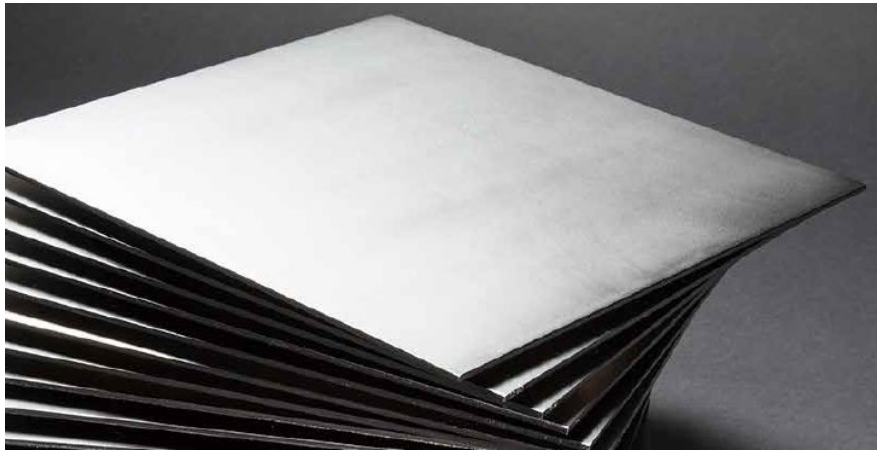
Market segments	Key product groups	Typical applications
Capacitor materials	**Tantalum capacitor powders** • High CV(1) powders • Mid CV powder • High Voltage powder	• Notebooks, tablets, mobiles, TVs • Telecom infrastructure • Connected car
High-purity metal powders	**Metal powders** • for sputter targets **(Tantalum)** • for sinter applications	• Semiconductors • DRAM and NAND Flash • Integrated circuit chips
Alloy additives	**Alloy Additives** • NiNb (40/60) • Niobium oxide (Nb_2O_5)	• Jet engine and industrial gas turbines • Oil & gas infrastructure

Products of Tokyo Denkai

ULTRA HIGH PURITY RARE METAL
TOKYO DENKAI

Niobium metal
Niobium plates
Niobium sheets for SRF Cavity

Tantalum metal for Sputtering target

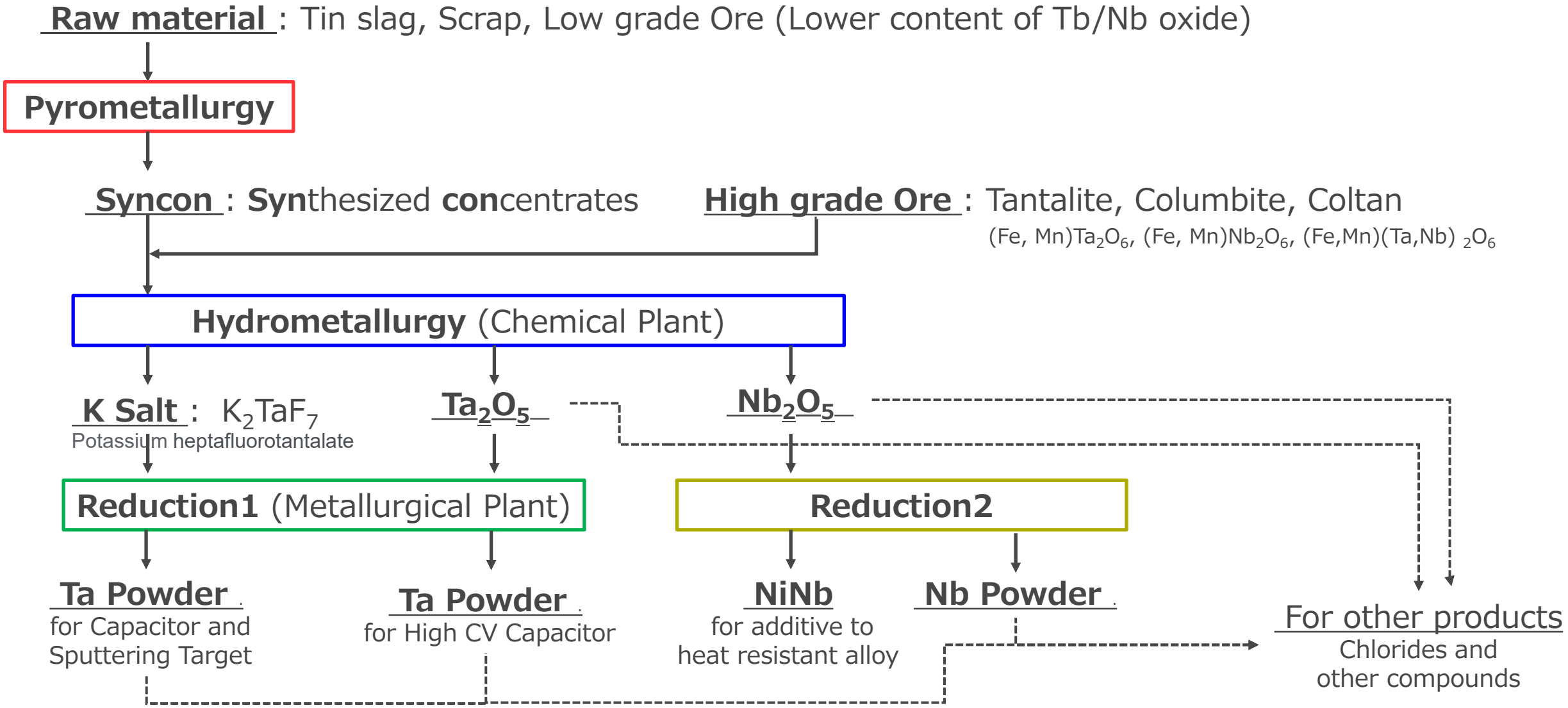


Niobium sheets for SRF Cavity

EB Furnace

3. Technologies of Ta and Nb production in TANIOBIS and Tokyo Denkai

Rough flowchart of Ta and Nb process in TANIOBIS



Pyrometallurgy -- Flowchart of Ta and Nb process 1

Raw material : Tin slag, Scrap, Low grade Ore

Reduction

$Ta_2O_5 + 7C \rightarrow 2TaC + 5CO$ with Fe

$Nb_2O_5 + 7C \rightarrow 2NbC + 5CO$ with Fe

Magnetic Beneficiation

TaC & NbC with Fe Elements are removed as Oxide

Oxidation

$2TaC + 7O_2 \rightarrow Ta_2O_5 + 2CO$

$2NbC + 7O_2 \rightarrow Nb_2O_5 + 2CO$

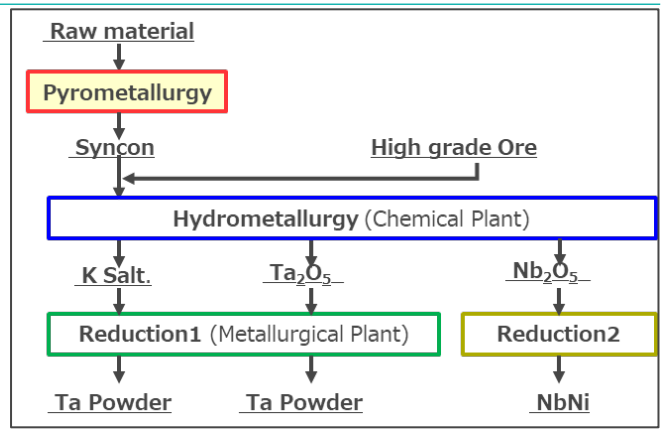
$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Partial Reduction

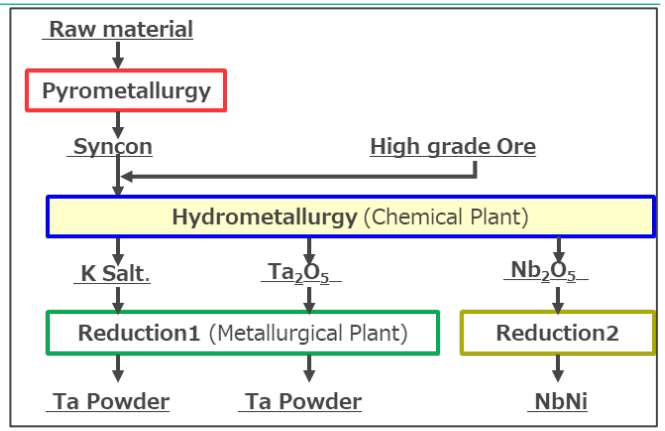
Only Iron Oxide is reduced, and Fe is separated from Ta/Nb oxide.

$2Fe_2O_3 + 3C \rightarrow Fe + 3CO$

Syncon : Ta_2O_5, Nb_2O_5 (Higher content of Tb/Nb oxide)



Hydrometallurgy -- Flowchart of Ta and Nb process 2



Syncon, Scrap **High grade Ore** : Tantalite, Columbite, Coltan

Digestion

$Ta_2O_5 + 14\ HF \rightarrow 2\ H_2(TaF_7) + 5\ H_2O$

$Nb_2O_5 + 14\ HF \rightarrow 2\ H_2(NbF_7) + 5\ H_2O$

Extraction

Separate Ta and Nb

Using MIBK (4-Methyl-2-pentanone: $CH_3COCH_2CH(CH_3)_2$)

Ta/Nb Separation

Ta solution.

Crystallization

$H_2(TaF_7)+2KF \rightarrow \underline{K_2TaF_7}\downarrow +2\ HF$

Drying

K Salt : K_2TaF_7 (Powder)

Nb solution.

Precipitation

Calcination

Ta_2O_5

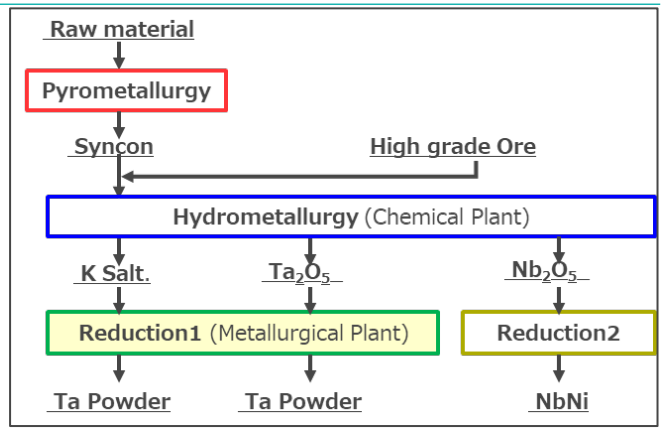
Precipitation

Calcination

Nb_2O_5

Hydration process

Reduction 1 -- Flowchart of Ta (and Nb) process 3



K Salt : K_2TaF_7 (Powder)

Na Reduction $K_2TaF_7 + 5Na \rightarrow Ta + 5NaF + 2KF$

Leaching NaF and KF are removed.

Drying

Finishing

Ta Powder
For Target and
For Conv. CAP

Ta_2O_5

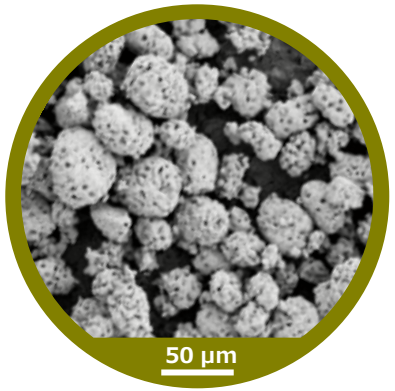
Mg Reduction $Ta_2O_5 + 5Mg \rightarrow 2Ta + 5MgO$

Leaching MgO is removed.

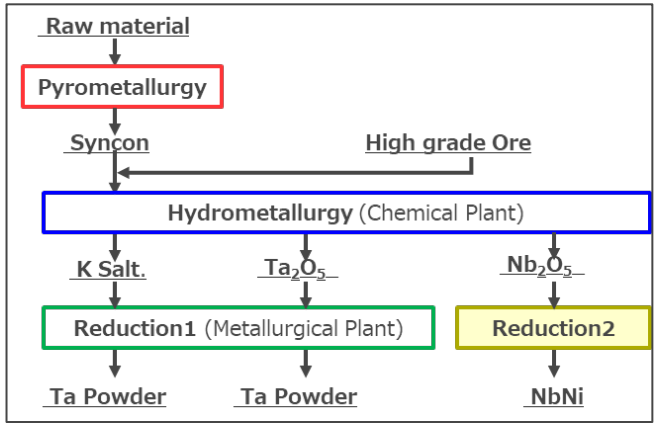
Drying

Finishing

Ta Powder
For High CV CAP



Reduction 2 -- Flowchart of （Ta and Nb process 4



Nb_2O_5

Al Reduction

Add Ni, Al etc, then get NbNi and Al_2O_3 (lower dens.)

Raw NiNb

Crashing

Cleaning

NiNb .
for additive to heat resistant alloy

Reduction

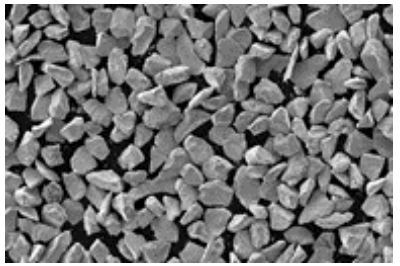
$Nb_2O_5 \rightarrow Nb$

Leaching

Drying

Finishing

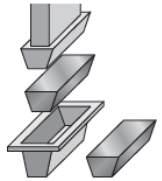
Nb Powder .



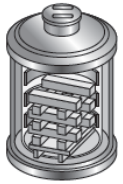
Flow of Ta ingot and Sputtering target in Tokyo Denkai and JX NMM

Ta Powder : TANIOBIS SPT grade

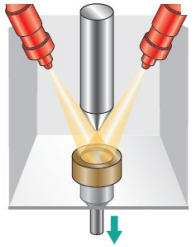
Pressing



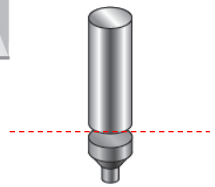
Sintering



EB Melting



Cutting



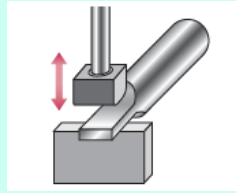
Ta Ingot

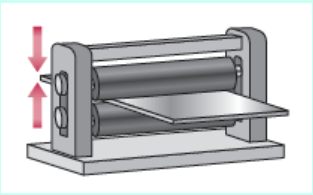
(Process for sputtering target at Thin Film Matl's Div. of JX NMM)

Cutting

Thermo-mechanical Work

Forging, Rolling and Heat treatment





Machining

Finishing

Inspection

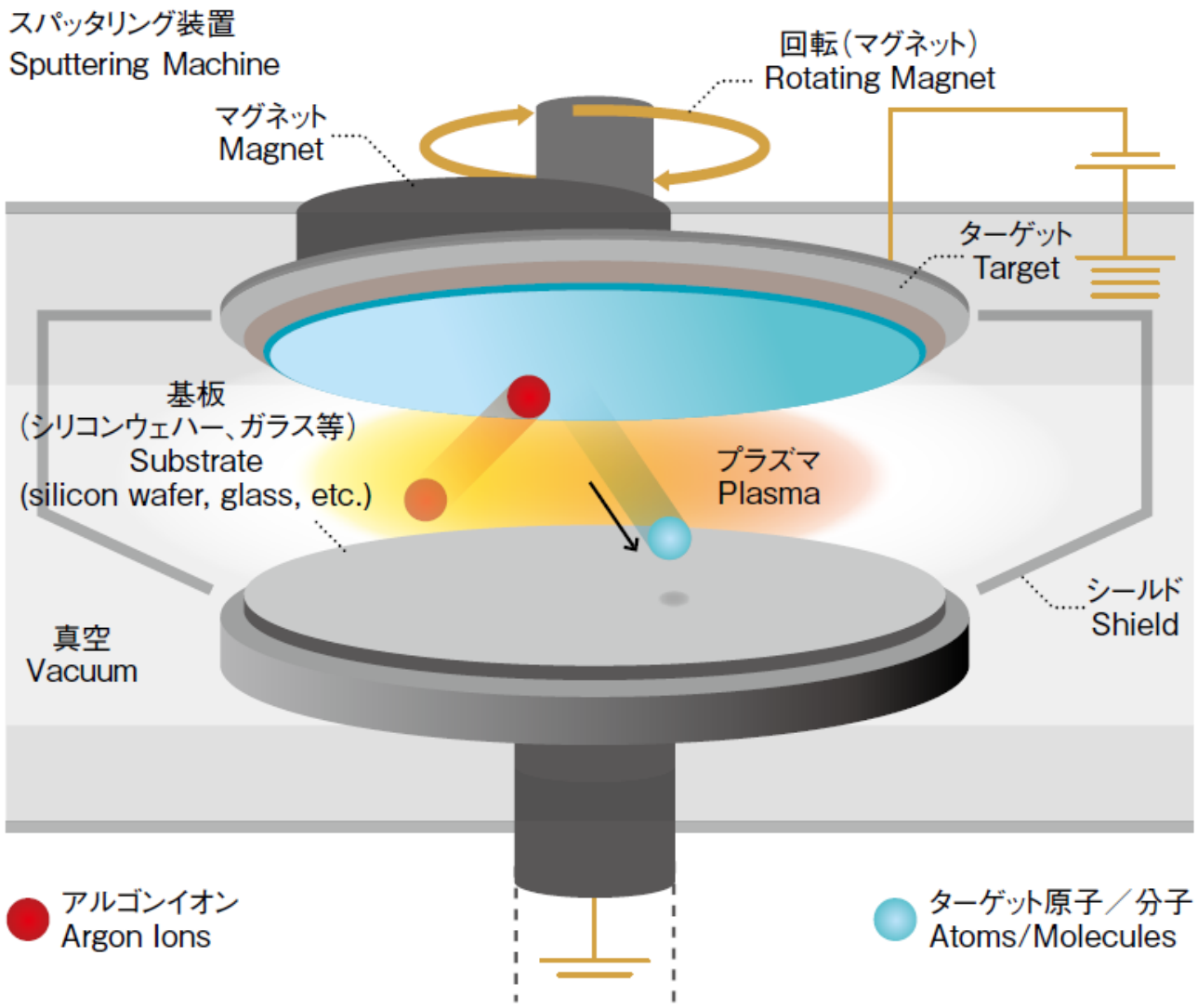
Sputter Target*

*: I. Sawamura and S. Irumata "Advanced Technology for Tantalum Sputtering Targets" T.I.C. Bulletin **114**, 2 (2003)

Sputtering Mechanism

スパッタリング法は真空状態の装置内でスパッタリングターゲットにアルゴンイオンを衝突させ、放出したターゲット原子／分子をシリコンウェハーやガラス等の基板上に付着させ、薄膜を形成する技術です。スパッタリングターゲットとは、このスパッタリングを行う際に、イオンがぶつかる的＝ターゲットとなることからつけられた名称です。

Sputtering is a technology used to form a thin film on a silicon wafer, glass, or other substrate. Within a vacuum state maintained in a sputtering machine, a sputtering target is bombarded with argon ions. This causes atoms or molecules to be emitted from the sputtering target. The atoms or molecules are deposited and form a thin film on the substrate.



Flow of High Purity Niobium sheet for SRF application

(Process at suppliers)

Raw material : Ore (Columbite, Pyrochlore, etc.)

$(Fe, Mn)Nb_2O_6$, $(Na,Ca)_2Nb_2O_6(OH,F)$

Al Thermite Reduction

$3Nb_2O_5 + 10Al \rightarrow 6Nb + 10Al_2O_3$

ATR Bar (**A**luminO**T**hermic **R**eduction) ～5% Al

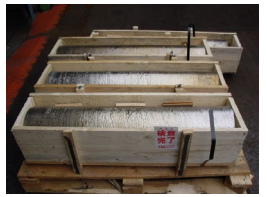
dry refining By EB furnace or VAR furnace

Nb Ingot (Low RRR ～30)

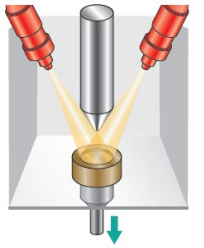
Referred from
Hiroaki Umezawa "Industrial production of niobium for superconducting accelerators", Proceedings of 44th. Kasokuki Kagaku Kenkyukai, 66-80 (2007) in Japanese

梅澤裕明「超伝導加速器用ニオブの工業的生産」第44回加速器科学研究会 66-80 平成19年

Nb Ingot

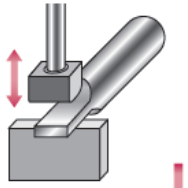


EB Melting

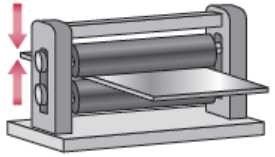


Cutting

Forging

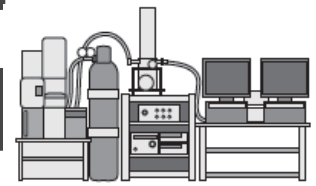


Rolling



Polishing

Inspection



Nb sheet

(RRR ～300)

Purity of High Purity Tantalum and Niobium

Impurities in H.P. Tantalum

Element	Value (wtppm)
C	<10
N	<10
O	<20
Ta	Matrix
Nb	0.08
Cr	<0.01
Fe	<0.01
Ni	<0.01
Hf	<0.01
Mo	0.32
Zr	<0.01
W	<0.05

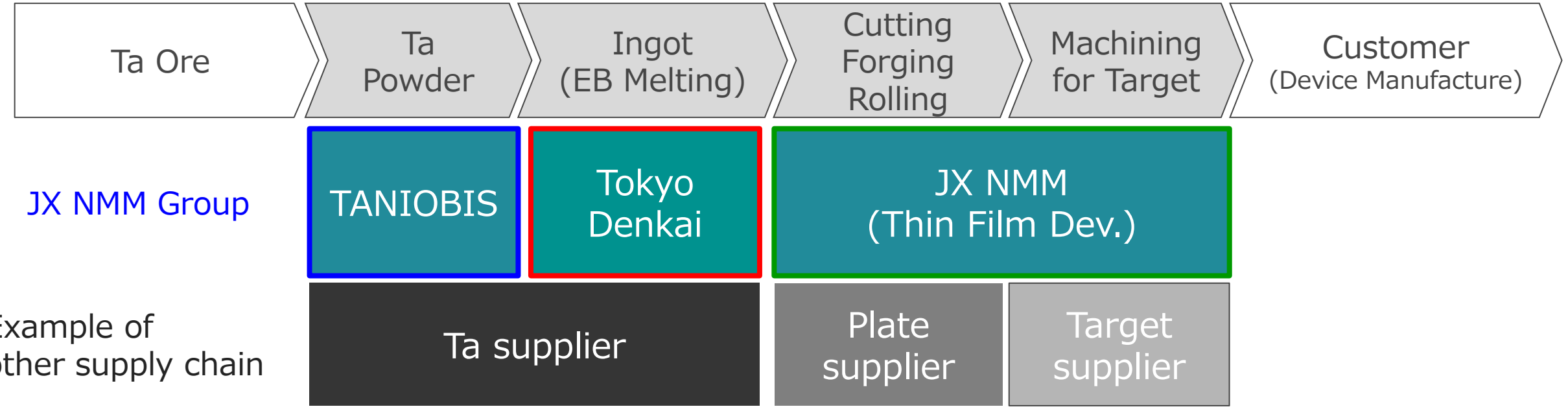
Impurities in H.P. Niobium

Element	Value (wtppm)
C	<10
N	<10
O	<20
Ta	35
Nb	Matrix
Cr	<0.01
Fe	<0.01
Ni	<0.01
Hf	<0.01
Mo	2.5
Zr	< 0.01
W	0.6

4. Future Business Plan of Ta and Nb

Tantalum Business

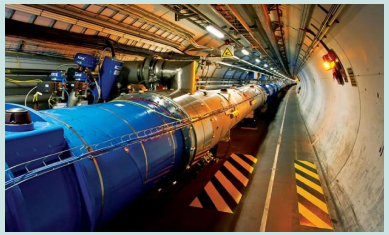
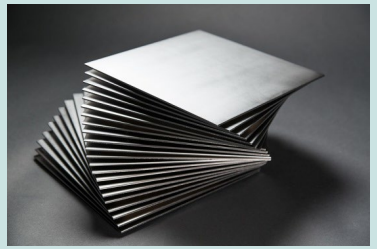
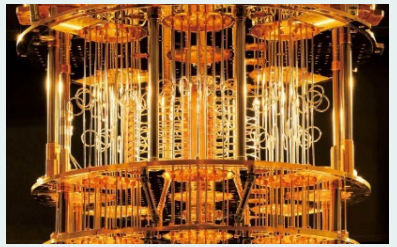
Supply chain of Ta target for semiconductor devices



JX NMM Group has established an integrated system from Ta powder to targets

Synergy in Niobium business

JX NMM acquired Tokyo Denkai in this April, and has started to have synergy effects on Niobium business as well as Ta business.

Synergy item		
Nb sheet for SRF cavity and other application	Nb sheets for SRF Cavity and other application. TANIOBIS to supply TD's Nb products for EU and US customers.	 
Nb ingot for Sputtering target	TD to use TANIOBIS's Nb powder for sputtering target for Quantum device.	Quantum Computer 
R&D in Nb and Nb alloy	TD, TANIOBIS and JX to collaborate in developing products and business scheme of Nb and Nb alloy.	

Nb Products of TANIOBIS 1

Nb Metal and NbO

Niobium		Purity min.	Main application
Nb Metal & NbO	Capacitor Grade NbO		• Nb capacitor
	Capacitor Grade Nb Powder		• High CV Nb capacitor
	AMPERTEC® Nb EB High-Purity	99.9%	• Medical applications
	AMPERTEC® Nb EB TS	99.9%	• Thermal spraying applications

$NbCl_5$

AMPERTEC® Niobium pentachloride $NbCl_5$	Purity min.	Physical characteristics	Main application
High Purity Grade	99.93%	Particle Size: < 3 mm Description: yellow crystals Melting point: 204 °C Bulk density: ca. 1.7 g/cm³	• Catalysis • Coating • MLCC
Highest Purity Grade	99.995%		• CVD precursor • Synthesis

Nb Products of TANIOBIS 2

Niobium Oxide

Our product range features a comprehensive spectrum of tantalum pentoxide (Ta_2O_5) grades and niobium pentoxide (Nb_2O_5) grades adapted for a wide variety of applications and markets. With a deep understanding of the different requirements, in terms of chemical purity and morphology, and thanks to intensive customer cooperation, we can improve product properties with respect to the continuously changing requirements of the specific applications.

Niobium pentoxide Nb_2O_5	Purity min.	Physical characteristics	Main application
Metallurgical Grade	99.0%		• Alloy additives • Super alloys
Chemically-Pure Grade	99.9%	D10% < 1 µm D50% < 2 µm D90% < 100 µm	• Carbides • Catalysts • Refractories • Pigments
Ceramic Grade	99.9%	D10% < 0.5 µm D50% < 1 µm D90% < 2 µm	• Carbides • Piezoceramics ferrites • MLCC • Pigments
High-Purity Optical Grade	99.99%	**HPO 400:** screened to be finer than 400 µm **HPO 600:** screened to be finer than 600 µm **HPO 1000:** not screened or screened to be finer than 1000 µm	• Optical lenses • Coatings

Niobium pentoxide Nb_2O_5	Purity min.	Physical characteristics	Main application
Lithium Niobate Grade (LN)	99.995%	D10% 1.0 - 1.5 µm D50% 4.0 - 7.0 µm D90% 20 - 100 µm	• Single crystal • High-purity applications
Sputter Target Grade (SPT-A)	99.995%	D10 > 15 µm D50 25 - 50 µm D90 40 - 70 µm	• Sputter targets

Nb Products of TANIOBIS 3

Niobium Hydroxide

Our niobium hydroxide ($Nb(OH)_5$) is used as a niobium precursor for the production of niobium compounds, among others for catalysis and electroceramics. As a non-calcined powder, with a water content of 30 - 60%, $Nb(OH)_5$ is an ideal starting material for homogenous doping.

$Nb(OH)_5$	Chemical characteristics	Physical characteristics	Main application
Moist (amorphous structure)	Nb_2O_5 min. 30% F max. 0.5% Loss on ignition, max. 70% NH_4 3 - 5%		• Niobium precursor for the production of niobium compounds, e.g. for catalysis and electroceramics
Milled	Nb_2O_5 min. 60% F max. 0.5% Loss on ignition, max. 40% NH_4 3 - 5%	D10% < 2 µm D50% < 10 µm D90% < 80 µm	
Crushed	Nb_2O_5 min. 60% F max. 0.5% Loss on ignition, max. 40% NH_4 3 - 5%		

Nb Products of TANIOBIS 4

NAmOx

Our **niobium ammonium oxalate (NAmOx)** is a white, crystalline powder that is stable in air and completely water-soluble. NAmOx allows the obtaining of clear solutions containing 40 - 160 g/l Nb. The powder provides an excellent niobium solution with high homogeneity, without using organic solvents. NAmOx is therefore benificial as a precursor for the production of niobium-doped catalysts.

Niobium Ammonium Oxalate	Chemical characteristics	Solubility	Application
NAmOx	Nb min. 19% C_2O_4 typ. 50 - 65% NH_3 min. 2%	60 - 230 g/l Nb_2O_5 (=40 - 160 g/l Nb at 20 - 70 °C)	• Production of catalysts, ferrites, electroceramics and pigments

Nb Oxalates

In addition to the NAmOx powder, we offer **aqueous solutions of niobium and tantalum oxalate.**

Our niobium and tantalum oxalate solutions are an ideal precursor for mixtures at an atomic level.

Aqueous solution of	Chemical characteristics	Typical content	Density	Application
Nb-Oxalate	Nb_2O_5 typ. 90 - 270 g/l C_2O_4 typ. 150 - 400 g/l Cl max. 50 mg/l F max. 100 mg/l	190 g/l Nb_2O_5	1.15 - 1.40 g/cm³	• Catalytic converters, ferrites, electroceramics and pigments

Nb Products of TANIOBIS 5

Niobates

Niobates are which consist of niobium and another metallic element. These ternary oxides materials can be used as dopants and precursors for piezoceramic materials. TANIOBIS provides not only the displayed compounds, but also upon request other niobates with different particle morphologies and sizes.

Niobates	Chemical characteristics	Solubility	Application
$KNbO_3$	K 21.0 - 22.8% Nb 49.7 - 52.3% Loss on ignition max. 0.5%	Surface Area (BET) 2 - 4 m²/g D10% < 2 µm D50% < 10 µm D90% < 80 µm	• Doping of PZT (Lead Zirconium Titanate) piezoceramics
$MgNb_2O_6$	Mg 7.7 - 8.3% Nb 59.9 - 61.1% Loss on ignition max. 0.2%		• Precursor for PMN (Lead Magnesium Niobate) piezoceramics

Amtrinsic® Materials for Additive Manufacturing

TANiOBIS

Right in step with the latest market developments, and based on our long expertise in powder metallurgy, we have developed atomized **AMtrinsic®** spherical powders with the properties required by different additive manufacturing technologies. Our powders are characterized by excellent flowability, high tap density, a perfectly spherical shape and narrow particle size distribution.

AMtrinsic® spherical	O (ppm)*	Flow rate (s)*	Tap density (g/cm³)*	Main application
Ta	< 400	< 12 (0.1 inch) < 3 (0.2 inch)	10 - 11	• Medical implants • Applications that combine high corrosion resistance with freedom of design • Corrosion-resistant components and high-temperature applications in the chemical processing industries
Nb	< 600	< 20 (0.1 inch) < 5 (0.2 inch)	4.5 - 5.8	• Corrosion-resistant components and high-temperature applications • Superconductor applications
Ti/Nb/Ta	< 3000	< 33 (0.1 inch) < 6 (0.2 inch)	2.5 - 4.5	• Next generation of customized medical implants
Ti42Nb	2700	< 18 (0.1 inch) < 7 (0.2 inch)	2.5 - 4.5	• High-performance applications that require the combination of high elasticity and high strength
Ta/W	< 800	< 10 (0.1 inch) < 3 (0.2 inch)	11 - 12	• Heat and corrosion-resistant components, e.g. in aerospace applications
Nb/Ta/W/Zr (FS85)	< 450	< 12 (0.1 inch) < 3 (0.2 inch)	6 - 7	• High-temperature application that requires high strength and good creep resistance
Nb/Hf/Ti (C103)	< 300	< 15 (0.1 inch) < 6 (0.2 inch)	5 - 6	• High stress resistance at extreme temperatures e.g. in aerospace applications
Ti/Ta	Under development			• High-temperature shape memory alloys • Biomedical applications
High-entropy alloys	Customer-specific compositions upon request			• Heat and corrosion resistance

* Reference value for exemplary lots with a grain size < 63 µm

5. To meet expectations for SRF Community and Projects

Future of Nb sheets for SRF Cavities

JX NMM / Taniobis supply various Niobium products (metal/alloy/compounds) now and are looking for “new” application of Niobium products.

JX NMM understands that the application for SRF cavity is very promising.

JX NMM / Tokyo Denkai / Taniobis will fulfill our supply responsibilities as a supplier of Niobium sheet for SRF Cavities.

JX Nippon Mining & Metals