TANIOBIS

Innovative Powders

www.taniobis.com

TANiOBIS

inspiring metal evolution

Tantalum and Niobium – Innovative Materials

Tantalum and niobium metal powders have a positive impact on our daily life. With their outstanding properties, they actively shape the development of future technologies.

Tantalum is characterized by having the fourth-highest melting point of all metals, a very high density, and good thermal and electrical conductivity. Due to its ability to form an extremely thin, tough, fully dense and protective oxide layer, it is outstanding for use in capacitor applications. Niobium is a ductile, oxidation and corrosion-resistant metal which improves material properties, often leading to the increased efficiency, safety and performance of end products.

The extraordinary properties of tantalum and niobium facilitate technological progress, including the IoT (Internet of Things), AI (Artificial Intelligence), smart factories, E-Mobility, or vehicle-to-vehicle communication. These materials are our passion; to utilize their innovative potential for future trends is our mission. Our experienced team can support you in the development of efficient and powerful solutions for existing and new application fields.

Miniaturization

Photo by Luke Chesser on Unsplash

Photo by Luke Chesser on Unsplash

A fundamental trend in consumer electronics is miniaturization. Smaller devices are expected to provide an ever increasing level of performance with more functions. Tantalum plays a crucial role in this trend.

The miniaturization of end devices, such as smartphones or notebooks, is supported by very high-capacitance tantalum capacitors, which achieve maximum energy density with a low footprint, thanks to their unique volume efficiency.

Moreover, our newly developed tantalum paste technology offers an innovative way to achieve ultra-thin capacitor designs and the increased volumetric efficiency of capacitance.

About TANIOBIS

A leading market position with the highest level of expertise in Ta- and Nb-based materials

TANIOBIS is a leading global producer of high-quality tantalum and niobium-based materials. We have more than 60 years of experience in the development and manufacture of high-performance tantalum and niobium metal powders for capacitors and sputter targets, high-purity oxides for the optical industry, and other specialty compounds including hydroxides, chlorides, oxalates, as well as alloys such as nickel niobium.

Sales Office

Manufacturing Site

Our highly-qualified R&D team develops specific product solutions targeted at the coming market trends, such as the Internet of Things (IoT), vehicle-to-vehicle communication, smart factories and additive manufacturing technologies.

Our company operates four production facilities located in Goslar and Laufenburg, Germany; Mito, Japan and Map Ta Phut, Thailand.

During the last decades, we have developed expertise to process tantalum and niobium containing primary and secondary raw materials into high-performance powders for diverse application fields.

Our core competencies within the value chain

Mining

Recycling

- Recycling of secondary raw materials, e.g. scraps and slags

Chemical/metallurgical processing

- Processing of tantalum and niobium (separation, refinement, purification & morphology adjustment)
- Output are high-tech, customized metal powders and compounds

Fabrication

- Conversion into semi-finished goods/components/parts (capacitors, sputter targets)
- Value-addition in order to enhance metal features

End-product manufacturing

- Manufacturing of end-products (e.g. telecom infrastructure, semiconductors, turbines)

Smelting

Raw material sourcing

- Tantalum and niobium ores
- Slags and residues
- Scrap

Pre-processing & concentration

- Concentration of low-grade raw materials by a multi-stage process in a smelting facility

Chemical plant

Separation of tantalum and niobium

- Raw material digestion
- Liquid-liquid extraction process

Precipitation of precusors & products

- K_2TaF_7
- Ta_2O_5
- Nb_2O_5

Metal plant

Reduction to metal

- Na reduction
- Mg reduction

Refining powder

- Provides flowability
- Optimizes particle morphology
- Further purification (deoxidation)

Continuous quality assurance

Highest Reliability in Future Technologies

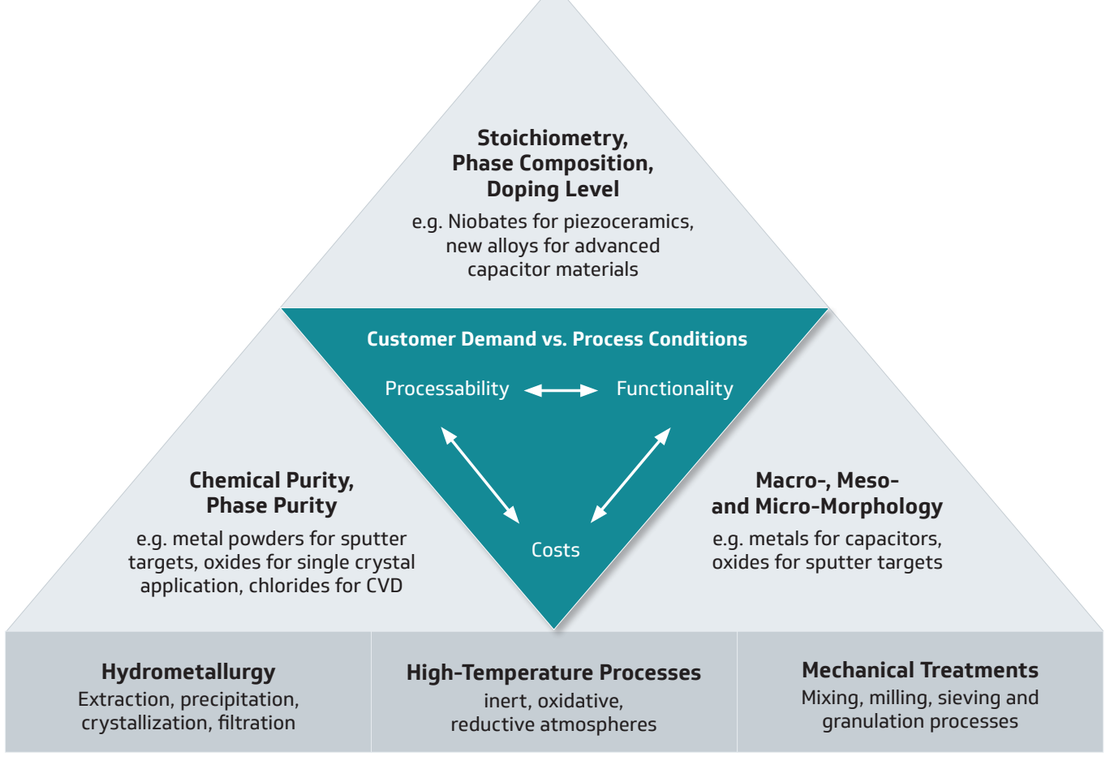
Our products are characterized by their consistent high quality. With our experience and expertise in application technology, we can provide engineered product solutions to your demanding, technically-challenging and unique requirements. We provide high-quality tantalum and niobium powders in six main product groups: capacitor materials, high-purity metal powders, specialty oxides, alloy additives, powders for additive manufacturing, and compounds & chlorides.

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 • 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
Specialty oxides	**Specialty oxides** • High-purity Ta_2O_5 • High-purity Nb_2O_5	• Optical lenses • Piezoceramics • SAW-filters
Powders for additive manufacturing	• **AMtrinsic®** Ta- and Nb-based powders and their alloys • Customized multinary alloys	• Medical and dental implants • Super conductivity • Aerospace engine systems
Compounds & chlorides	• **AMPERTEC®** Chlorides • Compounds	• CVD precursor • Piezo components

[1] CV refers to Capacitance and Voltage

Technological Expertise for Customized Solutions

The clear majority of our tantalum and niobium products are tailor-made, based on customer specifications. The close collaboration and partnership with our customers allows us to provide materials fully adapted to their processes and is one of our core competencies. This requires the ability to adjust not only the composition, but also the purity and morphology of the powder to achieve the required result. Our team draws upon deep material knowledge, unique equipment and strong process expertise in hydrometallurgy, high-temperature processes and mechanical treatments for the development and production of tailor-made materials.



Future Mobility

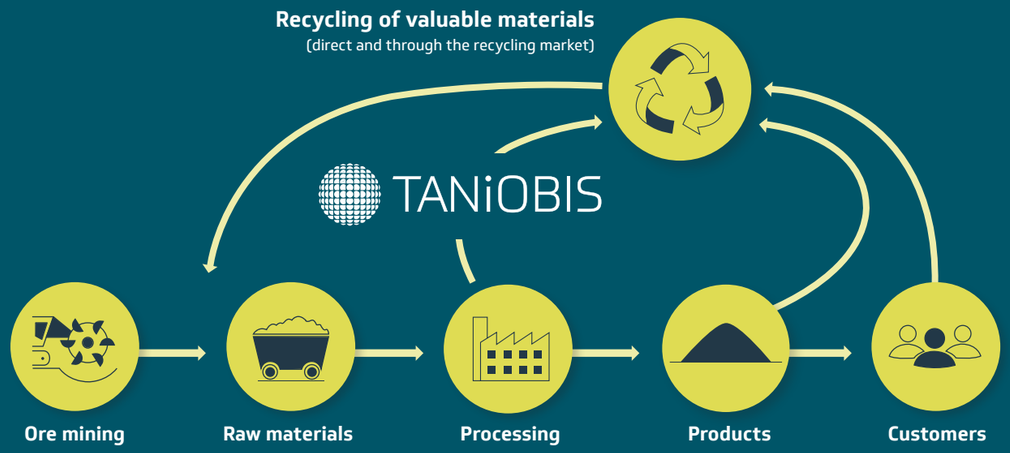
Our mobility behavior will change radically in the years to come. Automotive electronics encompass a wide range of applications, from cabin entertainment, airbags and ABS, to ADAS (Advanced Driver Assistance Systems). Due to their ideal properties, including enhanced reliability, a wide temperature range and low leakage, high-voltage tantalum capacitor powders are the perfect base for capacitors used in electronic mobility applications, contributing to increased vehicle reliability and passenger safety.

Photo by Maximalfocus on Unsplash

Sustainable Material Supply

Our raw material procurement strategy is based on two pillars: the responsible and ethical sourcing of primary materials, as well as the recycling of secondary materials (scraps, slags).

With unique expertise, we recover tantalum and niobium scraps from various industries (e.g. aviation), and return them into the supply chain, ensuring the sustainable use of resources.



Conflict-Free Smelter

TANIOBIS is at the forefront of the tantalum industry and we consider responsible and ethical raw material sourcing to be one of our core competencies.

Our activities are based on the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk areas.

We apply the due diligence systems of the:
- iTSCi (international Tin Supply Chain initiative – Full member)
- Responsible Minerals Initiative (RMI – Full Member), and
- Responsible Supply Chain Management (RSCM – internal supplier qualification system) to formalize the supervision and selection of mining, as well as trading activities.

We are a conflict-free smelter and conformant with the Responsible Minerals Assurance Process assessment protocols (RMAP) (formerly known as CFSP Compliant Smelters & Refiners) for all our manufacturing sites.

Formerly the Conflict-Free Sourcing Initiative

Our Process Excellence

Our innovative tantalum and niobium recycling processes allow us to reclaim tantalum and niobium from almost any type of tantalum and niobium-containing scrap or production by-products, and reintroduce them into the value chain with the same powder characteristics. Depending on the required product, our experienced team manufactures tantalum and niobium powders and compounds in the following production steps: pyro-metallurgy, hydro-metallurgy or powder metallurgy.

Oxides

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.

Tantalum pentoxide Ta_2O_5	Purity min.	Physical characteristics	Main application
Chemically-Pure Grade	99.9%	D10% < 1 µm D50% < 2 µm D90% < 100 µm	• Carbides • Catalysts • Refractories • Alloy additives
Ceramic Grade	99.9%	D10% < 0.5 µm D50% < 2 µm D90% < 5 µm	• Carbides • Ceramics • Electroceramics • Pigments
High-Purity Optical Grade	99.98%	**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
Grade LT	99.995%	D10% 0.3 - 0.5 µm D50% 1.0 - 2.0 µm D90% 5.0 - 60 µm	• Optical lenses • Sputter targets • Single crystals

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

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%		

Better Global Connectivity

High-volume data connectivity is an integral part of today's technological progress; the rapid growth of wireless data access and the need for high-speed data processing is greater than ever before. Electronic devices are becoming faster, smaller, more connected, and more energy-efficient. The Internet of Things, smart grids, smart factories and vehicle-to-vehicle communication cannot work efficiently without our tantalum and niobium powders. Our innovative approach makes it possible to develop thinner and smaller electronic devices with comprehensive functionality, thus providing a continuous contribution to better global connectivity.

Photo by iStock

Metal Powders

We provide a wide range of tantalum and niobium-based metal powders for capacitors used in applications, including vehicle electronics, ignition and engine control modules, as well as aerospace and defense technology.

We supply many different tantalum and niobium powders optimized for all voltage ranges. High-voltage capacitor powders, for example, play an important role in areas where safety and low breakdown rates are highly significant, such as in medicine (Implantable Cardioverter Defibrillator – ICD) or automotive.

Due to their high degree of purity and high quality, our tantalum and niobium ‚high-purity' powders are used in aviation and energy industry applications as alloy additives for corrosion-resistant turbine blades. In medical technology, the powders are used as radiographic contrast agents and in the production of bone replacement material and implants.

Moreover, our product portfolio includes tantalum pastes for ultra-thin electronic devices, as well as Ta- and Nb-based powders for various application technologies, like additive manufacturing.

Tantalum		Purity min.	Main application
Ta Metal	Capacitor Grade Na Reduction		• Ta capacitor
	Capacitor Grade Mg Reduction		• High CV Ta capacitor • High-voltage Ta capacitor • Medical devices
	Capacitor Grade Q		• High-voltage Ta capacitor
	Sinter Grade		• Mill products • Wire
	Sputter Target Grade		• Sputter targets
	AMPERTEC® Ta EB High-Purity	99.9%	• Medical applications
	AMPERTEC® Ta EB TS	99.9%	• Thermal spraying applications

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

AMtrinsic® spherical	Oxygen (ppm)	Purity min.	Main application
Spherical Ta	< 400		• Powder for additive manufacturing applications
Spherical Nb	< 600		• Powder for additive manufacturing applications

AMPERTEC® Chlorides

Niobium and Tantalum Pentachloride

Our **AMPERTEC®** niobium and tantalum pentachlorides ($NbCl_5$ and $TaCl_5$) are highly-reactive compounds of niobium and tantalum. Due to the reduced surface area, e.g. larger particle size, the compounds are associated with less dust formation, reduced moisture sensitivity and improved handling in dosage. The highest purity and semiconductor grades of the AMPERTECR product range are the purest of their kind currently available on the market in large scale production.

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: approx. 1.7 g/cm³	• Catalysis • Coating • MLCC
Highest Purity Grade	99.995%		• CVD precursor • Synthesis

AMPERTEC® Tantalum pentachloride $TaCl_5$	Purity min.	Physical characteristics	Main application
High Purity Grade	99.93%	Particle Size: < 3 mm Description: white crystals Melting point: 216 °C Bulk density: approx. 1.9 - 2.4 g/cm³	• Catalysis • Coating
Highest Purity Grade	99.995%		• CVD precursor • Synthesis
Semiconductor	99.999%		• Semiconductor

Tungsten Hexachloride and Tungsten Pentachloride

Thanks to its superfine particle size and its strong reactivity, **AMPERTEC®** tungsten hexachloride or pentachloride particularly meet the special requirements of catalytic applications. Coating is another field of utilization.

AMPERTEC® Tungsten hexachloride/pentachloride WCl_6/WCl_5	Purity min.	Physical characteristics	Main application
WCl_6	99.9%	Particle Size: < 2 mm Description: black-violet crystals Melting point: 282 °C Bulk density: approx. 1.2 g/cm³	• Catalysis • Sol-Gel • CVD precursor • Synthesis
RD WCl_5*	99.9%	Particle Size: < 2 mm Description: black crystals Melting point: 248 °C	• Semiconductor

Molybdenum Pentachloride

AMPERTEC® Molybdenum pentachloride $MoCl_5$	Purity min.	Physical characteristics	Main application
$MoCl_5$[1)]	99.9%	Particle Size : < 2 mm Description: black crystals Melting point: 194 °C [1)] Bulk density: approx. 0.5 - 0.7 g/cm³	• Catalysis • Sol-Gel • CVD precursor • Synthesis
RD $MoCl_5$ Semiconductor*[, 2)]	99.995%	[2)]Bulk density: approx. 1.0 g/cm³	• Semiconductor

Tungsten Oxidetetrachloride

This is a new development within the TANIOBIS **AMPERTEC®** product range. Due to its high phase purity and low metal impurity level makes it is the perfect candidate for catalytic and coating applications.

AMPERTEC® Tungsten oxidetetrachloride $WOCl_4$	Purity min.	Physical characteristics	Main application
RD $WOCl_4$*	99.9%	Particle Size : < 2 mm Description: orange crystals Melting point: 211 °C	• Catalysis • Sol-Gel • CVD precursor • Synthesis

* RD: development product

Compounds

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

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
Ta-Oxalate	Ta_2O_5 typ. 150 - 200 g/l C_2O_4 typ. 110 - 160 g/l Cl max. 50 mg/l F max. 100 mg/l	190 g/l Ta_2O_5	1.00 - 1.30 g/cm³	• Catalytic converters and electroceramics

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

Alloy Additives

Due to its high melting point and excellent oxidation and corrosion resistance, nickel niobium is a preferred component in superalloys used for parts that must withstand high temperatures. Moreover, nickel niobium compensates for high-tension stresses, as well as shocks caused by vibration and impact.

Refining steels with superalloys that contain niobium ensures optimized machine performance and fuel combustion, lower machine maintenance costs and a greater degree of safety. Nickel niobium slows material aging processes and prevents crack formation under thermal stress.

Product	Purity min.	Chemical / Physical characteristics	Main application
Nickel Niobium (NiNb)		40/60 58 - 65% Nb-content lumpy < 50mm	Alloy additives
Niobium Pentoxide Nb_2O_5 *Metallurgical Grade*	99.0%	Loss on ignition: max. 0.2% Tap density: 1.3 - 1.4 g/cm³ avg	Alloy additives

Nickel Niobium

- Production method: Metallothermic Reduction
- Nb nominal range: 58 - 65 wt%
- Available shapes: Lumps
- Typical sizes: 5 x 50 mm
- Packaging: various

AMtrinsic® Materials for Additive Manufacturing

Based on our strong expertise in the development and manufacturing of tantalum and niobium metals and their alloys, we have extended our portfolio to include gas-atomized **AMtrinsic®** spherical tantalum and niobium pure metals and alloy powders. Our powders are characterized by excellent flowability, high tap density, 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	• 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	< 400	<20 (0.1 inch) <5 (0.2 inch)	>4.5	• 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	< 3000	<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)	10 - 12	• Heat and corrosion-resistant components, e.g. in aerospace applications
Nb/Ta/W/Zr (FS-85)	< 500	<14 (0.1 inch) <5 (0.2 inch)	>6	• High-temperature application that requires high strength and good creep resistance
Nb/Hf/Ti (C-103)	< 350	<14 (0.1 inch) <5 (0.2 inch)	>5	• High stress resistance at extreme temperatures e.g. in aerospace applications
Nb/W/Zr (Cb-752)	<600	<14 (0.1 inch) <5 (0.2 inch)	>5	• High-temperature mechanical properties desirable for space and aerospace applications
High-entropy alloys	Customer-specific compositions upon request			• Heat and corrosion resistance

* Example values with a grain size < 63 µm

Other alloy compositions upon request

- Extremely low O content
- High tap density
- Spherical shape with smooth surfaces
- Very good flowability

→ **Excellent processability in 3D-printing, as well as in metal injection molding**

AMtrinsic® spherical powders are pre-conditioned for applications in Laser Beam Powder Bed Fusion (LB-PBF), Electron Beam Powder Bed Fusion (EB-PBF) and Directed Energy Deposition (DED) or according to customer requests.

AMtrinsic® spherical Tantalum

Additive Manufacturing for Medical Devices

Every person is unique. Optimum patient care in dentistry, orthopedics and implantology requires medical products that provide a perfect fit. Technologies, such as 3D-printing, open up entirely new ways of manufacturing custom-made components and highly complex elements that have, up to now, been simply unthinkable. 3D-printing technology, in combination with our new **AMtrinsic®** spherical Tantalum and Niobium Powders and their alloys, make it possible to produce bio-compatible implants with outstanding mechanical properties, optimized for each patient.

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