



High Performance Metal Solutions

Fabricated Products

High Performance Solutions

H.C.Starck 

High Performance Metal Solutions

Empowering High Tech Materials

H.C. Starck Solutions

Empowering High Tech Materials is more than a slogan at H.C. Starck Solutions. It is our starting point for the creation of high performance solutions for our customers around the world.

H.C. Starck Solutions, a division of the H.C. Starck Group, is a leading supplier of high performance products to a wide variety of industries. As experts in the manufacture and application of refractory metals, we utilize the outstanding properties of these materials to provide solutions to thermal, electrical, radiation, and chemical challenges.

We serve an extremely diverse group of markets – from aerospace to medical equipment to hybrid vehicles. Whether your application involves airplanes, arteries, or automobiles, H.C. Starck Solutions has the materials and the expertise to meet your high performance application.

A World Leader in High Performance Materials

H.C. Starck is an international company with approximately 650 employees around the world. Our 6 ISO-certified production locations, research and laboratory facilities, and sales and business offices are located in Europe, North America, and Asia.

We apply our engineering, technology, and industry expertise to develop custom solutions for our customers. We produce a unique assortment of refractory metals, including molybdenum, tungsten, tantalum, niobium, rhenium, and their alloys, as well as advanced ceramics.



Materials

1

We provide a unique range of high performance materials that are unsurpassed in quality and supply reliability.

Development

2

Our intensive R&D and application-oriented expertise makes us a driving force behind new products, technologies, applications and markets.

Solutions

3

We support our customers along the entire value chain – from powder to finished components – with innovative and customized solutions.

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 electronics, medical, aerospace, chemical processing, and several other industries. Final applications range from CT scanners to flat panel displays to oil well drill bits.

| Materials |

High Tech Materials for High Tech Applications



H.C. Starck Solutions has decades of experience in the production of a unique combination of high performance materials – particularly molybdenum, tungsten, tantalum, niobium, and their alloys.

Tantalum

Tantalum is dense, very ductile, and a good conductor of heat and electricity. It is renowned for its corrosion resistance and is, in fact, virtually inert to chemical attack by most acids. It is widely used in surgical instruments and implants because it is biocompatible. Alloyed with other metals, it is used in the production of superalloys for jet engines. Pure metals and alloys are used in components, chemical process equipment, nuclear reactors, and in the production of semiconductors.

H.C. Starck Solutions supplies tantalum as mill products (sheet, plate, foil, rod, tube, and wire) and as semi-finished and finished parts for use in a wide variety of products and applications, including:

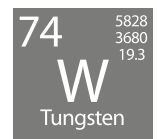
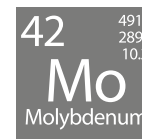
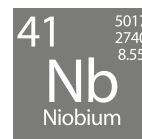
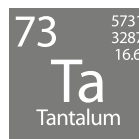
- > Capacitor grade furnace parts
- > Furnace elements, heat shields, and other parts
- > Heat exchangers, vessels, and columns
- > Crucibles
- > Sputtering target materials

Niobium

Niobium's chemical properties are similar to those of tantalum, so it is used in many of the same applications, such as surgical instruments, superconductors, and the chemical processing and pharmaceutical industries.

We supply niobium as mill products (sheet, plate, foil, rod, tube, and wire) and as semi-finished and finished parts, including:

- > Niobium components for the chemical processing industry
- > Formed cups
- > Sputtering target materials
- > Various fabricated parts





Like tantalum and niobium, tungsten and molybdenum are also transition metals that are characterized by their hardness and high melting points, making them ideal for a wide variety of demanding applications.

Tungsten

Tungsten is remarkable for its robust physical properties. Tungsten combines excellent corrosion resistance with the highest melting point, lowest vapor pressure, and highest tensile strength at temperatures above 1,650 °C of all metals. Its hardness and density make it ideal for the manufacture of heavy metal alloys that are used in a variety of high-density applications such as aircraft counterweights and radiation shielding.

We supply tungsten as mill products and as finished parts for use in a wide variety of products and applications:

- > **Balance weights for aircraft, helicopters, and instrumentation**
- > **Boring bars**
- > **Collimator plates**
- > **Fabricated parts**
- > **Sputtering target materials**
- > **Radiation shielding**
- > **High temperature shielding**
- > **Furnace elements, heat shields, and other parts**

Molybdenum

Molybdenum is extremely hard and has one of the highest melting points of all pure elements. It is used in aircraft parts, electronic applications, glass manufacturing, filaments, and many other applications. Due to its excellent thermal conductivity and low electrical resistivity, molybdenum is also widely used in the furnace industry for radiation screens, elements, and sintering trays.

We supply molybdenum as mill products and as finished parts for use in a wide variety of products and applications, including:

- > **Extruded tubes**
- > **Evaporation boats**
- > **Furnace elements, heat shields, and other parts**
- > **Glass melting electrodes (GME)**
- > **Plated and stamped components**
- > **Sintering trays**
- > **Molybdenum billets, pellets and rods**



Development – The Key to Customer Value

Development is the bridge that connects our material expertise with its practical application to our customers' products.

The number one goal of our customers is to design products that bring added value to their customers. Our goal at H.C. Starck Solutions is to ensure that our R&D activities are contributing to that value. That's why all of our development activities, whether they are conducted in our laboratories or at our manufacturing plants, are customer-driven.

We are providing technology that improves quality and performance. We work closely with customers, providing on-site support that delivers superior, cost-effective product solutions. These solutions result in accelerated product development, reduced time to market and, ultimately, help them achieve a competitive advantage.

The Innovative Power of H.C. Starck Solutions

World class R&D, innovative application technology, and unparalleled laboratory services allow us to work on customers' projects with tremendous energy and focus, helping our customers open doors for new products, applications, and markets. In short, our innovation helps customers develop tomorrow's products – today.

We often talk about our unique combination of high performance materials. Another unique combination is the interaction of H.C. Starck Solutions with other H.C. Starck Group business units. This company-wide synergy allows us to bring additional resources to bear on application challenges.

By focusing our development activities on what is important to our customers, we can help them optimize product performance while minimizing costly materials. For example, in the chemical processing industry, we work to provide customers with ever-thinner layers of tantalum and niobium to help them control costs, while maintaining superior corrosion resistance.

| Development |

The Driving Force Behind New Products

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.

In addition to the Central Research and Development Division at corporate headquarters, we conduct R&D activities at facilities throughout Europe, North America and Asia, in order to support our customers around the world. Our state-of-the-art labs routinely conduct tests for structure, porosity, microhardness, layer adhesion, particle count, coating thickness, differential interference contrast, and many other tests, including:

- > **Tensile Testing**
- > **Metallographic Characterization**
- > **Grain Size Analysis**
- > **Hydro Testing**
- > **Helium Leak Testing**
- > **Ultrasonic Testing**
- > **ICP – Hot Gas Extraction**



Advancing Through Innovation

Our technical and sales personnel are constantly working with customers, not just to develop specific solutions to existing applications, but also to help them create innovative new products. We can do this because, through our customers, we have been involved in these markets for decades.

For example, because of our work on beam blockers and focusers in the radiation shielding market, we are actively involved with several of the U.S. National Laboratories, as well as with CERN (Europe's Organization for Nuclear Research), in the field of large particle acceleration.

In the automotive market, we are applying the unique thermal characteristics of our materials to develop thermal management materials for power control units used in hybrid vehicles, and for high-brightness LEDs for headlamps.

| Solutions |

Value-Added Solutions for Growing Markets

H.C. Starck Solutions uses its expertise in molybdenum, tungsten, tantalum, and niobium to produce high performance products for a wide range of significant, growing markets.

Helping Aerospace Soar to New Heights

From the blistering temperature inside jet engine “hot zones” to the numbing cold encountered by NASA’s Deep Space Probes, you will find H.C. Starck Solutions’ high performance materials.

In the rapidly growing aviation market, H.C. Starck Solutions supplies materials that are critical to the industry. These include tungsten counterweights for helicopter rotor blades and the control surfaces of aircraft elevators, rudders, and ailerons. These counterweights also find use in missile guidance systems. We also supply our molybdenum alloy additive to the manufacturers of turbine blades that operate in the extremely high temperature of jet engine “hot zones”. Molybdenum TZM alloy is used to make the isothermal forging dies that are required to manufacture turbine discs made from superalloys.



Focusing on Medical Technology

Applications within the medical technology market are among the best examples of how the unique capabilities and market knowledge of H.C. Starck Solutions distinguish us from our competitors.

In the medical diagnostic market, we supply components for X-ray tubes (including stationary and rotating anodes, screws, shafts, custom parts, and powder and bar materials), as well as multileaf collimators for radiation therapy beam focusing, and detector plates for CT scanners. Detector plate assemblies utilize hundreds of ultra-thin tungsten plates, which we manufacture to extremely tight standards for flatness and surface finish at our tungsten rolling mills. This capability is further enhanced by our extensive precision machining experience.

Medical equipment OEMs value our vertical integration and our twenty-plus years of experience in their markets. They consider these to be key factors in our ability to partner with them to find solutions for their applications and to guide their projects from raw material production, through design support, to final delivery.



Taking the Heat Off the Electronics Industry

Custom-engineered thermal management materials from H.C. Starck Solutions are helping the electronics industry continue its rapid growth, part of which is driven by increasing miniaturization. This trend puts ever greater cooling demands on electronic circuitry. Our molybdenum and tungsten materials, laminates, and engineered composite materials are exceptionally qualified for these applications.

The thermal properties of our materials include their low and controlled CTE (coefficient of thermal expansion) and high TC (thermal conductivity), which help remove heat rapidly from high power density devices. Equally important is the expertise of our engineering staff in designing highly engineered materials that match the specific requirements of each application.

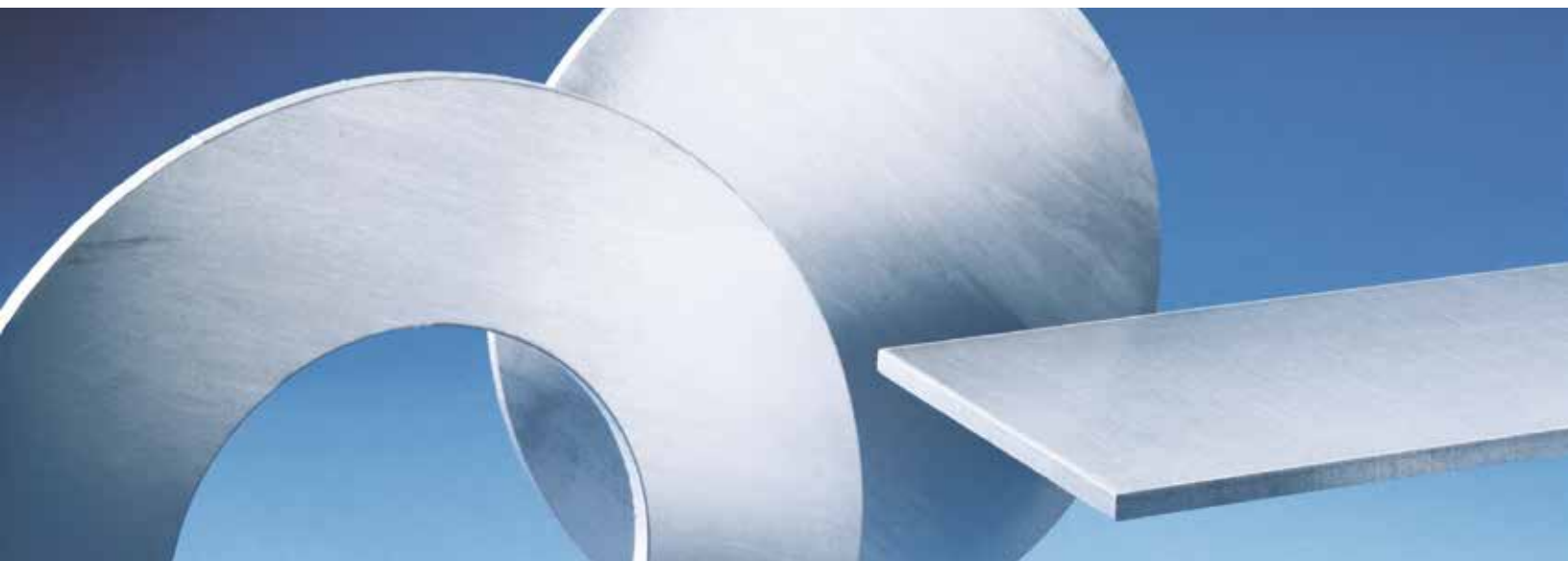
In addition to electronic packaging, thermal management applications include HB LEDs (High Brightness Light Emitting Diodes) for automotive headlamps and other applications, power semiconductors, and power controls for hybrid vehicles.

Targeting the Sputtering Market

Experiencing equally rapid growth is the market for sputtering targets, which are used in a wide variety of applications, including data storage, fiber optics, flat panel displays, large area coating, and semiconductors.

Our vertical integration, from basic material to finished plates, and our understanding of the technical issues facing the market, brings added value to sputtering target OEMs. One of our primary strengths is development and processing of the materials. We are experts at controlling material characteristics such as grain size, texture, and purity, not just from lot to lot, but also from plate to plate.

From start to finish, we work with customers to meet their specific needs, whether that means developing special alloys or engineering alternative shapes, such as tubes, cylinders, and other complex shapes.



| Solutions |



Chemical and Pharmaceutical Processing

The corrosion resistance, durability, workability, and heat transfer properties of tantalum and niobium make them ideal for challenging applications in the chemical and pharmaceutical industries. Our engineered materials are used to produce condensers, coils, pipe spools, heat exchangers, and a variety of components exposed to corrosive fluids.

As experts in corrosion resistance, we are able to bring a focused, cost-effective approach to chemical processing challenges, with initiatives such as providing customers with ever-thinner layers of tantalum and niobium, while maintaining superior corrosion resistance.

Glass Manufacturing

Our molybdenum and tungsten products have set the standard for the glass industry. Our bubble-free, low carbon Glass Melting Electrodes feature high purity (99.95% minimum) and excellent strength and stability at temperatures over 2,000 °C. Their high thermal and electrical conductivity, low CTE (coefficient of thermal expansion), and high corrosion resistance make them the best choice for electric heating in the glass melting process.

In addition to GMEs, we produce molybdenum stirrers, orifice plates, and mandrels, and large diameter molybdenum tubing utilized for quartz melting vessels. We also provide oxidation-resistant coatings to protect refractory metal components from oxidation at high temperature.



Energy

As fuel and energy demands increase, so do the challenges of drilling for hard-to-reach oil and gas reserves. Since their introduction in the mid-1970's, Polycrystalline Diamond Compact (PDC) drill bits have helped transform oil and gas exploration by making it possible to drill wells that are thousands of feet deep. Synthetic diamond manufacturers around the world rely on H.C. Starck's expertise in tantalum, niobium, and molybdenum in the manufacture of these PDC cutters.

Using our 5,000 metric ton extrusion press, H.C. Starck Solutions produces the downhole tubing that is used to secure these deep wells after they are drilled. We also produce a variety of sinker bars and boring bars used in all types of downhole equipment.



Furnace Construction and Heat Treating

Today's demanding applications in heat treating, sintering, brazing, annealing, metalworking, and other thermal processing applications require innovative product solutions. We serve the heat treating and furnace markets with products made from molybdenum, tungsten, tantalum, and alloys such as TZM, ODS Mo-La, and Mo_{30}W . These materials are characterized by their high ductility and toughness, high thermal and electrical conductivity, low coefficient of thermal expansion, and excellent strength and stability at temperatures up to 2,000 °C. Products include furnace parts, shields, boats, heating elements, sintering trays, mill products and other fabricated parts.

Forging and Extrusion Services

In addition to the manufacture of our own products, we perform toll conversion of all refractory metals and their alloys, including superconducting materials and other specialty alloys. We can take your project from material procurement to final processing. Post extrusion processes include heat treating, cleaning, straightening, and cutting.

We are a world leader in forging and extrusion technology. Our extrusion capabilities include our 5,500-ton extrusion press, which can produce near net shapes, including forward-extruded shapes, such as pipe and bar, and back-extruded heavy wall pipe. Our 220-ton rotary forge can produce tapers, steps, and other shapes. Both operations are controlled by state-of-the-art control systems.



Every Level

Complementing our material expertise, R&D, and application technology is our broad range of value-added operations and our world-class quality program. Our ISO certifications are the most obvious evidence of our adherence to quality standards, but we are equally proud of the quality awards and Approved Supplier Status designations we routinely receive from our customers.

Our extensive precision machining capability allows us to manufacture finished products to extremely tight standards for flatness, surface finish, and other characteristics.

Finally, the synergy between H.C. Starck Solutions and other H.C. Starck Inc. business units allows us to bring additional, unique resources to bear on customers' application challenges.



USA

H.C. Starck Inc.

21801 Tungsten Road
Euclid, OH 44117-1117 USA
T +1 216 692 3990
F +1 216 692 0029

H.C. Starck Inc.

45 Industrial Place
Newton, MA 02461 USA
T +1 617 630 5800
F +1 617 630 5879

H.C. Starck Inc.

460 Jay Street
Coldwater, MI 49036 USA
T +1 517 279 9511
F +1 517 269 9512

United Kingdom

H.C. Starck Ltd.

1 Harris Rd.
Calne, Wiltshire SN11 9PT UK
T +44 1249 822 122
F +44 1249 823 800

Germany

H.C. Starck Hermsdorf GmbH

Robert-Friese-Straße 4
Hermsdorf, Germany 07629
T +49 36601 922 0
F +49 36601 922 111

Japan

H.C. Starck Fabricated Products GK

3F Shiodome Building,
1-2-20 Kaigan,
Minato-ku, Tokyo
105-0022 JAPAN
T +81-3-6721-8177
F +81-3-6733-8896

Korea

CMT Co., Ltd.

20, Gangnam-daero 47-gil,
Seocho-gu, Seoul
(Seocho-dong, 2F), 06729, Korea
T +82 2 597 6207

Taiwan

H.C. Starck International Sales GmbH

Room 1307, 13F, No. 88, Sec. 2,
Zhongxiao E. Rd., Zhongzheng
Dist.,
Taipei City 100, Taiwan ROC
T +886 2 2393 3337
F +886 2 2393 2083

China

H.C. Starck Specialty Materials (Taicang) Co., Ltd.

Taicang Zhongyu Science Park
No.111 N. Dongting Rd of Taicang
Taicang City Jiangsu Province 215400
T +86 512 5318 8278
F +86 512 5318 8282

India

H.C. Starck (India) Pvt. Ltd.

Level 2 Raheja Centre Point
294 CST Road Near
Mumbai University Off Bandra-Kurla
Complex, Santacruz (E)
Mumbai, Maharashtra 400 098 India
T +91 72 5917 7599
F +91 22 6162 3086

H.C. Starck (India) Pvt. Ltd.,

#148, Prestige Featherlite Tech Park,
2nd Phase, EPIP Zone, Whitefield,
Bangalore – 560 066
T +91 7259177599

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