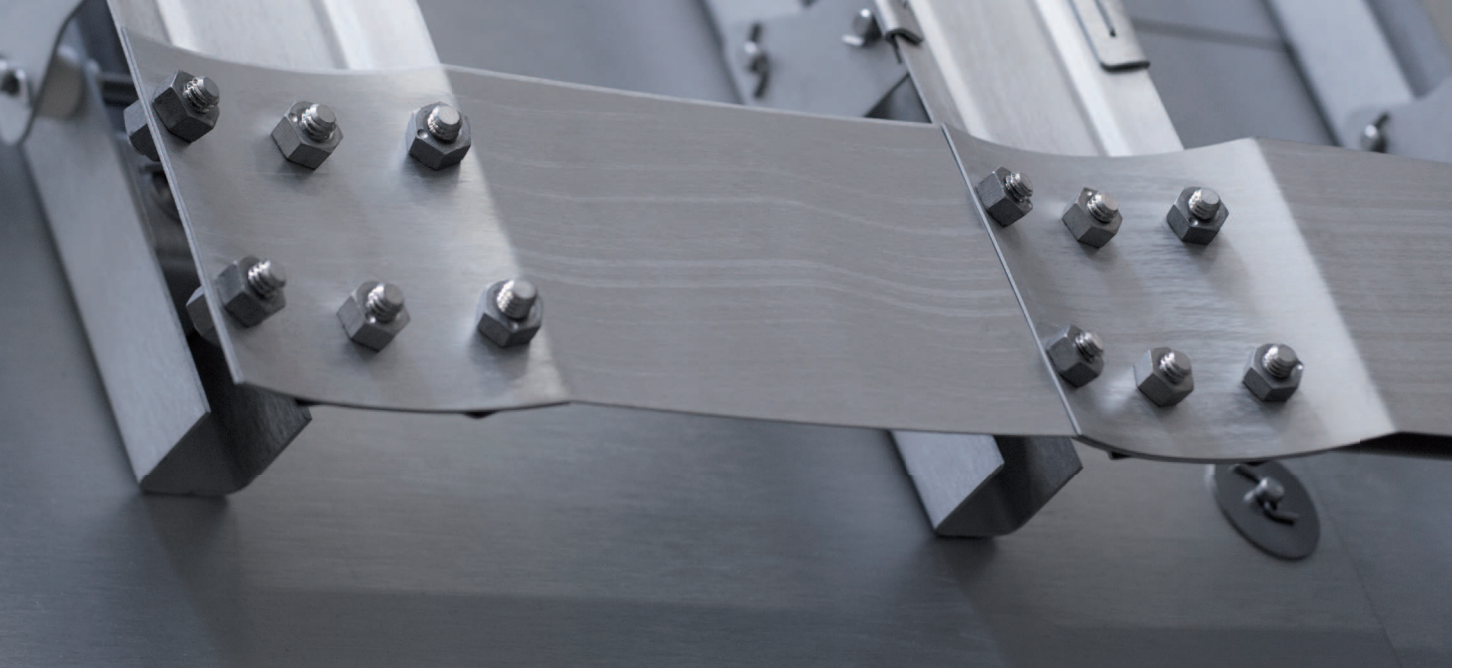


STRONG METALS

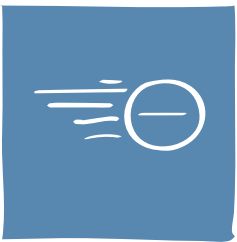


Plansee is the expert for refractory metals – in particular **molybdenum** and **tungsten**. Two very special metals that are fundamentally different from other materials. Whether in the electronics industry, coating technology or high-temperature furnaces: Wherever traditional materials are stretched beyond their limits, Plansee's alloys and composites come into their own.

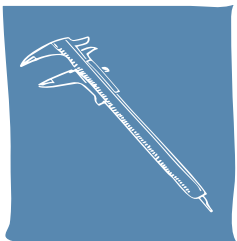


Molybdenum and tungsten have exceptional **heat resistance**, making them dimensionally stable and extremely strong, even at high temperatures. Molybdenum has a melting point of 2,620 °C. And at 3,420 °C, tungsten has the highest melting point of all metals.

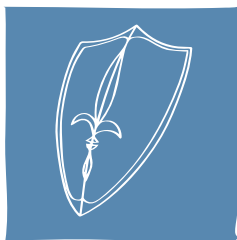
Both metals have a very **low vapor pressure** and are particularly well suited for high-temperature applications in vacuum and protective gas atmospheres.



Our metals combine excellent heat resistance with **good electrical and thermal conductivity**. And while some other metals such as copper are outstanding conductors, they cannot withstand high temperatures. In contrast, ceramic materials have good heat resistance but do not conduct electricity.



Even at high temperatures, molybdenum and tungsten only expand very little. Their **coefficient of thermal expansion** is similar to that of semiconductor materials or sapphire. As a result, our customers typically use molybdenum and tungsten in combination with these materials.



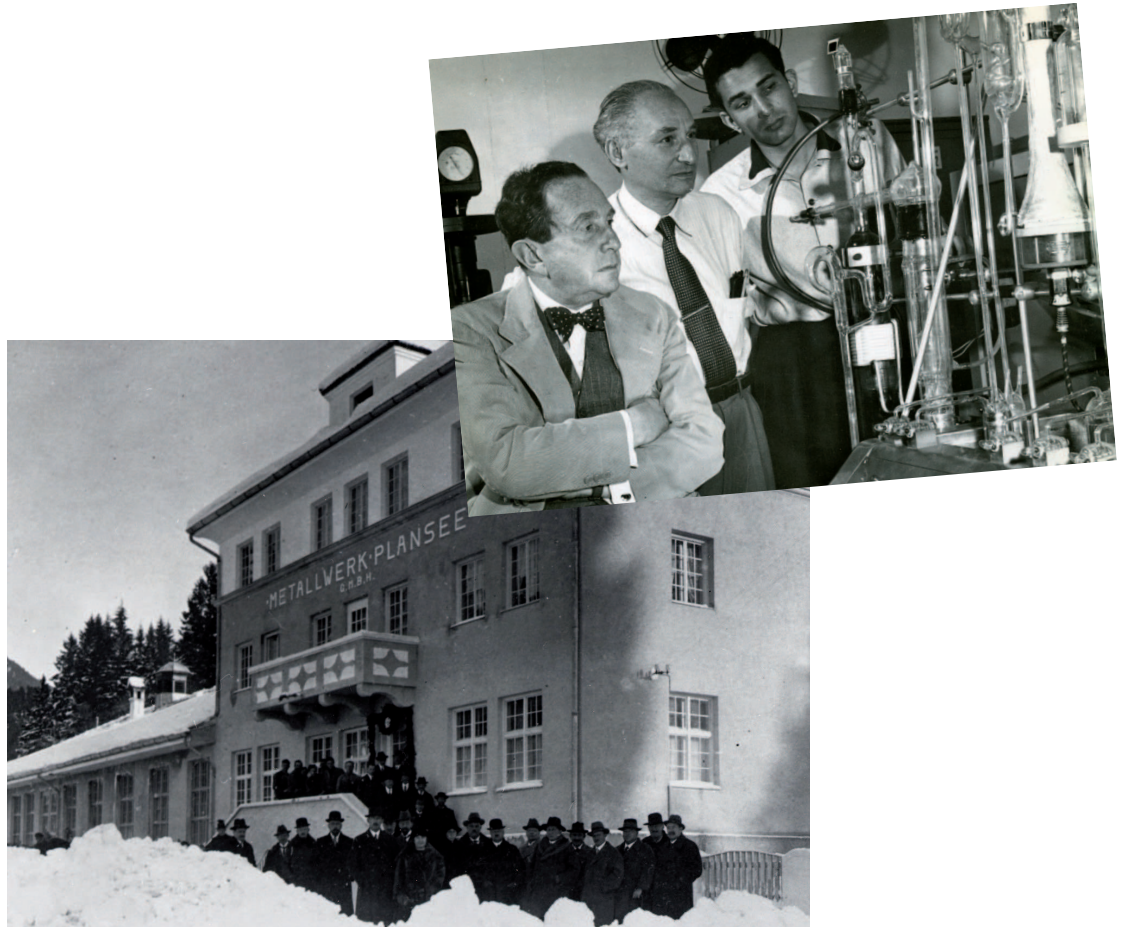
The density of tungsten is 60 percent higher than that of lead, which makes it a heavy element. **It reliably shields against X-ray and gamma radiation.**



Our materials are also **corrosion-resistant** in contact with many substances – even at high temperatures. For example, when exposed to metal or glass melts. We further optimize their corrosion resistance by utilizing special coatings and alloy additives.


Plansee is already manufacturing refractory metals since 1921.

The company's founder, Dr. Paul Schwarzkopf (in the foreground), started producing tungsten filaments for incandescent lamps in the Austrian town of Reutte with a team of only 15 employees.



In addition to filaments, our workforce of over 2,000 employees now globally produces thousands of products from refractory metals and composite materials.

We are divided into market-oriented business units. As a result, Plansee is not just the leader in terms of shipped volumes but also an applications specialist providing custom products for your industry.



Plansee was named after the lake whose name it shares. Even then, the waters of Lake Plansee were an important energy source for the company and the presence of the lake was a decisive factor in choosing Reutte as the site.



PLANSEE

PLANSEE



Key components for demanding industries.

The Business Unit Industries is responsible for manufacturing components and complex assemblies made of molybdenum, tungsten, niobium and tantalum, as well as from alloys containing these particularly hard-to-machine metals. From these materials, Plansee manufactures custom-made components for a range of industries.

These include, for example, **X-ray technologies**, in which tungsten and molybdenum are used for the generation and detection of X-rays in computer tomographs (CT). As a result, our products are important components in modern diagnostic imaging solutions.

Plansee has always been very closely associated with the **lighting industry**. Our tungsten filaments were lighting up incandescent lamps as far back as 1921. And today, our metals are still lighting the way, for example in halogen lamps and high-intensity discharge lamps.

Operators of **thermal process equipment** also use our refractory metals: Plansee manufactures components for furnace construction – such as heaters, shield packs, charge carriers or crucibles – from molybdenum and tungsten. For metallic hot zones, our service offering extends from the design right to the installation at the customer's premises.

Thanks to their outstanding thermal conductivity and low thermal expansion, our materials are also indispensable for the **electronics industry**. In the form of semiconductor base plates and heat sinks, our materials ensure that electrical equipment, semiconductor modules and LEDs enjoy a long service life.

Our metals also excel when it comes to reliably forming other materials and components, for example, as wear-resistant hot runner nozzles for plastic injection molding or long-lasting welding electrodes.

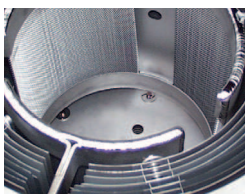


Market Unit Lighting:

Tungsten wire undergoing a quality inspection in Mysore, India. This wire is used in the manufacture of filaments for halogen lamps.

Market Unit Thermal Processes:

Hot zone with mesh heater made from molybdenum and tungsten



Market Unit X-Ray Technology:

CT electron beam trap manufactured from TZM, copper and steel



Market Unit Electronics:

Base plates made from molybdenum and tungsten for semiconductor modules



Market Unit Material Technologies:

Resistance welding electrodes with WL or TZM insert and a shaft made from CuCrZr





PLANSEE



Sputtering targets and arc cathodes.

Our customers use Plansee sputtering targets and arc cathodes to produce functional layers through PVD coating processes. The applications are as varied as the materials themselves.

For example, our sputtering targets create metal layers in the thin-film transistors in **TFT-LCD screens**. In touch panels, they are used for the production of wiring structures to connect to the ITO sensor.

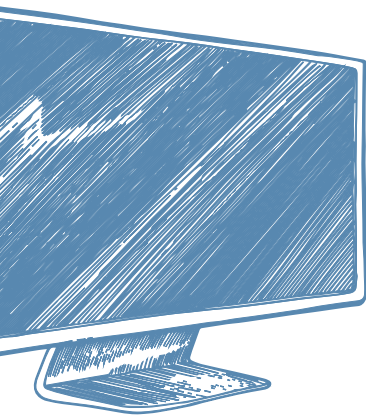
For the manufacture of absorber and rear contact layers in **thin-film solar cells**, we also supply the right materials. These include molybdenum, molybdenum-sodium or copper-gallium.

Used as hard material coatings on **tools or engine components** or as **decorative coatings**, our materials based on aluminum, titanium, zirconium, chromium and ceramics work hard to provide outstanding protection every single day.

In new technologies such as **smart windows** or **thin-film batteries**, our sputtering targets again provide the starting material for the vital thin films.

We are the only manufacturer of sputtering targets to perform every stage of the production process in-house. Through a strategy of consistent backwards integration within the Plansee Group, we ensure our continued access to raw materials. Our targets are produced in Austria and Germany. They are bonded in close proximity to our customers in our own bonding shops, for example, in Korea or Japan. The advantage of our global supply chain lies in the long-term security of raw materials supplies.

Our customers can rely on the comprehensive know-how of our coating experts in sales, development and production.



Market Unit Display:

Exceptionally pure sputtering targets from Reutte in Austria ensure clear, sharp image reproduction. They are used for the creation of functional coatings for image control in high-resolution flat screens.

Market Unit Solar:

Molybdenum rotary target for functional layers in solar cells



Market Unit Hard Coating:

Tungsten carbide target for coating tools





BUSINESS UNIT

BUW

TUNGSTEN
HEAVY ALLOYS

Tungsten heavy metals.

We manufacture our tungsten heavy metal alloys at Plansee Composite Materials in Germany and at Plansee Tungsten Alloys in France. They are used, among others, in the aviation and aerospace industries, medical technology, the automotive and foundry industries and in power engineering.

Densimet® and Inermet® alloys have an exceptionally high density and reliably shield against X-ray and gamma radiation. They are used, for example, as **shield packs** and **collimators** in radiation equipment or are employed as **balancing weights** in motor vehicles and helicopters.

The tungsten composite Denal® in particular excels through its strength, high density and elasticity.

Our wear-resistant **tungsten-copper electrodes** can process even hard metals without difficulty during the Electrical Discharge Machining process. As **plasma spray nozzles** and **plasma spray electrodes** for the coatings industry, the material properties of tungsten and copper complement one another perfectly.

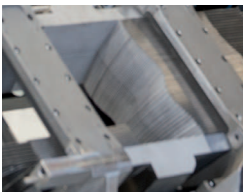


Market Unit Special Products:

Plansee Tungsten Alloys in France produces balancing weights for helicopters together with other products.

Market Unit Shielding:

Multi-leaf collimator for radiation therapy



Market Unit Applications:

Plasma spray nozzles and plasma spray electrodes



Switching contact systems.

Plansee is the leading producer of ready-to-use switching contact systems in the power transmission and distribution industry.

Thanks to their unique physical properties, our contact materials **tungsten-copper** (WCu) and **copper-chromium** (CuCr) have set new standards in the field of ultra-high-voltage and medium-voltage applications.

Tungsten carbide-silver (WCAg) convinces due to its combination of particularly high wear resistance, thermal conductivity and high resistance to arc erosion.

We manufacture our metal composites at our production sites Plansee Powertech in Switzerland and Plansee Shanghai in China. Using powder metallurgical techniques, we offer our customers optimized material properties combined with particularly homogeneous material compositions.

From the prototype to serial production, we work closely with our customers to develop both the optimum contact materials and the most efficient switching contact systems. Consequently, we help extend the lifetime of the switching chamber and reduce the maintenance costs.

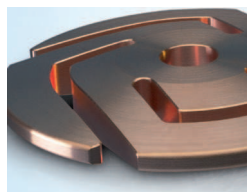
Market Unit Power Transmission and Distribution:

Quality inspection of copper-chromium contacts at Plansee Shanghai in China. In vacuum circuit-breakers, copper-chromium contacts are relied on to open and close the electrical circuit.

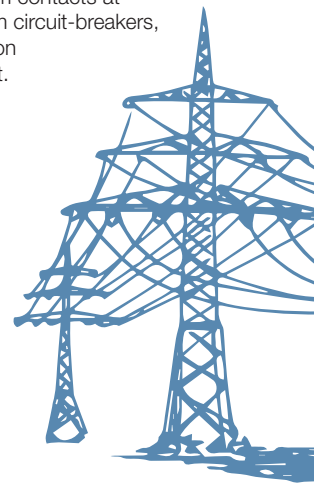
Tungsten-copper

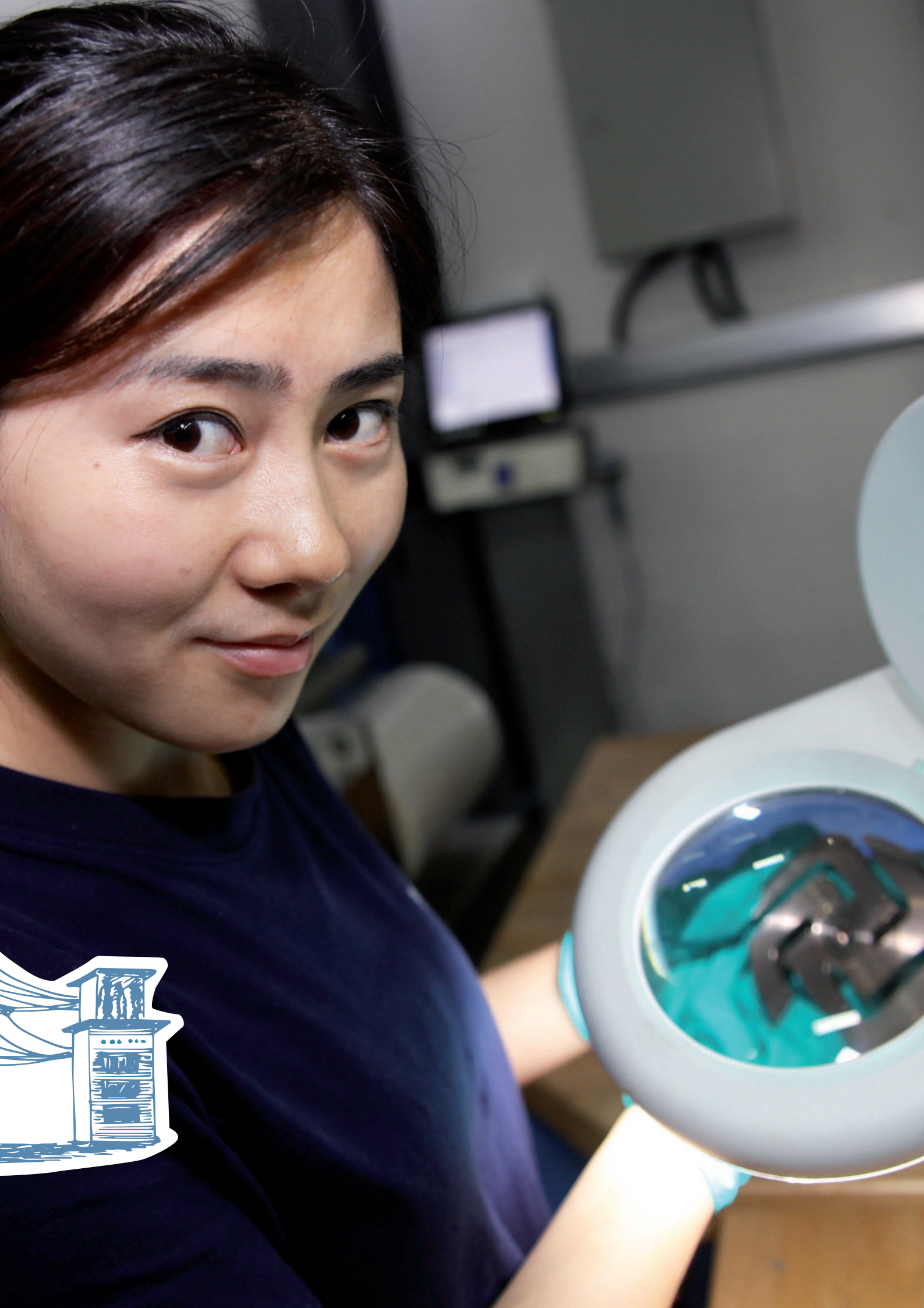


Copper-chromium



Tungsten carbide-silver







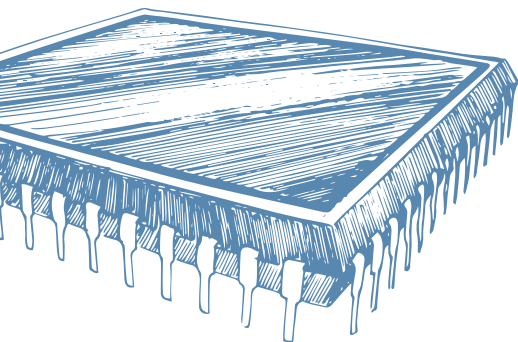
Components for ion implantation.

From the tiniest filament to the finished ion source. With more than 2,000 components for implanter systems, we are the world's largest second source supplier for ion implantation.

This process for the manufacture of semiconductors takes place at high temperatures, in the presence of aggressive process gases and strong electromagnetic fields.

Our heat-resistant components made from **molybdenum, tungsten, graphite or ceramics** excel due to their ideal combination of corrosion resistance, strength, excellent thermal conductivity and absolute purity. Each ion implanter contains 100 or more Plansee components. They guarantee the efficient creation of ions and guide them without added contamination onto the wafer.

At our production sites in California and Japan, we manufacture in strict compliance with the OEM standards of all the major producers. However, the main focus is placed on the improvement and further development of OEM spare parts. Marketed under the "Plansee Advanced Standard" brand, replacement parts from Plansee are known throughout the semiconductor industry for their extended service life, simplified handling, lower maintenance requirements and reduced costs.



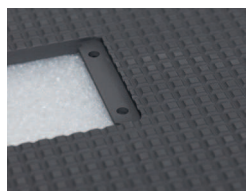
Market Unit Ion Implantation:

Plansee clean room in California. In the field of semiconductor manufacturing, even the minutest foreign particles can damage entire wafers. These wafers are used to manufacture tiny computer chips, for example for smartphones.

Extraction optics



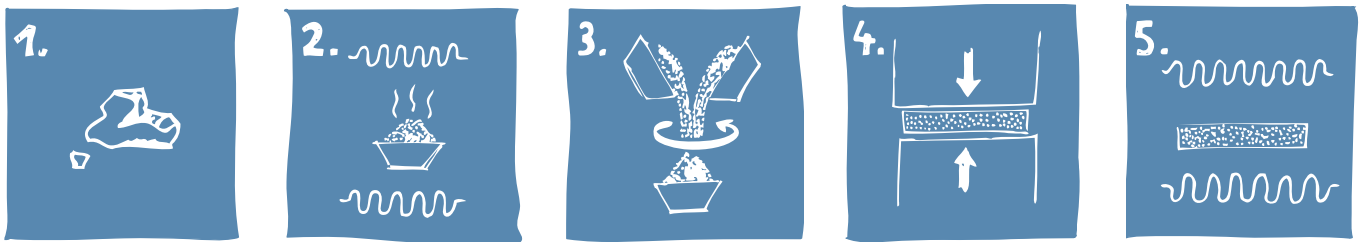
Diaphragm holder



Ion source



We manufacture our refractory metals and composite materials using powder metallurgical techniques and cover the entire production process from the ore concentrate to customer-specific components within the Plansee Group.



1. We cooperate closely with Western ore suppliers and have long-term supply agreements. The processing of the ore to obtain the concentrates is performed in the Plansee Group by GTP and Molymet:

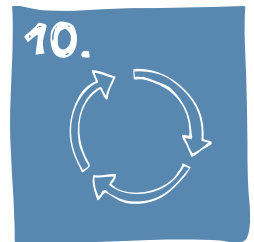
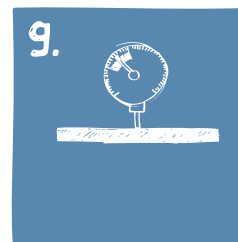
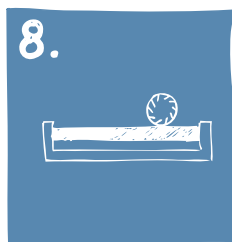
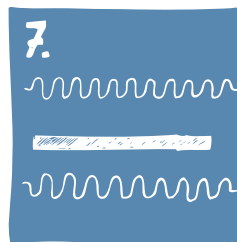
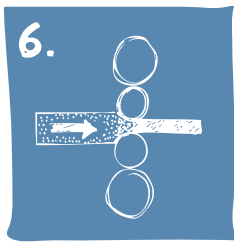
Global Tungsten & Powders (USA) is a division of the Plansee Group and our main supplier of tungsten metal powder.



Molymet (Chile) is the world's largest processor of **molybdenum** ore concentrates and our main supplier of molybdenum trioxide. The Plansee Group has a 20 percent share in Molymet.



2. Plansee manufactures metal powder through chemical reduction while simultaneously modifying aspects of the material's morphology. The result: outstandingly homogeneous and extremely pure powder.
3. One of Plansee's core skills lies in the production of particularly high-performance alloys. Their high quality is due in part to the homogeneous distribution of the individual components in the alloy.
4. We compact our metal powders and metal powder mixtures to form "green compacts". In the case of end products with particularly complex geometries, we press these green compacts to a corresponding near-net shape.
5. The core technology in powder metallurgy is sintering. The green compact is heated in a sintering furnace in a protective gas atmosphere. The powder grains adhere to one another and form a low-porosity sinter block.



- 6.** We deform sinter blocks to produce extremely resilient semi-finished products and operate the world's largest hot rolling mill for refractory metals. The density and mechanical strength of our materials increase the more they are worked.
- 7.** Heat treatment allows us to compensate for mechanical stresses, influence material properties and to ensure that our metals can be machined successfully.
- 8.** Whether it's a question of turning, milling, grinding, cutting, joining, coating, or finishing: we can perform all usual machining steps in-house. In this way, we can ensure that our customers get the very best quality.
- 9.** Very early in its development, Plansee set up a certified Quality, Safety and Environment Management System.
- 10.** The Plansee Group possesses its own recycling plants where it uses chemical, thermal and mechanical methods to prepare production by-products and used parts for further processing.

INNOVATION

IS

SERVICES

Research and Development

Our scientists are constantly working on new or improved products, production processes and materials. For example, Plansee's innovation team is one of the pioneers in the manufacture of interconnects for high-temperature fuel cells.

We exchange ideas and experiences in international collaborations with our customers and leading research institutes and invite guests to attend our international Plansee Seminar, which has been held every four years since 1952. Here, acknowledged experts from the field of powder metallurgy present their most recent insights into the development, manufacture and use of refractory metals.

Test laboratories, modeling and simulation

Simulation models based on the Finite Element Method (FEM) and Computational Fluid Dynamics (CFD) help us improve our materials, manufacturing processes and the design of our components.

In our test laboratories, we use mechanical tests and conduct chemical and metallurgical analyses to check the flawless quality of our materials. At Plansee, we also possess expertise in many non-destructive test methods, such as ultrasonic tests, eddy current testing or thermographic inspections. Our test laboratories are accredited by the relevant ministry.

Plansee continuously invests in research and development. With our state-of-the-art facilities and the expertise of our engineers, material scientists and technical staff, we make sure that all our products are ready for the challenges of the future.





Quality. Black on white.

Our quality management system is ISO 9001:2008 certified. We have introduced an energy management system in compliance with ISO 50001:2001, meet all the criteria of the OHSAS 18001:2007 standard on Occupational Health and Safety, and are also certified in accordance with the ISO 14001:2004 environmental management standard.

Purchasing made easy.

We combine impeccable product quality with an all-round logistics service. On request, we will, for example, provide the following services:

- Direct delivery including customs clearance in the destination country
- Supplier-managed inventories and consignment stocks
- Global transparency of the manufacturing status of our products
- End-to-end tracking of your shipment
- Invoicing in your national currency and language

Optimal service in the language you want.

We are represented in more than 20 countries worldwide through our production sites and sales offices.

You can find your local contact person and all our products at www.plansee.com. We're looking forward to your call!



One of our worldwide sales offices: The Plansee sales team in Korea.

Online shop.

You can purchase our semi-finished and standard products online: www.shop.plansee.com