Technology Metals | Advanced Ceramics

AMPERWELD®
Welding Powders for Wear Protection

H.C.Starck

H.C. Starck at a Glance

Whenever ideas are to be transformed into successful products or applications, the first step is to find the appropriate partner that can fulfill one's needs. H.C. Starck's unique and comprehensive product portfolio of technology metals and advanced ceramics offers an extraordinary choice worldwide.

High-Quality Products

We are a leading international developer and manufacturer of high-performance metals and ceramic powders as well as fabricated metal and ceramic products.

Top-Level Technology

We have outstanding analytical competence at our disposal with the Central Laboratory in Goslar, one of the largest industrial laboratories for inorganic element analysis and powder characterization in Germany. We possess extensive knowledge in powder development and application technology with the capability to "develop to application." Based on our outstanding process and product competence, we provide engineering of powder production and welding processes.

Fully Integrated Production Chain

As an independent provider of high-performance tungsten powders and compounds, H.C. Starck offers premium-quality products. We have fully integrated production chains from raw material sourcing to high-performance powders, and provide customized solutions and expert knowledge.

Sustainable Raw Material Supply Chain

With increased recycling activities, certified procurement and joint ventures in China and Vietnam, we ensure a conflict-free, secure, stable and competitive raw material supply.

For more information about H.C. Starck, please visit www.hcstarck.com.

High-Quality Partnership

Under the brand name *AMPERWELD*®, H.C. Starck is a quality supplier of metal and nonmetal-based powders for surface welding.

We market our powders for applications such as

- **Plasma transferred arc (PTA) welding**
- **Laser cladding**
- **Brazing**
- **Cored wire production**

Each of our ***AMPERWELD***® powders is designed for a specific welding process with tightly controlled particle size distribution and morphology.

H.C. Starck has extensive knowledge in powder development and application technology. We are equipped to meet customers' product-specific requirements and desires through our wide-ranging production capabilities, our spray laboratory and application technology department. Our competence to produce small batches for customized alloys with regard to chemistry, morphology, particle size distribution and spray behavior makes us your partner of choice in developing new solutions, even for the most demanding applications.

Your Main Advantages at a Glance

As a backward integrated welding powder manufacturer, H.C. Starck provides consistent quality along the whole

process chain. We are an independent global producer of tungsten carbide offering the highest quality products for the specific requirements of welding applications. Our flexible supply chain enables an efficient realization of customer demands.

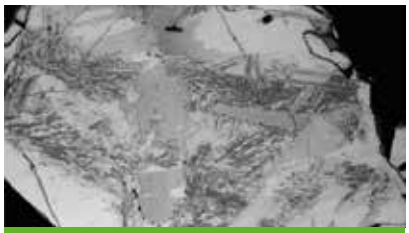
Our welding products are an essential component for industries such as surface mining, mineral and cement processing, food and agriculture, oil and gas, as well as the chemical industry, contributing to prolonged lifetime and easy repair of components.

In addition to surface welding, our powders can be applied with a broad variety of other surface coating processes like plasma spraying, cold spraying, HVOF (High Velocity Oxygen Fuel) and HVAF (High Velocity Air Fuel).

HIGH-QUALITY – FROM RAW MATERIALS TO STATE-OF-THE-ART WELDING POWDERS

AMPERWELD® Carbides

Picture 1:
High quality CTC from H.C. Starck



Picture 2:
CTC of lower quality

Cast Tungsten Carbide (CTC)

Cast tungsten carbide is an eutectic structure of the tungsten carbides W_2C and WC. As a result, our Cast Tungsten Carbide (CTC) exhibits an extremely high hardness and wear resistance.

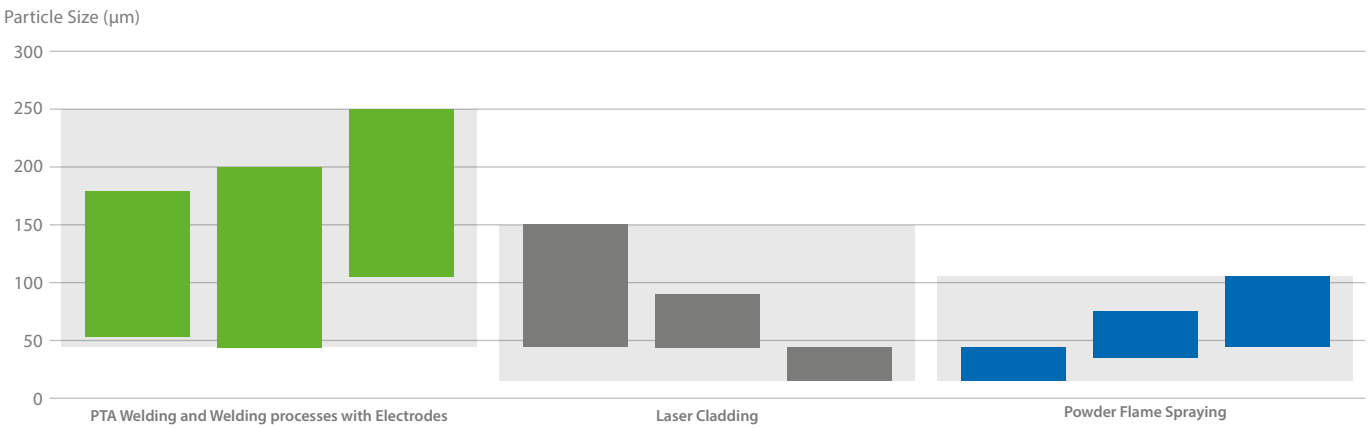
The uniform distribution of W_2C and WC has a very high influence on hardness and wear resistance (refer to pictures 1 and 2). Based on our unique manufacturing process, H.C. Starck's ***AMPERWELD***® Cast Tungsten Carbide shows an extremely fine "feather" microstructure (refer to picture 1) of lamellar W_2C and WC phases and exceptional hardness. For this reason, it is used primarily in advanced wear protection technology such as PTA welding and laser cladding.

Carbides and Borides for Welding Applications

AMPERWELD®	Chemistry	Range of Particle Sizes
Carbides and Borides		
Cast Tungsten Carbide (CTC)	WC/W_2C	**45/15 µm to 3,150/800 µm**
Macroline Tungsten Carbide (MTC)	WC/W_2C	**90/36 µm to 425/200 µm**
Titanium Carbide	TiC	**45/5 µm to 200/106 µm**
Vanadium Carbide	VC	**90/45 µm to 160/63 µm**
Chromium Boride	CrB or CrB_2	**400/63 µm**

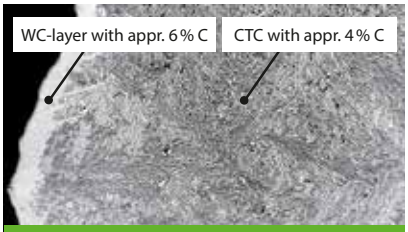
Customized specifications and powder compositions are available upon request.

H.C. Starck's Standard Particle Size Range is from 3,150 down to 15 Microns

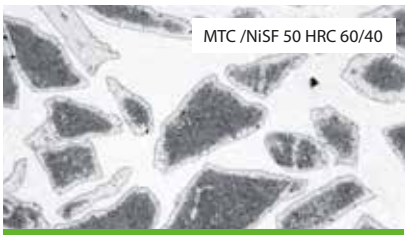


Macroline Tungsten Carbide (MTC): Superior Wear Resistance for the Highest Demands

H.C. Starck has developed WC-coated CTC (MTC) for the most demanding requirements in abrasion and wear resistance. Combining the advantages of CTC and WC, our distinctive ***AMPERWELD®*** Macroline powder features an improved thermodynamic stability. ***AMPERWELD®*** Macroline Tungsten Carbide (MTC) powder particles consist of a CTC core with high hardness and toughness combined with a stable shell of mono WC. The stable WC layer provides enhanced resistance against dissolution in Ni-based alloys during the welding process. Embrittlement of the Ni-alloy by brittle W-containing phases is prevented, resulting in higher toughness of the welded layer.



Cross section of ***AMPERWELD®*** Macroline

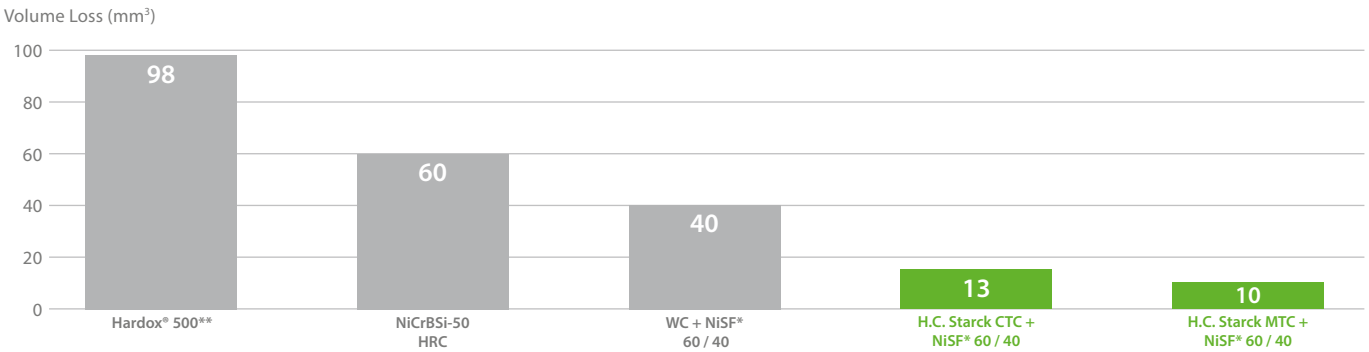


Welded ***AMPERWELD®*** Macroline

Product Advantages:

- **Very high hardness (2,500 +/- 200 HV 0.1)**
- **Excellent dissolution stability during welding process**
- **Unique feather structure of 95% +/- 5%**
- **Higher impact resistance due to absence of brittle W-containing phases in metallic matrix after welding**
- **Superior wear resistance**

Wear Test acc. ASTM G65 - 04: *AMPERWELD®* Macroline Tungsten Carbide (MTC) shows superior Wear Resistance



* NiSF 50 HRC (Cr-free)
** Protected trademark of SSAB Group

The MTC technology is covered by patents in several countries, among others by U.S. patents No. 7,810,587 and No. 7,541,090.

Atomized Powders and Pure Metals

H.C. Starck is a well-established specialist in the production of gas atomized metal powders and alloys.

AMPERWELD® metal and alloy powders are used in a wide variety of applications including but not limited to: vessels, heat exchangers, tanks, sheet metal, mining, as well as oil and gas extraction like drilling and extracting of oil and gas, or mining of ores, stone, sand and gravel.

AMPERWELD®	Chemistry	Range of Particle Sizes**
Atomized Metal Powders*		
Co-HFA NF 6	CoCrWSiC	**150/53 µm**
Ni-SA 625	NiCrMoNb	**150/53 µm**
Ni-SA 718	NiCrNbMoTiAl	**150/53 µm**
Co-SA 400	CoMoCrSi	**45/15 µm to 90/45 µm**
Co-SA 800	CoMoCrSi	**45/15 µm to 90/45 µm**
Ni-SA C 276	NiMoCrFeW	**150/53 µm**
CCA4	FeVCrCWMoMnSi	**53/22 µm; 150/53 µm**

* Other atomized alloys upon request
** For information about finer particle sizes please refer to our ***AMPERIT®*** spray powder portfolio

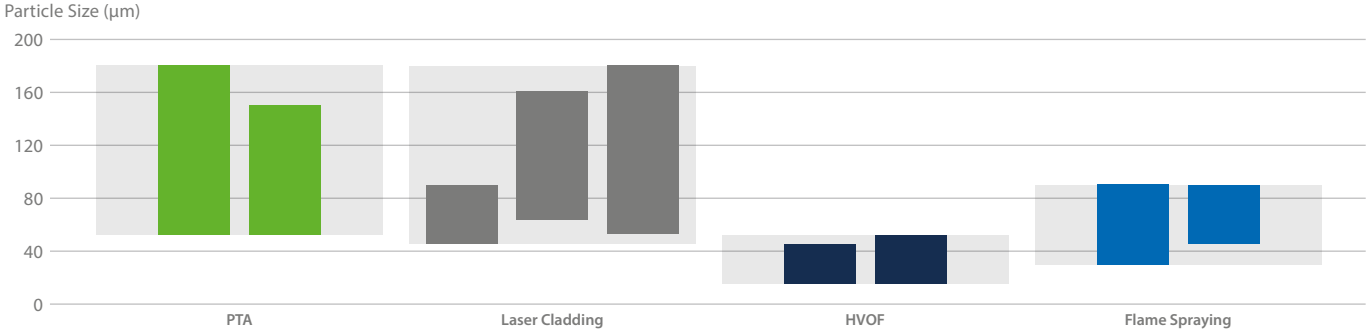
Pure Metals		
Mo	Mo	**customized***
W	W	**customized***

* For informations about standard particle sizes please refer to our ***AMPERIT®*** spray powder portfolio

Chemical composition and degree of melting determines abrasion, heat, and corrosion resistance of the thermal surface. Particle size distribution affects welding surface shape and is often equipment-specific. H.C. Starck offers a wide range of grain sizes and controlled chemistry for a multitude of processes. Our application technology department, with its in-depth knowledge of chemical and metallurgical processes, can help you choose the right powder according to your specific requirements.

In addition to our ***AMPERWELD®*** powders for welding applications, we also offer thermal spray powders under the name ***AMPERIT®*** and high-alloyed metal powders for the powder metallurgy market under the ***AMPERSINT®*** brand.

Typical Particle Size Range for Welding Applications:



Approved Quality and Responsibility

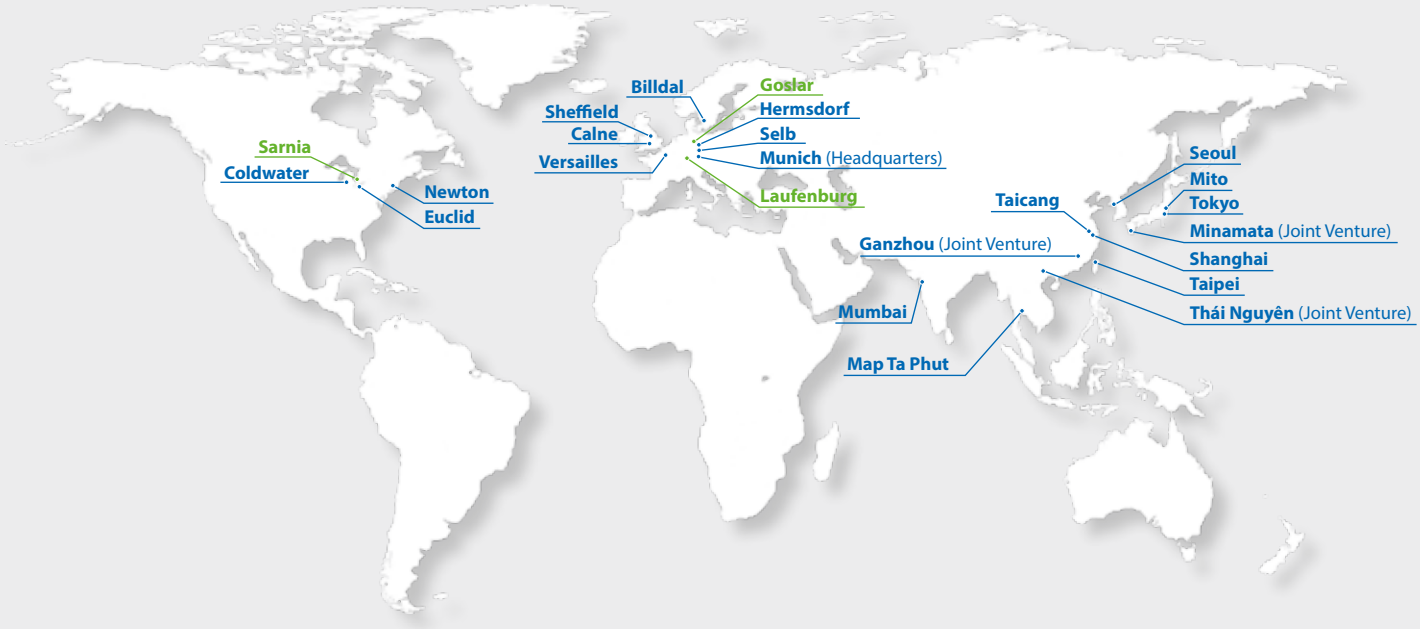
H.C. Starck has implemented various internal management systems that comply with international standards.

Among others, we are certified for the Quality Management System (ISO 9001) and the General Requirements of Quality Management System and Functioning of Analyzing and Calibrating Laboratories (ISO 17025).

H.C. Starck is certified for:

- **DIN ISO 9001: Quality Management System**
- **DIN ISO 14001: Environment Management System**
- **DIN ISO 50001: Energy Management System**
- **DIN EN ISO/IEC 17025: General Requirements of Quality Management System and Functioning of Analyzing and Calibrating Laboratories**
- **DIN EN ISO 13485: Management System of Design and Production of Medical Devices**
- **DIN AS/EN/JISQ 9100: Quality Management System for Suppliers for the Aerospace Industry**
- **OHSAS 18001 (British Standard Occupational Health and Safety Assessment Series) International Standard of Evaluation and Certification for Management System of Employment Protection**
- **RSCM: Responsible Supply Chain Management System focused on avoidance of raw material deliveries from conflict regions**

H.C. STARCK'S GLOBAL FOOTPRINT – CLOSE TO OUR CUSTOMERS



AMPERWELD® Production Facilities

Goslar, Germany	Laufenburg, Germany	Sarnia, Canada
Metal Powders, Carbides, Carbide Spray Powders	Cast Tungsten Carbide, Atomized Spray and Welding Powders, Titanium Carbide, Vanadium Carbide, Chromium Boride	Tungsten Metal Powders, Tungsten Carbide, Cast Tungsten Carbide

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