



High Performance Metal Solutions

# Tantalum and Niobium – Lasting Solutions in Severe Environments

H.C. Starck 

High Performance Metal Solutions

# Introduction of H.C. Starck Solutions

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H.C. Starck Solutions, with its unique competence in high-tech materials, is your partner for innovative products with high value creation.

We feel at home in all growing markets with our innovative and distinctive product portfolio of refractory metals, ceramics and electronic-chemicals. With 13 production sites in the United States, Asia, and Europe as well as sales offices around the world, we are as international as our customers.

Fabricated Products and Components, a business group of H.C. Starck Solutions, is a worldwide supplier of customized solutions for many industries. We are experts in refractory metals. These high performance materials have outstanding properties that provide solutions to thermal, electrical, radiation, and chemical challenges. In state-of-the-art facilities H.C. Starck Solutions manufactures semi-finished and fabricated products with applications in a variety of markets.

H.C. Starck Solutions is a leading supplier of corrosion-resistant refractory metals such as tantalum, niobium, molybdenum, and tungsten. H.C. Starck Solutions provides engineered material solutions for a wide range of industries where corrosion resistance is critical.

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**Materials**

*Stands for H.C. Starck Solutions' material competence which is unique the world over and extends throughout the company both vertically and horizontally.*

2

**Development**

*Stands for the innovation potential and expertise that makes us a driving force behind new products, applications and global markets.*

3

**Solutions**

*stands for the ability to support our customers with innovative and customized product solutions across their entire value chain.*

## Materials – Development – Solutions Driving Your Value Creation

**Our high tech materials and technologies, creatively combined with the innovative power of H.C. Starck Solutions, produce value-added solutions for a wide range of applications in the pharmaceutical and chemical processing industries. These include linings for piping, tubing for heat exchangers, cladding for vessels, and other parts for dependable corrosion control.**

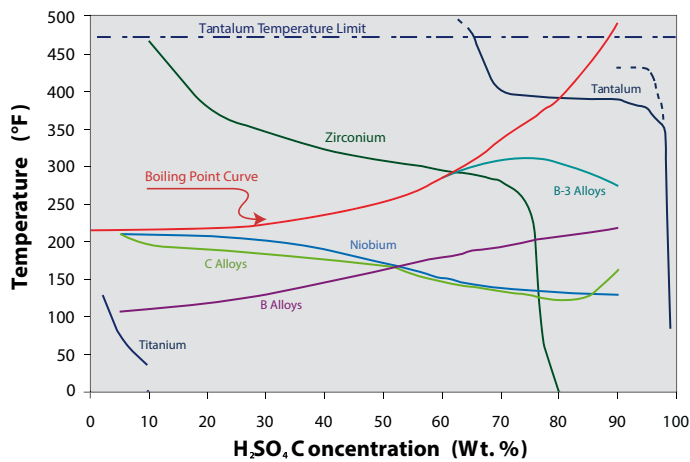
# | Materials |

## High Performance Materials for Demanding Applications

At H.C. Starck Solutions, we have experience in the production and processing of high performance materials such as tantalum, niobium, and their alloys such as NRC®.

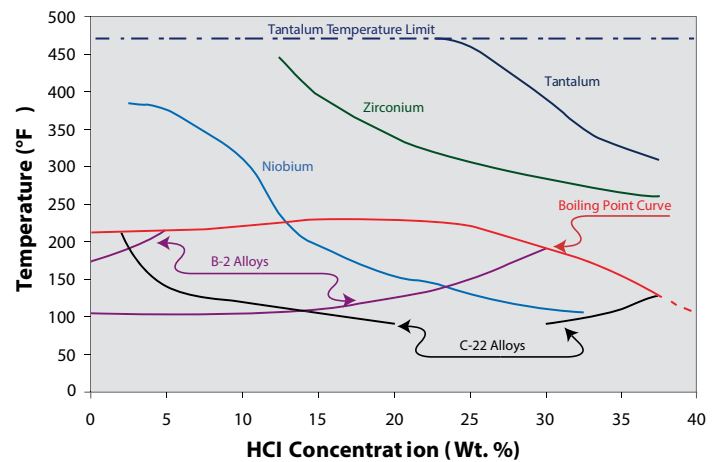
### ISO-CORROSION - SULFURIC ACID

5 mpy (0.14 mm/y)



### ISO-CORROSION - HYDROCHLORIC ACID

5 mpy (0.14 mm/y)



Tantalum and niobium are highly corrosion-resistant metals that are virtually inert to acid attack. These reactive metals outperform other materials, drastically reduce downtime, and add years of service life to process-exposed equipment.

### H.C. Starck Solutions' high purity NRC® tantalum a lasting solution in severe environments:

- > Excellent corrosion resistance
- > High strength and stability at elevated temperatures
- > High ductility and toughness
- > Superior thermal conductivity

# Tantalum - The Most Economical Solution for Corrosion Protection

Due to its much longer service life and maintenance-free durability, tantalum has proven to be your most cost-effective solution for corrosion protection in pharmaceutical and chemical processing applications.

Tantalum has a wide range of benefits:

## Chemical Resistance

- > Virtually inert to chemical attack
- > Operates in the broadest range of harsh oxidizing and reducing environments
- > Requires only a thin wall of material for tubes and vessels compared to other materials

## Regulatory Requirements

- > Avoid heavy metals contamination
- > Faster validated clean-out between batches

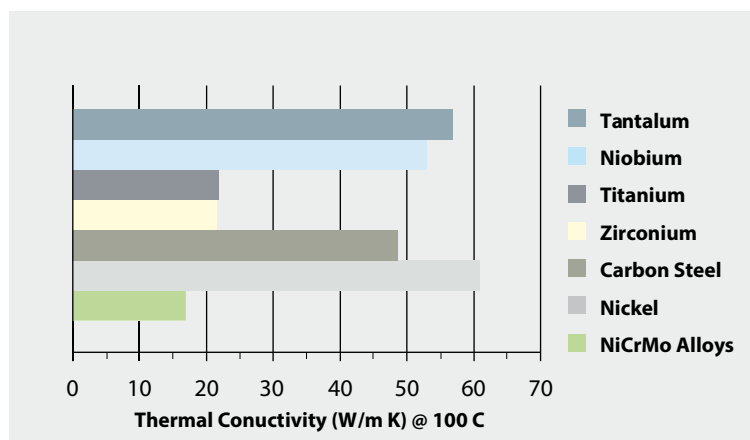
## Higher Heat Transfer Coefficients

- > 2.5 x higher heat transfer than titanium
- > Tantalum heat exchangers require 35%-45% less surface area, allowing a smaller footprint

## Cost

- > More cost-effective than other materials such as impregnated graphite and nickel-based alloys
- > Extends equipment life
- > Eliminates production downtime

## HEAT TRANSFER COMPARISON



## | Development |

# The Innovative Power of H.C. Starck Solutions

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Innovation and research are key strengths at H.C. Starck Solutions. As a worldwide leader in refractory metals, we have state-of-the-art laboratories where we are constantly refining and improving our products and materials. Our R&D programs are shaped by constant dialogue with our customers. By listening to their needs and requirements, we help them develop new and innovative products for the future.

H.C. Starck Solutions is committed to the science of corrosion resistance. In highly corrosive applications within the chemical and pharmaceutical industries, we are constantly striving to bring the market higher-performing materials that will give our customers manufacturing advantages. By focusing on the characteristics that are important to our customers and by minimizing costly materials, we optimize the performance of our products for a variety of applications.



## Experts in Corrosion Resistance

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At H.C. Starck Solutions, we are experts in the field of corrosion resistance. Our broad materials engineering expertise, with emphasis in the pharmaceutical and chemical processing industries, allows us to bring a focused, cost-effective approach to the solution of corrosion problems. We apply our engineering, technology, and industry expertise to develop solutions for our customers. We provide a variety of testing and analytical services:

- > **Corrosion failure analysis**
- > **Mechanical, metallographic, corrosion and non-destructive material testing**
- > **Root cause failure analysis for metals**
- > **Materials and corrosion prevention consulting**

# | Solutions |

## Value-Added Product Solutions for Severe Environments

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H.C. Starck Solutions offers a wide range of corrosion-resistant product solutions for the most severe environments. Tantalum and niobium are materials to consider in any application where corrosion is a factor and where the long-term benefits of reduced downtime, increased equipment life and profitability are important.

The corrosion resistance, durability, heat transfer properties and workability of tantalum and niobium make them perfect construction materials for virtually any application in the pharmaceutical and chemical industries. Our high performance materials are used to produce multi-purpose condensers, helical coils, pipe spools, valve linings, and a variety of components exposed to corrosive fluids. They are also used in the fabrication of shell and tube heat exchangers, columns and bayonet heaters.

### Typical Corrosive Applications

- > Polycarbonates
- > Silicones - via MethylChloride/HCl
- > Isocyanates - TDI and/or MDI
- > Nitrobenzene
- > Bromine
- > Bisphenol A
- > MEK & IPA
- > Acid Concentration
- > Pickling
- > Pharmaceuticals



### Sheet & Plate

H.C. Starck Solutions supplies tantalum and niobium sheet and plate with a cold-rolled and chemically cleaned surface. Because of its strength and workability, very thin sheets of tantalum can be clad to other surfaces, providing superior corrosion protection and cost effectiveness. All tantalum sheet and plate is visually inspected for slivers, laminations, excessive roll marks and handling scratches. Sheet and plate may be locally conditioned to remove defects, provided that thickness tolerance is maintained.

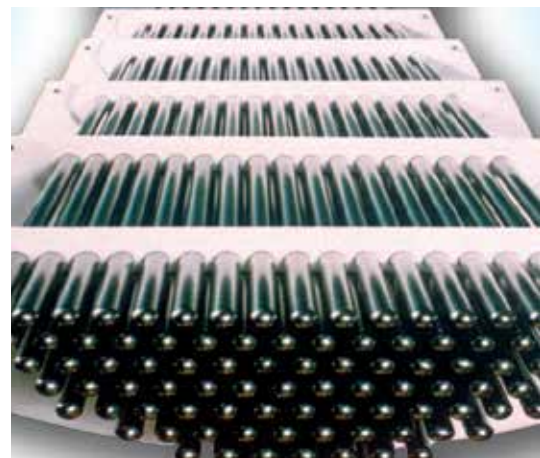
### Rod, Wire & Coils

Rod is worked cold from ingot to final diameter. Forging, rolling, swaging, and drawing are used to reach the desired size. Proprietary techniques are used to overcome highgalling tendencies. Rod is generally supplied with a forged surface above 1-5/8" diameter, and a swaged or drawn finish in smaller diameters. Rod, preferably unannealed, may be centerless ground to improve diameter tolerances. The minimum diameter for centerless grinding is 0.125". Rod to a maximum of 1/4" and wire may be supplied in coils or straight lengths. Wire with a diameter of 0.040" or below is shipped on spools.

### Welded Tubing

For chemical processing equipment, welded tantalum tubing is used for its excellent corrosion resistance and heat transfer. Since no allowance for metal removal by corrosion is generally necessary, wall thicknesses are specified to be as thin as structural conditions will permit.

Welded tubing, rolled and welded from annealed tantalum strip, has sufficient formability to meet requirements of most operations used in fabricating chemical process equipment. All H.C. Starck Solutions tubing exceeds ASTM B 521.





## Repair Kits

H.C. Starck Solutions provides repair kits for glass-lined equipment, including individual parts such as slotted studs, hex nuts, discs, and gaskets. All H.C. Starck Solutions patch kits are interchangeable with other standard 3-piece repair plugs and require no special installation tools.



## Quality

At H.C. Starck Solutions, we know that assuring product quality contributes to the success of our customers. Therefore, each step in our production cycle is monitored and our quality programs ensure the manufacture of consistent and high-quality products. H.C. Starck Solutions has a team of highly qualified technical experts who have material knowledge and application expertise, and they ensure that our products and processes are developed upon customers' demands. All our plants are ISO 9001 certified and we comply with all customer approval processes.

## Six Sigma

For those customers who are striving to meet goals of six sigma, tantalum is often the best choice for demanding applications. If you are interested in controlling your quality and defects, expanding your process capability, minimizing your process variation and ensuring a stable operation, tantalum is a clear choice. Because of its purity, inertness, toughness, reliability and robustness in a variety of environments, tantalum has been the leading choice of customers who are serious about the concepts of six sigma.

# Fabricated Products

## AVAILABLE TANTALUM FORMS AND TOLERANCES

Form	Thickness, Dia., Wall inches (mm)	Width, Length inches (mm)
Foil	0.0005" to 0.005" (0.0127 to 0.1270 mm)	12" max. width x coil (305 mm max. width x coil)
Sheet	0.005" to 0.020" (0.1270 to 0.50 mm)	36" max. width x coil (915 mm max. width x coil)
Sheet	0.015" to 0.060" (0.380 to 1.524 mm)	40" width x coil (1000 mm width x coil)
Plate	0.060" to 0.125" (1.524 to 3.175 mm)	width not to exceed 40" (1000 mm)  Total weight of finished plate not to exceed 350 lb.
Wire	0.028" to 0.125" dia. (0.711 to 3.175 mm dia.)	coil
Rod	0.125" to 0.625" (3.175 to 15.875 mm dia.) 0.625" to 3.000" dia. (15.875 to 76.200 mm dia.)	coil or straight lengths  straight lengths
Ingot	> 3" (76.2 mm)	depending on weight depending on weight
Welded Tubing		0.5" OD x 0.015" - 0.040" wall (12.7 mm OD x 0.380 - 1.0 mm wall) 0.75" OD x 0.015" - 0.050" wall (19.05 mm OD x 0.380 - 1.27 mm wall) 1.0 - 4.0" OD x 0.015" - 0.100" wall (25.4 - 102 mm OD x 0.380 - 2.540 mm wall)

## MECHANICAL PROPERTIES FOR PLATE, SHEET AND TUBING (ANNEALED)

Grade and Form	Ultimate Tensile Strength min, psi (MPa)	Yield Strength min, psi (MPa) (2% Offset)	Elongation min, % (1 inch GL)
Unalloyed Tantalum (R05200), (R05400) Plate, Sheet and Strip 0.003" - 0.060" thick ≥ 0.060" thick	30 000 (207) 25 000 (172)	20 000 (138) 15 000 (103)	20 30
97.5% Tantalum, 2.5% Tungsten, (R05252) Sheet and Strip Plate	40 000 (276) 40 000 (276)	30 000 (207) 28 000 (193)	20 20



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