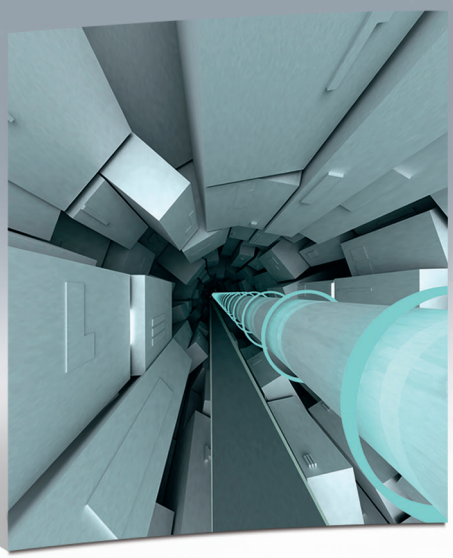
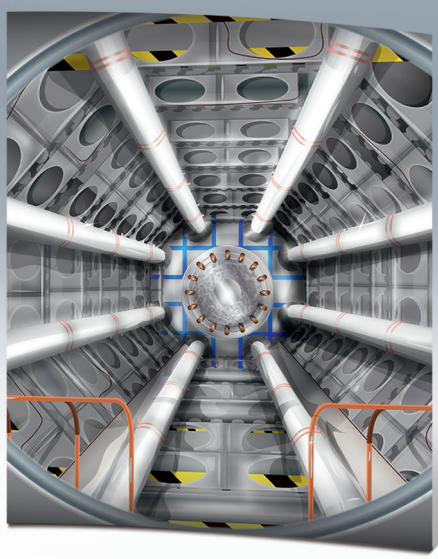
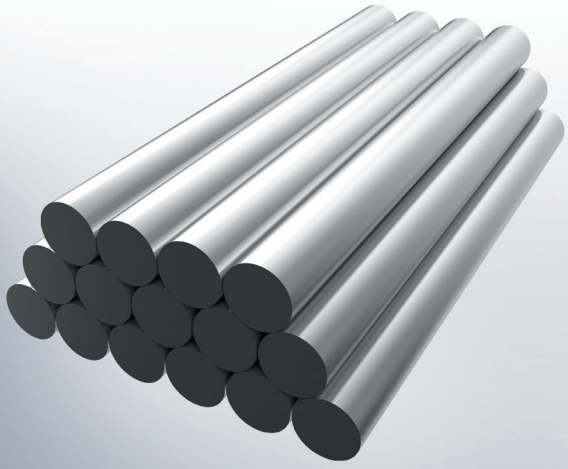
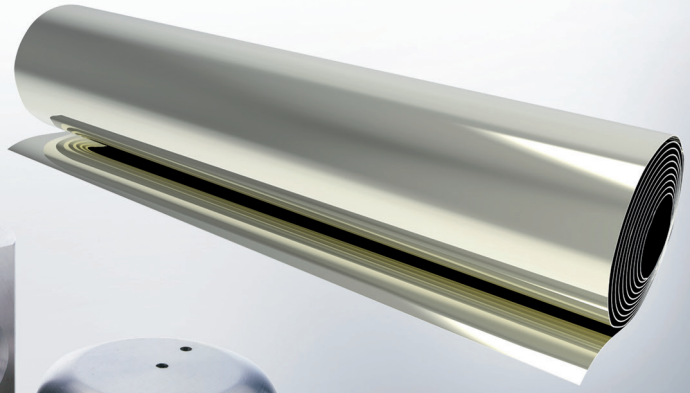
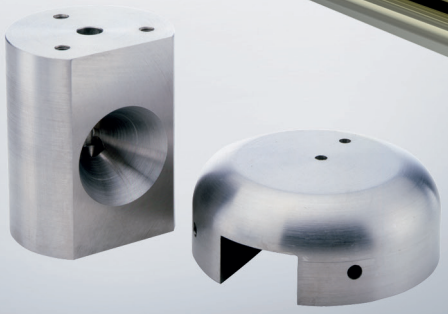










High Performance Metal Solutions

Pushing the Limits of Physics with Technology Metals

H.C.Starck

High Performance Metal Solutions

Technology Metals Designed for Particle Accelerators

In high energy projects like particle physics, particle accelerators are used to speed up and collide sub-atomic particles like protons or electrons to break them into smaller, fundamental particles. The short-lived particles are detected and then analyzed to determine how they interact with each other with the ultimate goal of understanding the physical laws of the universe.

As an example, inside the Large Hadron Collider (LHC), the world's largest and most powerful particle accelerator, two high-energy beams of protons travel close to the speed of light in opposite directions. These particle beams are guided around an accelerator ring by a strong magnetic field generated by superconducting electromagnets before they collide within sophisticated detectors.

H.C. Starck Solutions' tungsten (W) alloys are used as beam collimators and shields, while H.C. Starck Solutions' niobium (Nb) and tantalum (Ta) metals have unique properties that make them the primary choice for superconducting material to create the electromagnetic fields that steer and propel the charged particles to very high speeds. In addition, H.C. Starck Solutions offers extrusion services for extruding large diameter superconducting wire bundles.

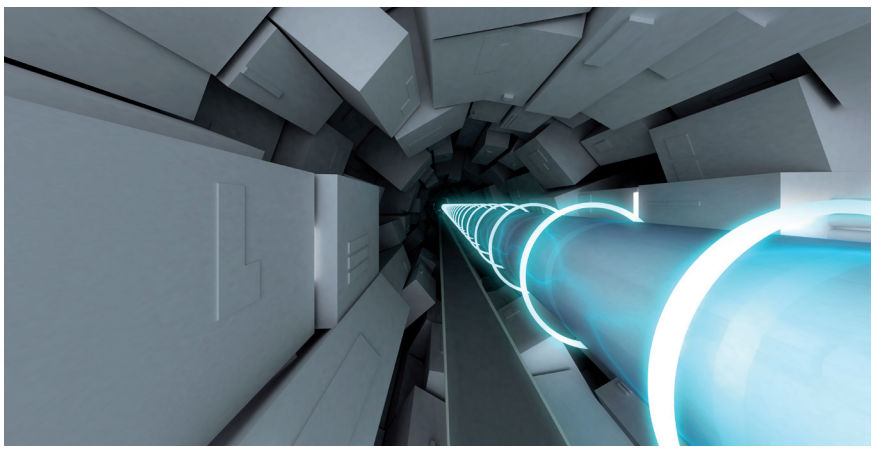
Applications

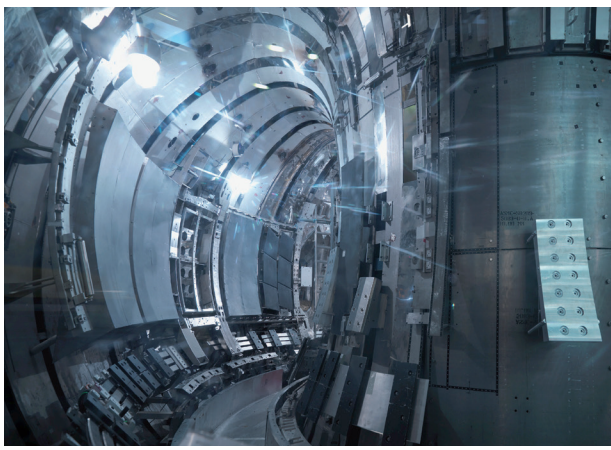
- MRI and NMR medical equipment
- Mass spectroscopy
- Nuclear fusion research equipment
- Magnetic levitation
- Particle accelerators
- Superconductors
- Beam Blockers
- Targets
- Shielding Blocks
- RF Cavities and Supporting Parts
- Calorimeters

W, Nb, Ta Products

- Sheet
- Tube
- Plate
- Fabricated Parts
- Bar

H.C. Starck Solutions has supplied fabricated products including tungsten slugs used in the FCAL Section of the Atlas Detector of the Large Hadron Collider (LHC).





Refractory Metal Characteristics

H.C. Starck Solutions' outstanding material properties provide shielding from radiation along with other highly desirable characteristics.

Tungsten High Density Alloys

> High Density
> High Strength
> Excellent Machinability
> High Melting Point

Niobium

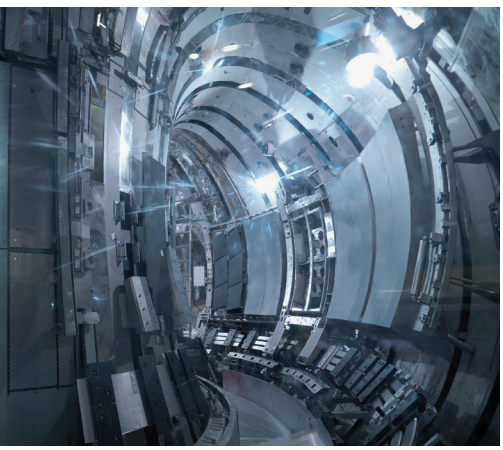
> Low Temperature Superconductivity (low resistivity)

Tantalum

> High Density
> Excellent Corrosion Resistance
> Good Ductility

Property Data for Pure Metals*		Niobium	Tantalum	Tungsten
Property	Atomic Number	41	73	74
	Atomic Weight	92.91	180.95	183.86
	Lattice Type	bcc	bcc	bcc
Mass	Density at 20 °C gm/cc	8.57	16.6	19.3
Thermal	Melting Point °C	2468	2996	3410
Properties	Boiling Point °C	4927	6100	5900
	Linear Coefficient of Expansion per °C	$7.1x10^{-5}$	$6.5x10^{-6}$	$4.3x10^{-6}$
	Thermal Conductivity at 20 °C, cal/cm2/cm °C/sec	0.523	0.13	0.4
	Specific Heat cal/g/°C, 20 °C	0.126	0.036	0.032
Electrical	Conductivity, %IACS	13.30%	13%	31%
Properties	Resistivity, microohms-cm, 20 °C	15	13.5	5.5
	Temperature Coefficient of Resistivity per °C (0-100 °C)	0.00395	0.0038	0.0046

* Metal Alloys also available



Niobium and Tantalum Rod and Sheet for Superconductors

ASTM B392 (Nb) and B365 (Ta) Compliance

Rod Sizes:

> Diameters: 10 – 130 mm
> Max. length: 2.5 – 7.5 m

Sheet Sizes*

> 0.25 – 2.5 mm thick, up to 1m wide

*Other dimensions available upon request

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DPAP 03/2020

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High Performance Metal Solutions