AMPERWELD®
Welding Powders for Wear Protection
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).

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

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Production Process</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ores and Scrap</td>
<td>Pyrometallurgy</td>
<td>Metal &amp; Ceramic Powders</td>
</tr>
<tr>
<td></td>
<td>Hydrometallurgy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Powder Production</td>
<td></td>
</tr>
<tr>
<td>WC</td>
<td>W</td>
<td>CTC</td>
</tr>
</tbody>
</table>
**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

<table>
<thead>
<tr>
<th>Carbides and Borides</th>
<th>Chemistry</th>
<th>Range of Particle Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Tungsten Carbide (CTC)</td>
<td>WC/$W_2C$</td>
<td>45/15 µm to 3,150/800 µm</td>
</tr>
<tr>
<td>Macroline Tungsten Carbide (MTC)</td>
<td>WC/$W_2C$</td>
<td>90/36 µm to 425/200 µm</td>
</tr>
<tr>
<td>Titanium Carbide</td>
<td>TiC</td>
<td>45/5 µm to 200/106 µm</td>
</tr>
<tr>
<td>Vanadium Carbide</td>
<td>VC</td>
<td>90/45 µm to 160/63 µm</td>
</tr>
<tr>
<td>Chromium Boride</td>
<td>CrB or CrB$_2$</td>
<td>400/63 µm</td>
</tr>
</tbody>
</table>

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**

![Particle Size Distribution](image)
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.

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

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.

<table>
<thead>
<tr>
<th>Atomized Metal Powders*</th>
<th>Chemistry</th>
<th>Range of Particle Sizes**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-HFA NF 6</td>
<td>CoCrWSiC</td>
<td>150/53 µm</td>
</tr>
<tr>
<td>Ni-SA 625</td>
<td>NiCrMoNb</td>
<td>150/53 µm</td>
</tr>
<tr>
<td>Ni-SA 718</td>
<td>NiCrNbMoTiAl</td>
<td>150/53 µm</td>
</tr>
<tr>
<td>Co-SA 400</td>
<td>CoMoCrSi</td>
<td>45/15 µm to 90/45 µm</td>
</tr>
<tr>
<td>Co-SA 800</td>
<td>CoMoCrSi</td>
<td>45/15 µm to 90/45 µm</td>
</tr>
<tr>
<td>Ni-SA C 276</td>
<td>NiMoCrFeW</td>
<td>150/53 µm</td>
</tr>
<tr>
<td>CCA4</td>
<td>FeVCoCrMoMnSi</td>
<td>53/22 µm; 150/53 µm</td>
</tr>
</tbody>
</table>

* Other atomized alloys upon request
** For information about finer 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:**

<table>
<thead>
<tr>
<th>Particle Size (µm)</th>
<th>PTA</th>
<th>Laser Cladding</th>
<th>HVOF</th>
<th>Flame Spraying</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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<tr>
<td>40</td>
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<tr>
<td>80</td>
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<tr>
<td>120</td>
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<tr>
<td>160</td>
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<tr>
<td>200</td>
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</table>
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
> 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

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AMPERWELD® Production Facilities

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goslar, Germany</td>
<td>Metal Powders, Carbides, Carbide Spray Powders</td>
</tr>
<tr>
<td>Laufenburg, Germany</td>
<td>Cast Tungsten Carbide, Atomized Spray and Welding Powders, Titanium Carbide, Vanadium Carbide, Chromium Boride</td>
</tr>
<tr>
<td>Sarnia, Canada</td>
<td>Tungsten Metal Powders, Tungsten Carbide, Cast Tungsten Carbide</td>
</tr>
</tbody>
</table>
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Please send your inquiries to the globally valid e-mail address: amperweld@hcstarck.com