#22

LIVING METALS

2026

Future in the Making

LONG-TERM THINKING
Karlheinz Wex on tungsten supply, partnerships, and technologies

TUNGSTEN WIRE & DRAWING DIES
How new applications are continuously being developed

A NEW GENERATION FOR INDUSTRY
On tomorrow's talent, changing expectations, and new opportunities

Innovation, n.
(from Latin *innovare* – to renew)

Dictionaries define innovation as the implementation of a novel, progressive solution: the introduction of an application that surpasses existing products or processes and addresses challenges that once appeared impossible to overcome. Still, innovation is not a coincidence or spontaneous inspiration. It is the result of a development process – and thus a question of culture that can be deliberately promoted.

Natural sciences in particular are innovative by default. They ask questions, observe phenomena, and challenge the boundaries of what has been feasible and conceivable thus far. Our tungsten and molybdenum metals address precisely these boundaries – thanks to their unique property profile, which makes them more reliable than other materials under extreme conditions. Materials developers and engineers specifically seek innovation. They want to solve manufacturing and processing problems.

At the Plansee Group, innovation is part of our vision; we invest in it, and measure our innovative strength based on the rate of new product development. And with the Plansee Seminar, one of the largest powder metallurgy conferences, we bring the entire industry together and promote cross-disciplinary innovation through exchange and networking.

In this issue of *Living Metals,* we look at innovations in a wide variety of areas: in our history with tungsten wire – a product we have manufactured for 100 years and for which we continually discover new applications. We also look to the future with fusion reactors, which may one day help solve global energy challenges; the effort to attract young talent to technical and scientific careers; and strategies for raw material supply, which are continually tested by shifting trade policies and resource limitations.

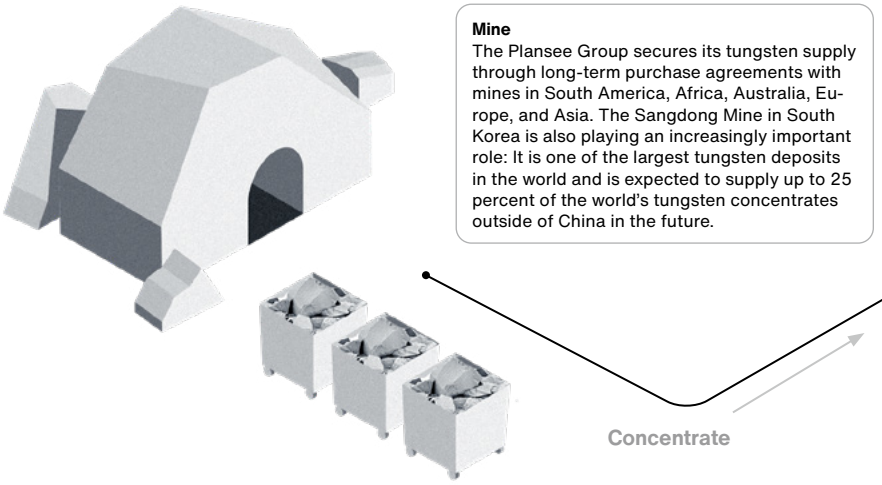
To enter the future successfully and, above all, sustainably, innovation is indispensable.

We hope you enjoy reading this issue!

Contents

Contents

Tungsten's Journey



Mine
The Plansee Group secures its tungsten supply through long-term purchase agreements with mines in South America, Africa, Australia, Europe, and Asia. The Sangdong Mine in South Korea is also playing an increasingly important role: It is one of the largest tungsten deposits in the world and is expected to supply up to 25 percent of the world's tungsten concentrates outside of China in the future.

From ore to high-tech application – and back again. The tungsten value chain illustrates how this critical material is used and continuously repurposed. What journey does it undergo?

19.25 g/cm³

Tungsten has a density similar to that of gold.

6,192°F

Tungsten is the metal with the highest melting point. By comparison, iron melts at 2,827°F and copper at 1,949°F.

12%

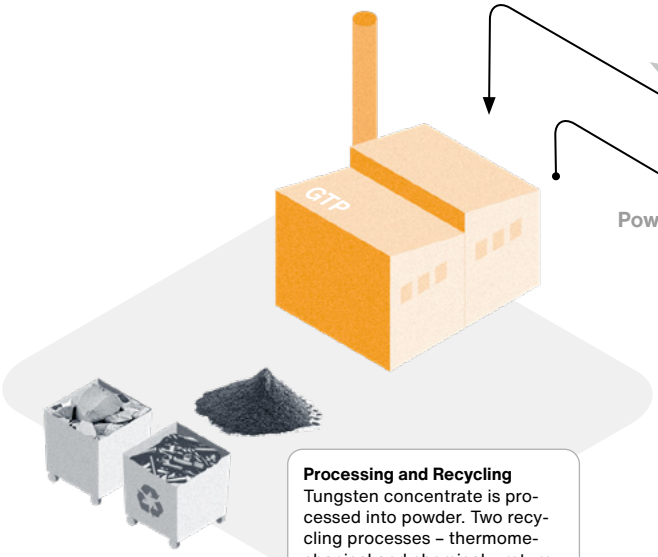
Today, the Plansee Group is the largest manufacturer of tungsten products outside of China. In 2025, its business areas delivered 14,200 tons of tungsten in the form of primary, semi-finished and finished products, thereby meeting approximately 12 percent of global tungsten demand.

250 t

To obtain one ton of tungsten, about 250 tons of ore must be mined and processed.

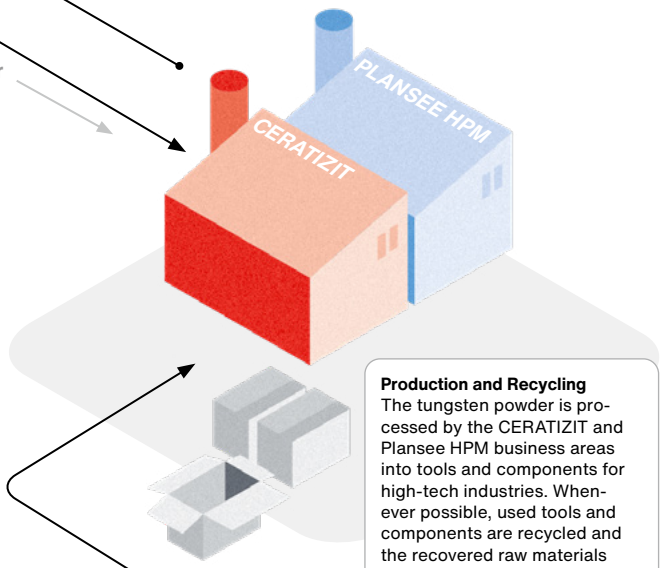
123,500 t

Global demand for tungsten stood at 123,500 metric tons in 2025. Global tungsten production from mines totaled about 80,000 metric tons, over 80 percent of which came from China.



Production scrap

Powder



Processing and Recycling
Tungsten concentrate is processed into powder. Two recycling processes – thermomechanical and chemical – return end-of-life products, production waste, and scrap back into the material cycle.

Production and Recycling
The tungsten powder is processed by the CERATIZIT and Plansee HPM business areas into tools and components for high-tech industries. Whenever possible, used tools and components are recycled and the recovered raw materials are used to manufacture new products.

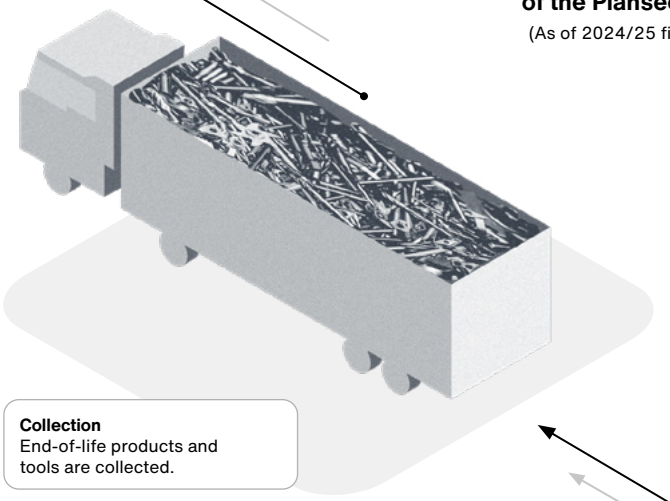
88%

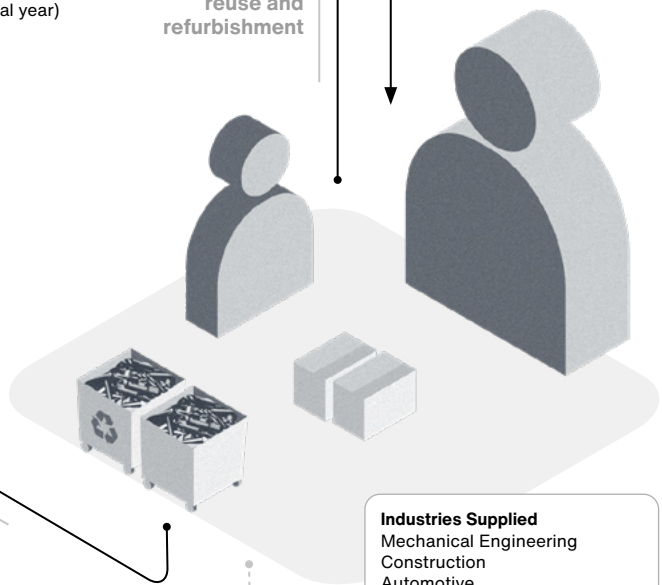
Tungsten Recycling Rate of the Plansee Group

(As of 2024/25 fiscal year)

Products and tools

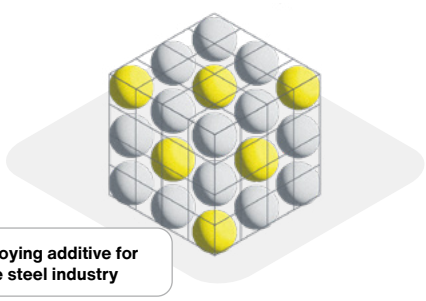
Tools and products for regrinding, reuse and refurbishment





Collection
End-of-life products and tools are collected.

Industries Supplied
Mechanical Engineering
Construction
Automotive
Aerospace
Security & Defense
Medical Technology
Semiconductor Industry
Consumer Electronics
Energy
Oil, Gas & Mining



Alloying additive for the steel industry

Tungsten is a critical raw material, which makes it all the more important to consistently return end-of-life products to the economic cycle of the respective region. The Plansee Group's value chain demonstrates how recycling reduces dependencies and secures the long-term supply of tungsten, a critical material that, in theory, is infinitely recyclable.

Long-Term Thinking Is Essential

Chairman of the Executive Board Karlheinz Wex takes a look at the Plansee Group's raw material strategy and explains the crucial role of technological developments and long-term partnerships. He also discusses why European politicians should pay closer attention to the topic of tungsten.

KARLHEINZ WEX has been Chairman of the Executive Board of Plansee Holding AG since 2023 and has been a member of the Plansee Group's Board for 25 years. After studying business and technical physics, he started his career in the company's finance department 35 years ago.

In the beginning, there was light. When humanity began to turn night into day, an unassuming metal soon played the starring role: tungsten. A fine wire, made to glow by electrical current, provided people with reliable, bright, and affordable electric light.

Tungsten's journey into the world's lightbulbs is owed in part to the foresight of the Plansee Group's founder Paul Schwarzkopf. He recognized the potential of this metal early on and advanced the industrial production of ultra-thin fine wire: the foundation for manufacturing filaments for modern lightbulbs. Thus began a success story that continues to this day.

Other high-tech applications for tungsten would follow the filament bulb: rotating X-ray anodes, carbide tools, and balancing weights – all of which have become an integral part of our modern world. Tungsten is found in products and applications that shape, protect, drive, and make our daily lives more precise.

A secure supply of tungsten is not only important – it is crucial to our progress and our future.

Alongside molybdenum, tungsten is the main material used by the Plansee Group, and the company is continually developing new applications jointly with its customers. What makes this metal so special?

Tungsten is a refractory metal, meaning it is particularly "stubborn" to process. Since these metals cannot be processed industrially by metal fusion, they are processed by powder metallurgy: under high pressure and at high temperatures, but still well below the melting point. Their unique properties make them demanding to work with and accordingly expensive.

However, when precise material performance is required, refractory metals like tungsten are indispensable. Its exceptional and diverse properties are why tungsten plays a central role in the aerospace industry, for example. Its shielding capability against X-ray and gamma radiation makes tungsten the material of choice for radiation equipment used in cancer therapy.

So, this metal is used in the manufacture of components for the aerospace industry or serves as radiation shielding. What else is tungsten used for?

Tungsten is primarily used in the tool industry as hard metal, which is tungsten carbide combined with cobalt. Tools made from hard metal can cut a wide variety of materials and are therefore used in manufacturing and all professional wood and stone working applications.

Tungsten is also used in many other areas: as a balancing weight for crankshafts or as fine wire in surgical robots. In many of these applications, there is no suitable substitute for tungsten. Reliable supply is therefore crucial for these industries.

→ **Life-Saving Wires:** Pages 58 and 59 provide insight into the role of tungsten in surgical robots.

Why is the supply situation in Europe particularly critical?

Tungsten is one of the critical metals. Because of its limited supply, we must use this special metal responsibly. Around 50 percent of known natural tungsten reserves are located in China. The country has systematically developed these reserves and – much like to rare earth elements – dominates the global tungsten market through targeted pricing policy. While other regions have deposits, they are often not utilized because inexpensive tungsten from Asia in many instances makes extraction economically unattractive. Over the past two decades, this has made the Western world highly dependent on China. This became clear when China restricted exports at the beginning of 2025, leading to a sharp increase in tungsten prices. In the second half of 2025, we received numerous inquiries from customers who could no longer fully meet their tungsten material needs.

How does the Plansee Group ensure its tungsten supply security?

More than 20 years ago, we decided to pursue backward integration. This way, we ensure independent tungsten supply for all major regions of the world and a “local for local” production approach wherever possible. This move required strategic foresight, entrepreneurial courage, and the acceptance of high risks.

→ **Keyword: “Courage”:** Starting on page 60, Karlheinz Wex and economic researcher Klaus Wohlrabe discuss the current situation.

Our supply is built on three pillars: collecting tungsten scrap, developing and optimizing recycling technologies, and long-term purchase agreements with tungsten mine operators.

Our tungsten products are made from 88% scrap and used products. With our company GTP, we have recycling infrastructure and two different technologies in the USA and Europe, which we continuously enhance. Our subsidiary Stadler handles the logistics as well as the collection and sorting of scrap – a central step in ensuring high-quality raw material. We have integrated these companies into our group over decades. Today, we have a robust foundation in raw material processing, strengthening our supply security.

Products made from recycled tungsten are equal in quality to those made from primary material, at a significantly lower overall CO_2 footprint. Besides supply security, this aspect is becoming increasingly important for our customers.

One of our long-term mining partners is the reactivated Sangdong Mine in South Korea, for example. It’s considered one of the largest tungsten deposits in the world and operated by Almonty Industries. We are the largest shareholder of Almonty and, through a 15-year purchase agreement, have secured the majority of the company’s production from the Sangdong Mine.

→ **Value Chain:** The journey from tungsten ore to high-tech products and back to powderis outlined on pages 6 and 7.

To build such a strategy, it’s important to anticipate as many possible scenarios as early as possible, right?

Long-term thinking is vital for us, almost second nature. A company only survives for over 100 years by truly operating sustainably. Our current approach has grown gradually over many years: from the original emphasis on products, to a stronger customer focus, to developing in-depth application knowledge, and finally securing our raw material base. We have invested heavily in this area over the past decades, facing significant risks. Today, we see that this decision was correct.

Speaking of "Long-term thinking". How do you see the future of the Plansee Group?

We want to expand our capacities to continue to reliably supply Europe and the USA in the future. Today, the Plansee Group is the largest producer of tungsten products outside China and currently meets approximately 12 percent of global tungsten demand. GTP has evolved into one of the most important powder manufacturers and can now fully secure not only our own needs, but also provide raw materials for the market.

We fundamentally aim to be among the top 3 globally in everything we do. We have already achieved this in 80 % of our business and consider it in every strategic decision.

→ **Future Technical Talent:** Starting on page 34, a board member, a vice rector, and a student discuss the appeal of the industry.

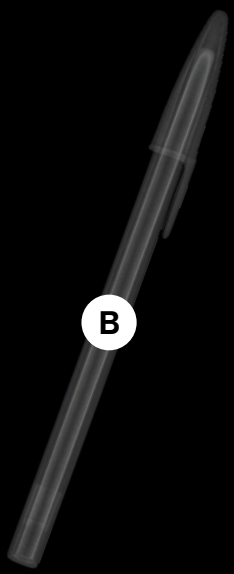
Lastly, what does the industry have to do to ensure adequate sufficient tungsten supplies in the future?

We want to be a reliable partner and a stable source for tungsten long-term, both for ourselves and our customers. At the same time, it's clear: Western supply cannot be secured by one company alone. The entire industry must take responsibility and actively ensure diversified supply chains. Politically, the EU Raw Materials Act is an important first step, providing some regulation for strategic raw materials. What's missing, however, is a clear, comprehensive strategy that secures long-term tungsten supply and provides the industry with a reliable framework for operation. We have invested in the tungsten mine in South Korea and signed a long-term purchase agreement – a step that is unusual in the private sector. If industry and politics assume joint responsibility here, we can reliably ensure tungsten supply in the future.

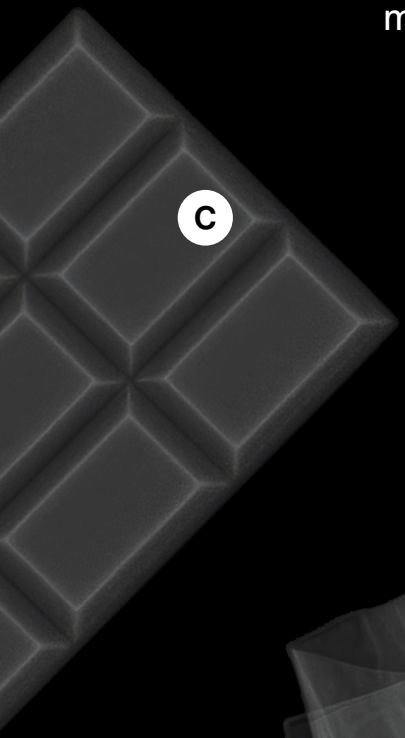
Our goal is to be among the top three in the world in everything we do. We have already achieved this in 80% of our business activities.

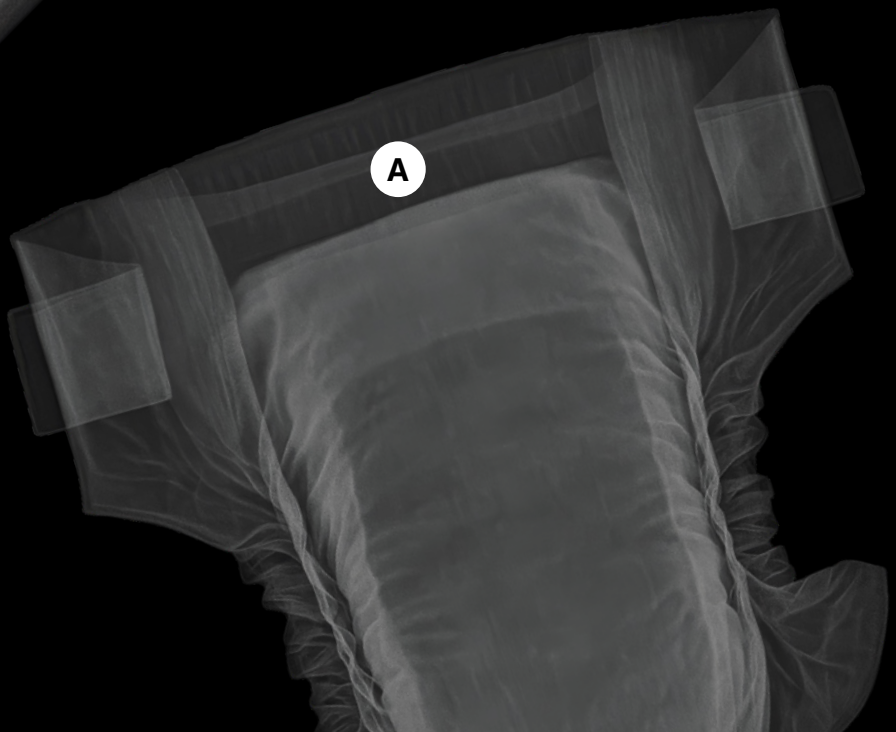
Karlheinz Wex

Hidden Heroes



They are found in products we use every day, and in others where we would never expect them: tungsten and molybdenum are true all-rounders. Their unique properties make them indispensable materials in a wide range of industries: whether as sputter targets for screens, as components of carbide drill bits, or in now nostalgic light bulb filaments. But beyond these uses, there are many more applications waiting to be discovered.





A

FUNCTION CUTTING

Alongside sleepless nights, empty baby food jars, and lullabies on repeat, **the diaper** is a central part of most parents' first months with their child. In fact, there's tungsten behind the disposable diaper made of cellulose. To ensure the most efficient production of diapers or even sanitary pads, manufacturers need highly reliable, rotating cutting tools. These can be quickly and easily produced using carbide blanks.

B

FUNCTION GLIDING

Hardly any writing instrument glides as smoothly over paper as **a ballpoint pen** – even if fans and friends of fountain pens, pencils, and the like might disagree. The eponymous ball in the tip rotates, allowing ink to easily transfer to the page without leaking. And this ball is made of tungsten carbide. An evenly smooth and corrosion-resistant surface is essential here, so the pen doesn't scratch the paper.

C

FUNCTION CRUSHING

When you think of sweets, **chocolate** almost automatically comes to mind: smooth and tempting. One of its main ingredients is the cocoa bean, which is grown in tropical regions around the world. The so-called cocoa crusher, made from carbide, is used to break down the hard cocoa beans for further processing. Whether it's hot chocolate, pralines, or the classic chocolate bar – the food industry's imagination knows no bounds, thanks in part to carbide

D

FUNCTION HEAT RESISTANCE

A hip prosthesis enables many people to regain their mobility. The titanium parts for hip joint implants are fired in special **furnaces with metallic heating elements** made of molybdenum, molybdenum alloys, or tungsten. These withstand temperatures from 900 to 2,500°C (1,650 to around 4,500°F), a range where other materials would have long since failed. And unlike graphite, these heating elements contain no carbon. That means: no contamination of products and maximum process purity.

In the Interplay of the Elements

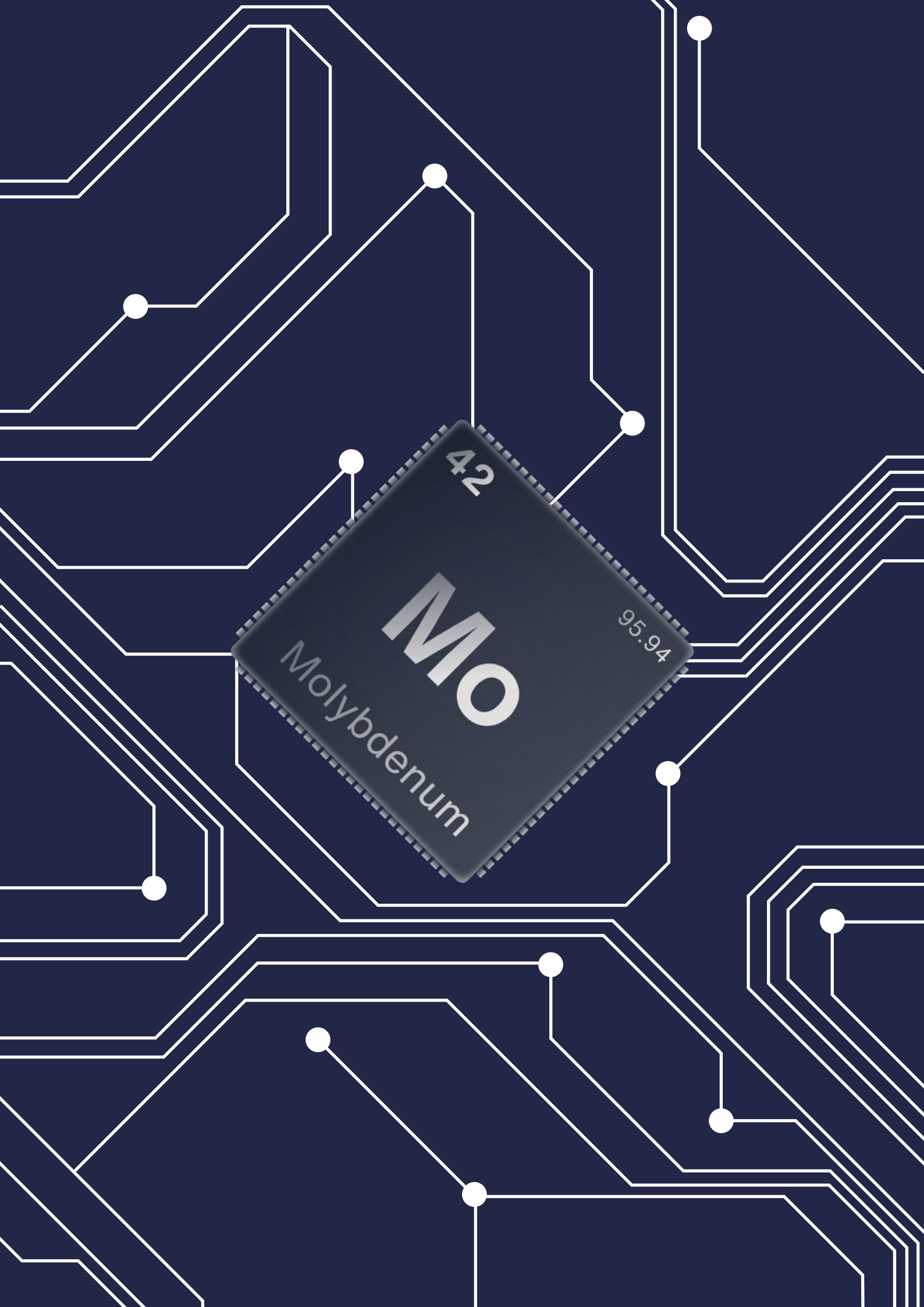
In June 2025, Reutte once again became a gathering place for the most innovative minds in powder metallurgy. 529 participants from 30 countries came together for the 21st Plansee Seminar. They brought with them 287 contributions – including 114 presentations and 173 posters. Amid lectures and intensive discussions on technical developments, a network of new insights and perspectives emerged from science, research, and industry. Founded in 1952, the seminar is now held every four years, driven by scientific collaboration within the industry for materials made of refractory and hard metals. Not even the inclement weather could dampen the energy.

Comments and impressions from the 21st Plansee Seminar can be found in the highlight video on our website.

5.59 µΩ·cm

Chemical elements can be very diverse. Even refractory metals differ considerably from one another – depending on whether they belong to Group 5 (such as niobium and tantalum) or Group 6 (such as molybdenum and tungsten) of the periodic table. While they all share extremely high melting points and low thermal expansion, they vary greatly in other properties – and this is true even within the same group.

Each of these metals has its own “personality”: it melts at a different temperature or undergoes a different chemical reaction. This unique combination of properties is precisely what makes high-melting-point metals so suitable for a wide range of demanding technical applications – especially where high heat resistance or wear resistance is required. To find the right metal for each application, you need to ask the right questions about operating conditions and requirements. After all, each property unlocks very specific possibilities for how they can be used.


42
Mo
95.94
Molybdenum

Molybdenum is a chemical element and is classified as a refractory metal (metals with high melting points). In addition to a high melting point, it also has low thermal expansion and high thermal conductivity. This profile of properties means that the material is used in many different applications. For over 100 years, the Plansee HPM business area has processed molybdenum into products and components for a wide range of industries – such as medical technology, the glass industry, or electronics.

Materials conduct electricity to different extents – some allow a relatively unhindered current flow, while others slow it down considerably. This behavior is described by the parameter ρ, known as **specific electrical resistivity**. It indicates how well a material, a pure element, or an alloy can be used as a conductor, semiconductor, or insulator. The basic rule is: the smaller the value, the higher the electrical conductivity. Since ρ is also temperature-dependent, it is always specified in conjunction with a defined temperature.

Molybdenum has a specific electrical resistivity of 5.59 µΩ·cm.

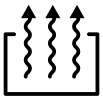
The specific electrical resistivity of molybdenum at room temperature is **5.59** µΩ·cm. For comparison: for iron, this value is about 10 µΩ·cm; for tungsten, 5.50 µΩ·cm; and for copper, a particularly good conductor, 1.68 µΩ·cm.

The specific electrical resistance ρ is a material constant. If it is multiplied by the length of a wire (or a conductor of another shape) and divided by the cross-sectional area, the result is the total resistance of the wire. ρ is measured in units of ohm-meter (Ω·m) or in a comparable unit such as **µΩ·cm.** Ohm is the unit of electrical resistance. This resistance of a conductor is linked with its geometry to obtain the specific electrical resistivity. For very low ρ values, the notation in microohm-centimeter (µΩ·cm) is common to keep the numbers manageable.

Fields of Application
In these applications, molybdenum is used when high electrical conductivity is required:

ELECTRONICS – as a target material for applying thin electrically conductive layers in smart phone, computer, or TV displays and in electronic components using PVD (Physical Vapor Deposition)

GLASS INDUSTRY – as a corrosion-resistant and temperature-resistant electrode material with favorable electrical conductivity in glass melting tanks



HIGH-TEMPERATURE FURNACES – as a high-strength (creep-resistant) heating element material with favorable conductivity for efficient and energy-saving heating processaes

The Plansee Group possesses extensive expertise in coating technology, ranging from applications in microelectronics to wear-resistant coatings on cutting tools. A wide range of technologies is used for this purpose, including ALD (Atomic Layer Deposition), PVD (Physical Vapor Deposition), and CVD (Chemical Vapor Deposition), as well as VPS (Vacuum Plasma Spraying), APS (Atmospheric Plasma Spraying), and gas hardening processes. In addition to coating technology, the production of coating materials is another core competency, particularly the manufacture of PVD target materials for a range of applications from hard materials to electronics.

Molybdenum for Tomorrow's Chips?
The next generation of computer chips is presenting the semiconductor industry with major challenges: significantly more transistors in ever smaller spaces, faster computing speeds, and lower energy consumption. Above all, AI applications are driving this development: They make it necessary to process enormous amounts of data within fractions of a second.

With the materials previously used for metallic connections between transistors in memory and logic chips, semiconductor manufacturing is increasingly reaching physical limits. The current layer systems, which use, for example, copper or tungsten, show disadvantages at the smallest structure sizes. Ultra-high purity molybdenum is therefore being discussed as a promising alternative: Its lower effective resistivity at the smallest scale enables faster signal transmission—with less heat generation and lower energy requirements. Another advantage over existing conductor materials like copper or tungsten: molybdenum does not require an additional diffusion barrier to the silicon transistor, freeing up valuable space and allowing even more transistors to be integrated on a chip. The layers can also be made slightly thicker, so that molybdenum offers advantages in terms of total resistance despite having the same or slightly lower resistivity compared to tungsten and copper (see p. 20). The layer thicknesses are typically 10–20 nm (0.01-0.02 µm) and are deposited within seconds.

This is precisely where a completely new market is emerging with major opportunities for innovation, so far there are few providers. This requires extremely high purity and quality standards compared to existing uses of molybdenum. To reliably provide ultra-high purity molybdenum (>99,995%) with the desired properties, the entire process chain must be geared toward it – from powder production, to processing of semi-finished products, to the finished product. The deposition of thin molybdenum layers for semiconductors is mainly done using a process known as ALD (Atomic Layer Deposition). This enables very uniform and defect-free structures to be achieved in layers that are only a few nanometers thick. The use of ALD for applying molybdenum layers on an industrial scale is a novelty in the semiconductor industry. The starting material for this process are so-called molybdenum chlorides, which are used as solids in ALD reactors, vaporized there, and used to produce the molybdenum metal layers through chemical reactions.

Besides molybdenum, ruthenium is currently being investigated as a promising alternative.

How Much Circularity Is in Molybdenum?

The molybdenum industry faces a challenge: providing a material that is indispensable for numerous high-tech applications due to its high temperature and corrosion resistance, using a process that is as resource-efficient and climate-friendly as possible, and keeping this material in the circular economy.

From the Copper Mine

Globally, the Plansee Group ensures a independent supply of molybdenum for its production for all major regions of the world. One advantage is that more than three-quarters of the molybdenum processed by the company is a byproduct of copper mining.

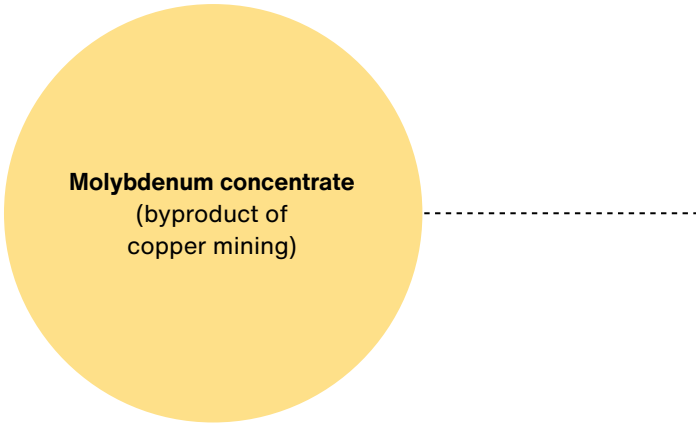
China, the United States, Chile, Peru, and Russia have large molybdenum reserves and mining operations. The metal is mostly obtained as a byproduct of copper mining. These ores contain about 0.5 percent by weight of molybdenite. Using a process called flotation, the accompanying minerals are separated from the molybdenum. Since the CO_2 emissions from mining are mainly attributed to copper in this case, molybdenum has a comparatively lower raw material footprint.

Molybdenum, alongside tungsten, is the second key material for the Plansee Group. The Plansee HPM business area processes it into semi-finished and finished products. Plansee HPM's molybdenum supply is secured long-term through a 31 percent stake in Molymet, the world's largest processor of molybdenum concentrates headquartered in Chile. Molymet's processing technologies enable the production of molybdenum trioxide – the starting material for further processing at Plansee HPM – with the lowest CO_2 footprint in the industry.

Second Life

Molybdenum is a material that can demonstrate its special properties over multiple life cycles: whether as a component made of molybdenum metal, as a reprocessed part, or as an alloy in high-quality steel.

To keep the material in the cycle as long as possible, targeted projects and initiatives have been launched in recent years. They allow molybdenum products to be reused after their service life with the customer. This includes, among others, coating materials (sputter targets), where only a small portion is actually consumed during the coating process. Components from the glass industry or, the medical technology sector also return to Plansee HPM after their first life cycle. Depending on the need, they are reprocessed, refined, or directly reused – thus beginning their second life.



76%
Molybdenum Byproduct Rate

Molybdenum Makes Steel Strong

For the powder metallurgical production of molybdenum components, as carried out at Plansee HPM, the circular economy approach differs from that used for tungsten (see page 6–7).

Nevertheless, molybdenum scrap finds valuable further use: It is used in the steel industry as an alloying additive. The strength of the material also becomes apparent here: molybdenum makes steel harder, more temperature-resistant, and more corrosion-resistant.

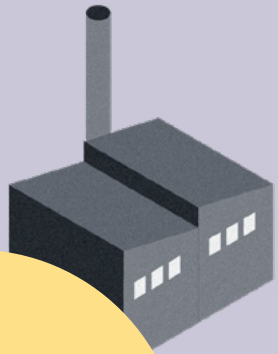
All molybdenum-containing scrap generated during processing is sorted, cleaned, and then supplied to the steel industry. As a result, most molybdenum remains in the recycling loop of steel manufacturers. Therefore, pure metal recycling plays a rather minor role in practice, but it is of great benefit to the entire industrial cycle.

Expressed in Numbers ...

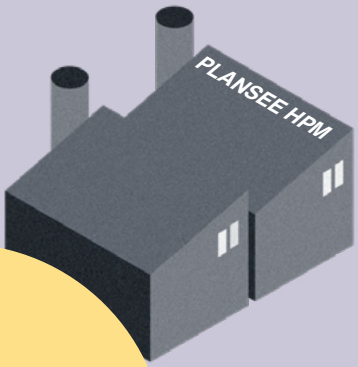
The **molybdenum circularity rate** for Plansee HPM is **26% (2024/25).** This metric describes the share of molybdenum in products that, after the end of their service life – regardless of their origin – were returned and recycled, relative to the total weight of primary products delivered in the same period.

The **molybdenum byproduct rate** is currently just over **75%**, meaning that about three-quarters of the molybdenum used at Plansee HPM comes from South American copper mines.

In addition, there is a **utilization rate** of over **99% (2024/25):** Thanks to the reprocessing of used customer products and the reuse of the material (whether as a product at the end of its life cycle or as byproducts of production) as a valuable alloying element in the steel industry, nearly all molybdenum material is utilized.

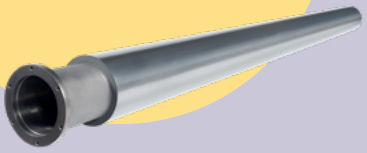


Processing
Conversion of molybdenum concentrates into molybdenum trioxide



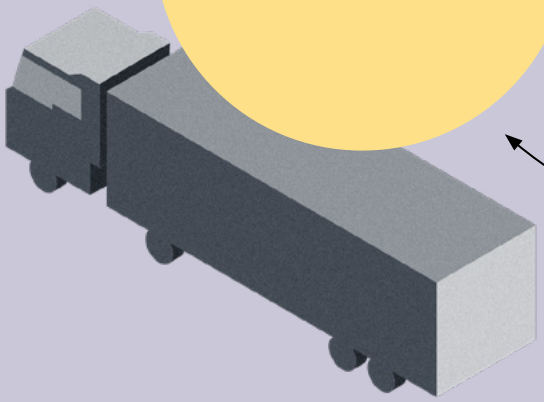
Production
Processing of molybdenum powders into semi-finished products and finished components

Use of the products in high-tech applications
(e.g., coating material for displays)



Alloying additive for the steel industry

Acceptance of returned products
Reuse, rework or refurbish



26%
Molybdenum Circularity Rate

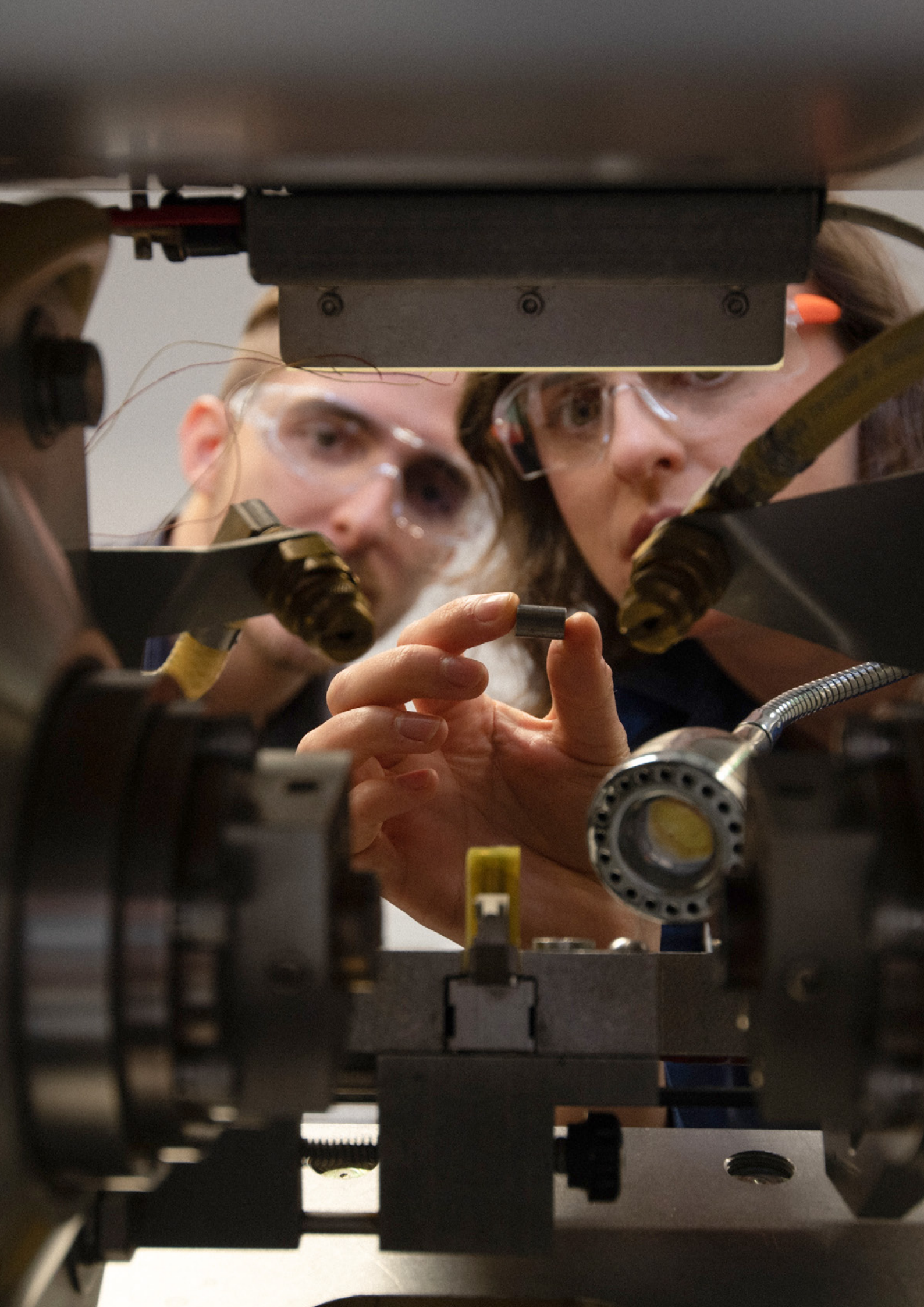
99%
Molybdenum Utilization Rate

On the Smallest Scale Possible

Professors Sophie Primig and Simon Ringer from Sydney delve into the world of metals down to the atomic scale. Their research covers the full range between current challenges and visions for our future: lower-emission mobility, 3D printing of prosthetics and ship components, and resource-efficient material compositions and recycling.

SIMON RINGER is a graduate of the University of New South Wales in Sydney, and is now Pro-Vice-Chancellor for Research Infrastructure and Professor of Materials Science and Engineering at the University of Sydney.

SOPHIE PRIMIG is a graduate of Montanuniversität Leoben and is now an Alcoa Distinguished Professor and Australian Research Council Future Fellow at the School of Materials Science and Engineering at the University of New South Wales in Sydney.



What are your respective research focal areas?

SOPHIE PRIMIG My topics are broad. I work with superalloys that must withstand extreme conditions, such as in aircraft engines or the oil and gas industry. I also address fundamental questions in metal additive manufacturing, for example how the cyclic temperature effects during 3D printing influence the material and its properties. Together with CERATIZIT, I analyze cobalt alloys as are used in hard metals, which act as a binder for tungsten carbide grains – especially at the interfaces formed and with a view towards increasing contents of recycled materials.

SIMON RINGER One focus of my work is how atoms are distributed in alloys. Not only the amount that is present, but also where individual atoms cluster or accumulate. For this, I use high-resolution microscopy techniques. This research is especially relevant for recycling: How much contamination can a material tolerate before its properties are compromised? I also examine the interplay of microstructure, properties, and manufacturing processes. Additive manufacturing is an important area here as well. Ultimately, it's always about how we can apply research results to industrial processes and scale them – I work closely with industrial partners on this.

Just like sugar crystals in tea, atoms in an alloy do not always distribute evenly. Concentrations are made visible using high-resolution microscopes.

You both mentioned additive manufacturing, or 3D printing. To what extent is this a future technology?

SOPHIE PRIMIG Additive manufacturing will become more significant – but probably not for mass production. Instead, I see targeted applications: With a specialized 3D printer on board, ships could produce replacement parts directly at sea, for example. In medical technology, customized prosthetics can be produced instead of standardized catalog parts. In aircraft construction, printed components enable more complex property profiles with fewer individual parts. So, 3D printing occupies an important niche.

SIMON RINGER I agree with Sophie's assessment. The technology is growing, being promoted, and becoming more professional. Now, it's important to establish certifications and qualifications. The trust of industry – and end customers – depends on consistent quality, whether a part was printed or produced the traditional way.

Sustainability is a major topic when it comes to climate change. How does materials research contribute to this?

SOPHIE PRIMIG Early in my career, I was more indirectly involved with sustainability – for example what materials can reduce fuel consumption in aircraft engines. Now I'm directly researching resource-conserving solutions: How can we make energy-intensive metallurgical processes more efficient? How can we utilize waste products? How can we manage material contamination and impurities when using higher proportions of recycled materials?

SIMON RINGER Lighter cars, planes, or trains use less energy, produce fewer emissions, and consume fewer raw materials. The potential is huge. That's why I'm working to make materials stronger and more resource-efficient at the same time. Less material should be able to do more – which starts with microstructure. This is also crucial for high-performance magnets, which are needed for electrification and contain rare earth elements, as well as for companies working with these finite resources.


Simon Ringer

Currently, artificial intelligence (AI) is a driver in various industries and sectors. What does it mean for you?

SIMON RINGER For me, AI is a tool that can generally speed up research cycles – regardless of the field of application.

SOPHIE PRIMIG The development of new materials has traditionally followed the "trial and error" principle. AI can simulate parts of these experimental series and thus accelerate them.

You are regular participants in the Plansee Seminar, one of the world's largest powder metallurgy conferences. What did you take away from last year's event?

SOPHIE PRIMIG For me, it's a very special conference – ever since my first participation with my doctoral thesis. The mix of depth and manageability makes it unique: There aren't too many parallel sessions, so you can keep meeting colleagues and exchanging ideas throughout the week. Last year, I was impressed by the progress in analysis and modeling methods that help solve research problems long considered nearly unsolvable – especially in the field of interfaces and grain boundaries.

SIMON RINGER: I found it fascinating to see how realistically and purposefully current research addresses extreme conditions – loads or high temperatures. Personally, I was especially interested in the presentations about the connections between micro-, nano-, and atomic scales. What also struck me at the last seminar was the strong focus on fostering young talent – such as the new Student Dinner, the networking evening for students.

Young talent is essential for driving industry and research forward. How can we get young people interested in these topics?

SIMON RINGER It's important to inspire young people for our work and show them how multifaceted it is. Young people with diverse backgrounds bring fresh perspectives to established teams, as it's scientifically proven that diverse teams develop better solutions. Ultimately, every university and every company wants to attract the best talent.

SOPHIE PRIMIG In Australia, we have the advantage of the English language, which attracts many international students and researchers – I myself came from Austria ten years ago. Anyone dealing with microstructures and their effects on properties must first immerse themselves deeply in the subject. But once you understand the principles, a fascinating world opens up.

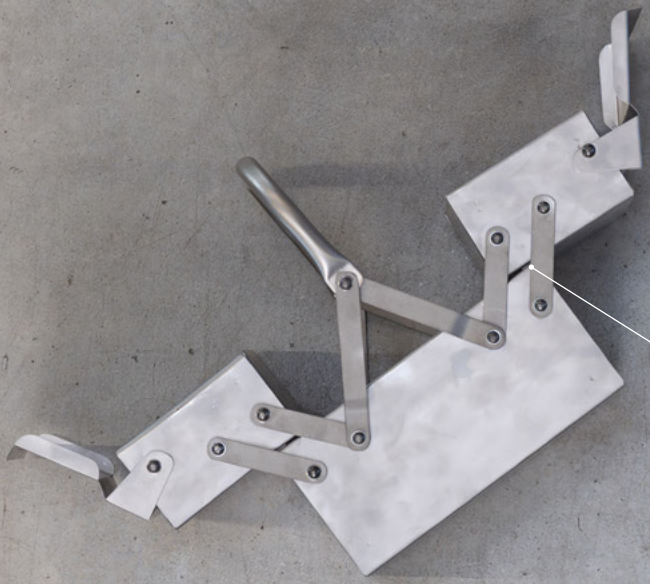
Less material should be able to do more – which starts with the microstructure.

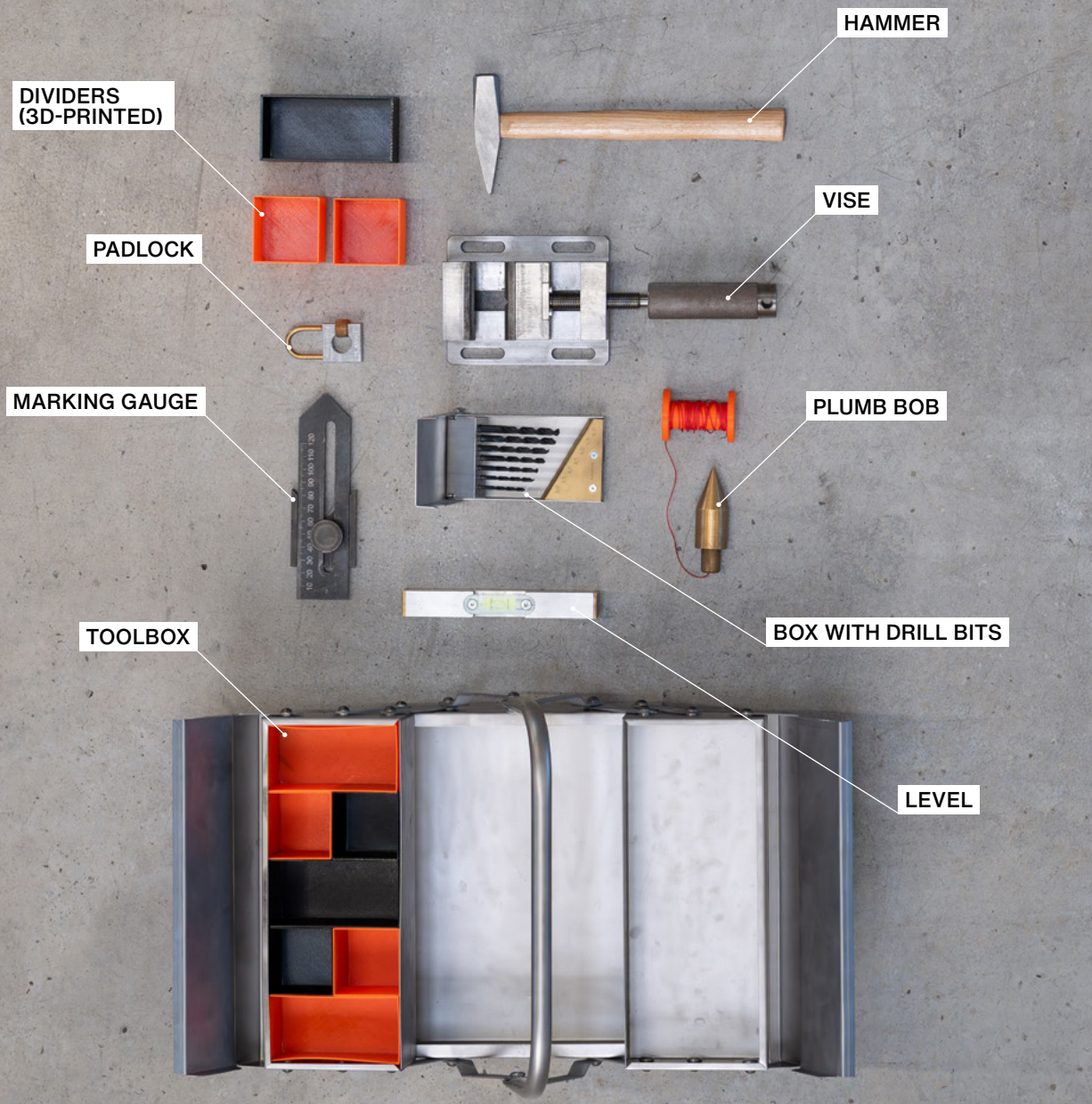
Simon Ringer

WHAT'S IN MY TOOLBOX?

At the training center in Reutte, the apprentices' toolboxes offer a glimpse into a special project: as early as their first year of training, the next generation of skilled workers build their own personal toolboxes entirely from scratch. A peek inside reveals just how much craftsmanship is already evident early on in their training.

The apprentices not only build the sturdy toolbox out of sheet steel, but also its contents: a hammer, vise, or padlock, as well as custom-fit plastic dividers from the 3D printer. In this way, they combine theoretical knowledge with teamwork and practical experience, creating a companion for the rest of their apprenticeship — and perhaps even beyond.


OPENING AND
CLOSING MECHANISM


HAMMER
DIVIDERS
(3D-PRINTED)
VISE
PADLOCK
MARKING GAUGE
PLUMB BOB
BOX WITH DRILL BITS
TOOLBOX
LEVEL

Fresh Ideas Secure the Future

Innovation doesn't happen in a vacuum – it thrives where people put their heads together and venture beyond familiar territory. This is true for the metal industry as well. It requires both the expertise of seasoned researchers and professionals, and the fresh impulses from the next generation. But how do we spark enthusiasm for our sector among young talent? And do they even still exist?

Professor Helmut Antrekowitsch is not only Vice Rector at Montanuniversität Leoben, a technical university, Head of the Non-Ferrous Metallurgy Department, and a renowned researcher, but also an optimist. What fascinates him most about his field is its potential to change the world. "Without metals, many everyday objects wouldn't exist. Anyone who understands how metals work can actively shape the major transformations of our world."

In other words, working with metals is meaningful work. Whether it's the energy transition, circular economy, or digitalization: metallurgy students can be part of the solutions to these challenges. This is what Helmut Antrekowitsch tries to convey in his lectures. "What amazes me most is how inspired my students are by the end of their studies, filled with visions. There is just one catch: There are just too few of them."

Helmut Antrekowitsch

Understanding the World

One of these "few" is Katharina Lammer. "I never expected my worldview to expand so quickly during my studies. Every day, I come across ordinary objects that I now understand more deeply – for example, because I know how particles behave," she explains. Another milestone was Katharina's internship at CERATIZIT in Reutte, a business area of the Plansee Group. "Alongside the mountains and the fantastic team, what motivated me most was seeing how I could apply my academic knowledge and make a difference," she says. "I can imagine working in a business role in a company in the future, but metallurgy provides a great foundation – everything else builds on that technical understanding."

This attitude is also reflected in the career of Gerfried Weiss – now a member of the Management Board of Plansee HPM, who is also a former metallurgy student.

The Fascination of Production

"What makes the Plansee Group so special is that it offers something for almost anyone who is passionate about technology: from manufacturing specialty components to automated mass production," says Gerfried Weiss, who has gained insights into various companies across different continents. However, what excites him and others must also be passed on to the next generation. "As an industry, we need to work on modernizing the image of the metalworking sector," he emphasizes.

"We have to demonstrate how important value creation is in our own country, how exciting our topics are, and what contribution we make to products and high-tech applications everyone relies on." After all, it's the people who have brought the Plansee Group to where it is today over its more than 100-year history. "We want to find the right talent for every area – people who are also a fit culturally." But the question remains: Where will the next generation for research and industry come from?

Katharina Lammer

We have to demonstrate how exciting our topics are, and what contribution we make to products and high-tech applications everyone relies on.

Gerfried Weiss

Inspiring Interest Early

Katharina was introduced to metals by her chemistry teacher and was encouraged even as a child to experiment and work with her hands. In her view, encouraging this kind of curiosity during childhood and reintroducing hands-on, analog technology into education plays an important role. Montanuniversität Leoben takes exactly this approach. “We offer a variety of programs to fill young people with enthusiasm for the natural sciences – for industry, but also for research. We all need many capable people,” says Helmut Antrekowitsch.

For example, students can simulate recycling processes at the university as part of their school lab classes. Additionally, Montanuniversität is Austria’s only university to require a mandatory internship and employ the most student workers. “Through practical work, pupils and students see what their knowledge can achieve,” he explains.

Personal Connection

The Plansee Group began early on to support and invest in training and education at all levels: from apprenticeships, through its own foundation and the HTL in Reutte, to partnerships with universities. “There isn’t a shortage of skilled workers at every site worldwide, but where it’s difficult, our strength lies in the personal connection,” says Gerfried Weiss. In addition to internships and projects with universities, students regularly visit our sites as part of excursions. “Connecting with employees who make time for them – across all levels up to the Management Board – really resonates with students and pupils,” he explains. One thing is clear: There is still a fascination for natural science and technology, and dedicated young people still exist. Everyone agrees on that.

There is still a fascination for natural science and technology, and dedicated young people still exist.

Gerfried Weiss

Get a comprehensive look at the Plansee Group as an employer and a driver of innovation on our LinkedIn profile.

HELMUT ANTREKOWITSCH began his scientific career at HTL Leoben and first encountered metallurgy there. After working in the industry, he moved on to university, where he continues to be fascinated with exploring the processes from raw material to finished product.

KATHARINA LAMMER is studying metallurgy at Montanuniversität Leoben, a technical university and discovered her interest in the world of metals thanks to her inspiring chemistry teacher. However, she had already been introduced to experimentation and hands-on exploration as a child – encouraged by practical gifts – and sees this as a key factor for inspiring the next generation.

GERFRIED WEISS studied metallurgy in Leoben and for many years worked for a variety of companies in Europe and Africa – primarily with a focus on steel as a material. Nearly five years ago, he entered the world of refractory metals at Plansee HPM and appreciates the personal corporate culture.

“Together with our customers and business partners, we seek optimal solutions for the challenges of the future.”

Competent Reliable Hands-on

Always the right tool at the right time

High-tech applications at the limits of what is technically and physically feasible

Individual Solutions

Knowledge Building & Exchange: The Plansee Seminar as an Innovation Platform

New Product Rate (2024/25)

30%

Priority:
Quality

Keeping a Finger on the Pulse of the Markets

Increasing Customer Success

Kundenerfolg steigern

Accroître la réussite des clients

Our values are the foundation of the Plansee Group. They guide our actions and shape our decisions – both internally and externally. One of our core values is to help our customers around the world achieve even greater success.

For us, this means we are consistently driving innovation: both through our own research and development and through close collaboration with the scientific community and users – including through our Plansee Seminar, one of the world's largest conferences on powder metallurgy. We seek to maintain a high proportion of our revenue from products that are less than five years old.

We develop new solutions for applications at the limits of what is technically and physically feasible, based on the unique properties of our materials – especially where other materials reach their limits. This results in high-tech solutions for future-oriented fields such as the semiconductor industry or energy and medical technology.

This makes us not only a reliable partner with integrity in collaboration, but also a driving force for the sustainable growth of our customers and the development of new markets.

More about our values

Careers Without Labels

The metals industry has traditionally been a male-dominated world. In Germany and Austria, about one fifth of all employees in the sector are women. Yet more and more women are opting for careers in technical professions and are shaping their workplaces.

What matters is not the quota, but equal opportunities. And equal opportunities depend on having the right conditions in place: suitable changing rooms in production, flexible working and parental-leave models for all parents, as well as easily accessible contact points for equality and anti-discrimination topics. In the end, everyone benefits from an inclusive workplace culture.

To raise the profile of this vision, Aurubis, an international company specializing in metal processing and copper recycling, founded the Women4Metals initiative in 2019 – an industry-specific network dedicated to advancing women in the metal sector. The Plansee Group has been a member since July 2025.

Spotlight on Four Career Paths

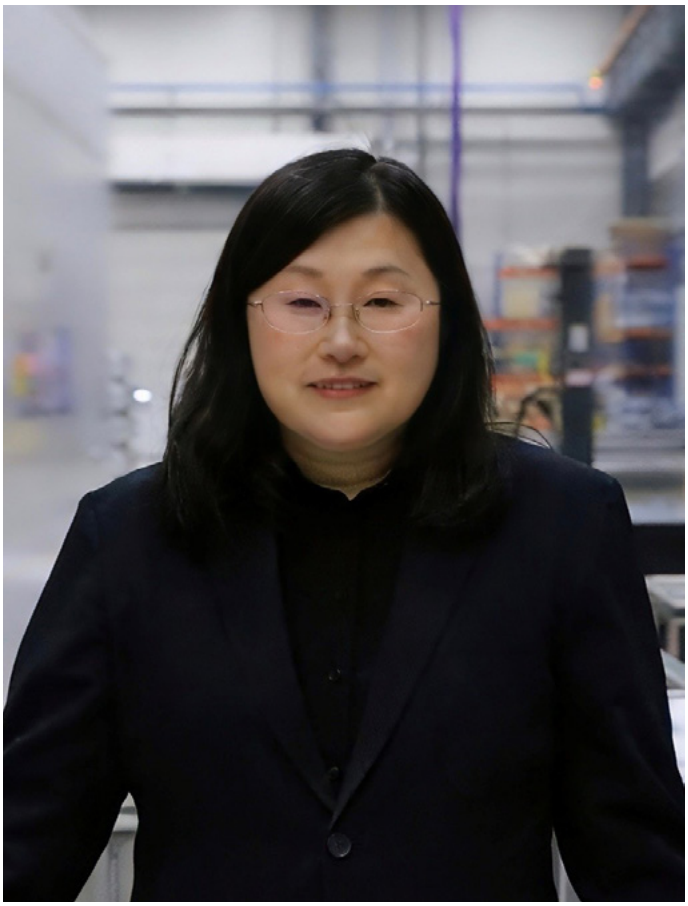
In the 2024/25 fiscal year, the share of female employees in the Plansee Group was 21%. Four of them – from different departments and across different sites – share their personal journeys in the industry and offer insights into their daily work: from the development laboratory and logistics to the training center. In addition, Stefanie Klein, who heads Women4Metals, talks about her vision for the future of the industry.


HYSTER


K. Alhayek

Cindy Sun

“My message to women: don’t hesitate to step into technical roles or leadership positions. The metal industry is evolving, and your contributions can make a real difference.”



Development Department Director at Plansee HPM in Shanghai, China

Why did you choose a career in the metal industry, and how has it developed?

I’ve always been fascinated by the important role that metals like tungsten and molybdenum play in high-performance applications – from electronics to energy systems. Joining this industry gave me the chance to combine scientific curiosity with real-world problem-solving and contribute to innovations that truly matter. I started at Plansee HPM in 2013 right after completing my Ph.D., so this has been my first professional role. Today, I serve as Director of the Development Department in Shanghai, where I lead a team focused on developing innovative materials and processes and driving innovation projects that support our global strategy.

Which skills are particularly important in your job?

Technical expertise in materials science and powder metallurgy is essential. But beyond that, strong analytical skills, project management skills, and effective cross-cultural communication are critical for success. Leadership and adaptability also play a big role because our work often requires balancing cutting-edge innovation with practical manufacturing constraints.

What opportunities do you see when more women work in the industry or take on leadership positions?

Diversity in leadership brings fresh perspectives and fosters innovation. When more women join the industry, it not only challenges stereotypes, but also strengthens collaboration and decision-making. Gender diversity is an important driver for sustainable growth and helps attract the next generation of talent. Plansee HPM has a strong culture of meritocracy and inclusivity. Our company offers equal opportunities for growth, mentorship programs, and actively supports initiatives like Women4Metals, which create a supportive environment for female professionals. My own journey, from R&D engineer to department director, reflects this.

Chelsea Howard

“There are still many times when I’m the only woman in the room. But I've always felt treated equally.”

Supply Chain Manager at GTP in Towanda, USA

How long have you worked in the industry and what are your responsibilities in your current job?

I joined the company in 2016 after earning my degree in Supply Chain Management and working in the steel industry for a year. Today, I’m the Supply Chain Manager at GTP. My main responsibility is to ensure we have the right supply and production capacities to meet the demand for tungsten at GTP and, ultimately, within the entire Plansee Group. I also oversee our warehouse operations. What I really enjoy about my position is the international exposure. We work with colleagues and customers all over the world and collaborate closely with many different production departments. In addition, I’ve always been fascinated by chemistry, and many of the processes here at our Towanda site are chemical in nature.

Which skills are particularly important in your job?

Adaptability is key. Over the past year alone, global supply chains have faced major disruptions. Being flexible and finding alternative business models to navigate changing market conditions is essential. Data analysis is another critical skill. As Supply Chain Manager, I rely on data every day to guide my decisions and optimize processes.

Do you experience or have you experienced challenges as a woman in your field?

Logistics, and the metals industry in general, has traditionally been male-dominated. There are still many times when I’m the only woman in the room. But I've always felt treated equally. At the Plansee Group, my colleagues have always been supportive, and my contributions are valued just like anyone else’s. We work together really well across sites and cultural backgrounds. Despite our differences, we come together as one team. That said, I do think it’s important to educate young women about the opportunities in this field and to highlight the women who are already thriving here.

Kinda Alhayek

“If you really want something, you can learn anything. Be strong and hold on to your dreams.”

Machining Technician at
Plansee HPM in Reutte, Austria

Why did you choose a career in the metal industry?

In 2017, I fled Syria with my family and came to Austria. I couldn’t get my degree in commerce and economics recognized and struggled to find a job in that field. Through the FiT program (Women in Crafts and Technology) in Tyrol, I discovered the profession of machining technician. I had never worked with machines before and had a lot of respect for them, but I did well in math and physics in school, so I decided to give it a try and started my apprenticeship in 2022.

What was your apprenticeship like?

I quickly adapted to working with machines, and the precise work with our metals fascinates me. The language was my biggest challenge – especially the technical terms. I had to work very hard, studying with books, videos, and vocabulary lists late into the night while my husband and I cared for our six children. My family supported me tremendously throughout this. In my second year of training, I even won silver in the apprentice competition – something I am very proud of. During our departmental rotations, I was especially impressed by our production line for X-ray rotating anodes.

What was it like for you to step into this field as a woman?

As a woman in a predominantly male production environment, I have experienced a lot of help and support from my colleagues. Still, it can be challenging to fit in. It would be great if more women took on leadership positions in production, as they contribute different perspectives and can often relate more easily to women’s topics such as childcare or women’s health. I’m proud that, through my training, I can now also repair small things at home. And I’m even more proud that my daughter is now attending a technical school (HTL) with workshop classes here at Plansee Group.

Teodora Zheglova

“I want to show my child that with persistence and hard work, any challenge can be overcome successfully.”

Machine Tool Operator at
CERATIZIT in Gabrovo, Bulgaria

How long have you worked at the Plansee Group, and what are your responsibilities?

I have been with the company since 2023, and for about six months now I have held the position of Machine Tool Operator. My main responsibilities involve preparing and setting up tools to ensure accuracy and precision in the production process. In this job, attention to detail and technological literacy are essential. It also takes analytical thinking and the ability to solve problems quickly and effectively. I chose this profession because I like to work accurately and precisely. I like the challenge of delivering high quality and contributing to processes that require real technical expertise.

What was it like for you to step into this field as a woman?

It was a challenge because most people in this field are men, and in the beginning, it was difficult to establish myself as a professional. But the corporate environment helped me by showing that no distinction is made here between genders: Knowledge and skills are what matter. As a single mother, I had to reconcile my career with my responsibilities at home. My child is my motivation to keep developing professionally. The company supports me in this by giving me different opportunities to continue my education. I am currently attending university.

What opportunities do you see when more women work in the industry or take on leadership positions?

I believe that when more women join the industry, it opens doors to equality even wider and introduces new perspectives. I would like to tell all women not to be afraid to choose professions that are traditionally considered male. It is important to believe in yourself and to know that success is a matter of knowledge, skills, and perseverance – not gender. Every woman can be strong and confident in this industry if she has the desire to grow.

Stefanie Klein

“Sometimes you have to make yourself visible so that others can follow. Visibility provides direction for other women.”

Head of the Women4Metals initiative at Aurubis AG in Hamburg, Germany

What fascinates you personally about the metals industry?

The combination of substance, international reach, and impact. Metals are the basis for almost all future technologies, from energy transition to digitalization. At the same time, the industry is very honest: things have to work, processes have to be effective, and responsibility has to be taken. And I love closing cycles.

What advice would you give to young women who are interested in the industry but may not consider it, for example because it is male-dominated?

Don't be put off by old stereotypes. The industry is often different from how it appears from the outside. Male dominance does not mean that there are no opportunities. Stay curious. Ask questions. Forge ahead and stay true to yourself, even if you don't see any role models at the beginning. Find allies, networks, mentors, and supporters. No one walks this path alone.

How can companies contribute to equal opportunities and an inclusive atmosphere?

By looking and listening honestly. Equal opportunities are not created by individual measures, but by structural changes: transparent career paths, fair evaluation processes, managers who take responsibility, and a culture that takes different realities of life into account. It's not about “fixing” women. It's about changing the systems that create inequality. It's also important to actively involve employees. Only then can good intentions have a real impact.

How do you envision the metal industry as an employer in 10 or 20 years?

I would like to see a metal industry in which diversity is a given and doesn't need explanation. An industry that takes people in different stages of life into account, retains and promotes talent, and where performance counts, not conformity. With Women4Metals, we want to contribute to exactly that. My goal will be achieved when the initiative and I are no longer needed in this position. Then the system will be ready.

STEFANIE KLEIN has worked at Aurubis, a Hamburg-based metal processing and copper recycling company, for 15 years, where she heads the Women4Metals initiative. Her vision is to establish the metal industry as an attractive employer for women, with fair conditions for all.

Active projects at the Plansee Group:

- The Plansee Group is looking for the best talent – regardless of gender – for a wide variety of tasks and leadership positions. Everyone should feel comfortable and respected and have the opportunity to grow and contribute to the company's shared success.
- The Employer of Choice initiative is working on a clear vision and specific measures to make our company an even more attractive employer and to create an inclusive and supportive workplace for everyone. This will allow us to attract, retain, and promote talent.
- The internal FeMales@Plansee network and the Culture Department organize presentations, networking events, training courses, and workshops on topics such as intercultural cooperation and awareness.
- Specially appointed contact persons in a pilot project offer advice on equality, discrimination, bullying, and harassment at the workplace.

Uniquely Diverse

Tungsten wire has a dramatic history:
The element was discovered by chance because it consumed tin. It became globally sought-after to illuminate the world. Rediscovered to advance digital medicine. What its turbulent history shows:
The element and its wire offer many unique features.
This also ensures its future.

Voracious as a wolf – The Mysterious Background

At first, tungsten was a major nuisance. Mining historians first reported in the mid-16th century about a mineral that caused problems in the mines. Tin ore laced with this element turned into slag during smelting, making it impossible to extract the tin. Like a wolf tearing apart a flock of sheep, this substance "devoured" the tin ore. The Saxon scholar Georgius Agricola, founder of modern mineralogy, described the mysterious mineral as "lupi spuma" – "wolf's spit."

In the mid-18th century in Sweden, mineralogist Axel Frederic Cronstedt searched for previously unknown rocks with his blowpipe. In a mine, he found a stone laced with a substance and noticed it was heavier than stones of the same size without the element. So he called it "tungsten" – "heavy stone." He had stones with similar properties sent from Freiberg in Saxony, which has been home to a mining academy since 1765. These minerals were of the same type as those previously discovered by Georgius Agricola.

Starting in 1780, German-Swedish chemist Carl Wilhelm Scheele began researching this substance. He managed to extract an acid from the heavy stone: tungsten-syra. Two Spanish chemists continued the experiment, using carbon reduction to produce small metallic spheres from the acid. They called the isolated element "wolfram," in reference to the name Agricola gave the substance.

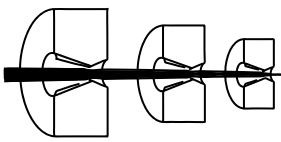
Soon, confusion began over the naming of the new element: In Germany, people initially tried to eternalize Carl Wilhelm Scheele, but the term "Scheelium" did not catch on. In English and French, the term "tungsten" remained. Ironically, the Swedes – whose language the word originated from – adopted, along with the Spanish and eventually the Germans, the name "wolfram." There have been repeated attempts to standardize the designation worldwide. For a while, "wolfram" was considered the global name of the element, and its symbol in the periodic table is W. Currently, "tungsten" is the official designation again, but both names are still used.

A Light Comes On – The Race for the Best Filament Element

The phenomenon that certain wires glow when electric current is passed through them was already known at the start of the 19th century. The big question that occupied researchers worldwide throughout the century: What should such a filament and its environment look like so that an electric lamp burns as long as possible without the wire breaking or melting?

Thomas Alva Edison is commonly considered the inventor of the light bulb, but English physicist Joseph Wilson Swan had already developed a workable model two years earlier, equipped with a carbon filament of high electrical resistance. Edison's achievement was to improve the technology and industrial scalability. He realized this was a potential mass product, and so, starting in the 1880s, with the introduction of the Edison lamp, the electrification of the world began. The lamp industry invested heavily in optimization, realizing that carbon filaments were not the final answer. Alternatives existed, especially osmium and tungsten, two metals with very high melting points that prevent the filaments from melting at temperatures up to 3,000 degrees Celsius (5,432 degrees Fahrenheit).

Enter Carl Auer von Welsbach. The entrepreneur from Vienna was not only the discoverer of four chemical elements but also a man of brilliant ideas. He invented the gas light mantle (also known as "Auerlicht") and the flint in lighters ("Auermetall"). In 1898, he developed the first metal filament lamp using osmium. Auer pulverized the element, formed it into a thread, carbonized it, and

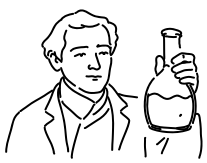


around 1530

Georgius Agricola discovers a mineral in the Ore Mountains that seems to consume others and calls it "wolf's spit."

1751

In Sweden, mineralogist Axel Frederic Cronstedt finds a stone in the mountain that is laced with a similar substance and heavier than expected. He calls it "tungsten" – heavy stone.



around 1780

Chemist Carl Wilhelm Scheele extracts an acid from the "tungsten." Today we know: it's calcium tungstate.

wound it into a filament. The result: the light was bright and white, and above all, the lamp lasted longer. Demand for electric lamps soared, and companies like Siemens, Philips, and General Electric dominated the market, along with Auer's company. It was clear: the light bulb would be a unique success story.

The problem: Osmium is rare and therefore expensive. A competition began on two fronts. First, who would secure the limited osmium deposits? Second, who would find an alternative to the rare and brittle osmium? It soon became clear that tungsten was the better candidate. It was more abundant and additionally easier to process. "Tungsten has an unmatched melting point of 3,422 degrees Celsius, or 6,192 degrees Fahrenheit," says Uwe Schleinkofer, Director of R&D at CERATIZIT, a business area of the Plansee Group. "Tungsten is also brittle, but: under certain conditions it remains a malleable material. That means it can be processed industrially – a fundamental requirement for technical innovation."

Like many other researchers at the time, Carl Auer von Welsbach adapted his approach. He coated the carbon filament with tungsten powder and called the improved lamp "Osram" – a portmanteau of osmium (the idea's inspiration) and tungsten (the optimal element). From 1919, the company he founded bore this name. Today, the Osram brand still reminds us of the brief time when osmium and tungsten competed for the best filament material.

The Alchemist at Lake Plansee – Paul Schwarzkopf and His Patents

Paul Schwarzkopf, born in Prague and educated in Berlin, was working at the Italian lamp factory Lampada Zeta when he developed a method to manufacture tungsten wire industrially. He used the technique of powder metallurgy: Tungsten ore becomes tungsten oxide, which is turned into powder. Heating this powder to up to 3,000 degrees Celsius (5,432 degrees Fahrenheit) yields a workpiece with tremendous density, hardness, and strength, but which still remains malleable. Powder metallurgy made tungsten manageable and industrially scalable. "Paul Schwarzkopf didn't invent tungsten wire, but he was undoubtedly the pioneer of industrial production," says Alexander Tautermann, Director of Marketing and Sales at Plansee HPM, also part of the Plansee Group.

The alchemists of the Middle Ages tried to turn base metals into gold. Paul Schwarzkopf, the alchemist of the electric age, created a wire from "wolf's spit" that illuminated the world.

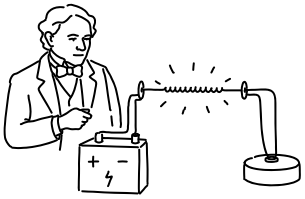
Back in Berlin, Schwarzkopf foresaw the tremendous global demand for filaments in the early 1920s. He also recognized the high energy demands during production and decided to locate industrial production of tungsten wire where energy was less expensive than in Berlin. He read in the newspaper about a new hydroelectric plant at Lake Plansee in Austria. He quickly founded Metallwerk Plansee GmbH in Reutte in 1921, the ancestor of today's Plansee Group.

Only Tungsten Conquers Tungsten – The Invention of the Drawing Die

Manufacturing the wire remained a technical challenge. Tungsten is extremely abrasive due to its hardness. It grinds down and wears out other materials, making this metal difficult to work and shape. Schwarzkopf's idea: Only tungsten itself can handle tungsten. He developed the drawing die, which like the wire is made from tungsten processed in this application to carbide. This is still produced today by CERATIZIT. "You feed a wire that has too large a diameter into the smaller hole of the die and pull it through with tremendous force, so it comes out thinner at the end," explains Uwe Schleinkofer about the principle of plastic deformation. Paul Schwarzkopf

1782

Spanish mineralogist Juan José Elhuyar and his brother Fausto use coal to reduce the acid described by Scheele into metallic powder spheres. They name the new element tungsten.

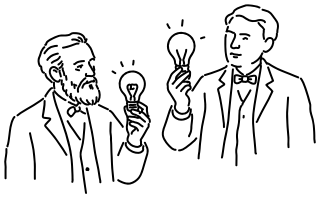


1801

In France, chemist Louis Jacques Thénard shows that metal wires can be made to glow with electricity, producing light.

around 1850

Several chemists patent light bulbs. The problem: the burn time is short, then the wire breaks or melts.



around 1880

First Joseph Wilson Swan, then Thomas Alva Edison, develop the first lamps that are suitable for everyday use and burn longer, but continue to rely on carbon filaments.

The world we live in wouldn’t exist without without hard metals.

Uwe Schleinkofer

patented both the industrially manufacturable tungsten wire and the drawing die. “With these two innovations, he renewed the entire production process,” says Alexander Tautermann.

Drawing dies are still in use today as an example of carbide tools – the expertise of CERATIZIT. For these, brittle hard materials like tungsten carbide are bonded with tough metals. The result: a compound that combines the positive properties of both – hardness and toughness. The impact of carbides on the world of technology is hard to overstate, adds Uwe Schleinkofer. “The world we live in wouldn’t exist without carbide. We wouldn’t be able to process metal efficiently enough to build cars, ships, or tunnels."

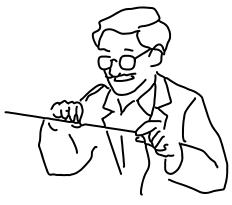
Suddenly Obsolete – As the Light Bulb Fades Out, Tungsten Wire May Vanish With It

For decades, the worldwide hunger for tungsten wire was almost insatiable. The major lighting manufacturers long ago began producing their own filaments. “They’re the heart of every lamp. If the tungsten wire is good, the bulb is good. If not, then not. That’s why manufacturers took production into their own hands,” says Uwe Schleinkofer. Plansee HPM, specializing in the manufacturing of tungsten wire, discontinued production for light bulbs in the 1960s because the lighting industry no longer needed a supplier.

For decades, the light bulb was a successful mass-produced item worldwide, illuminating millions of homes. Starting in the 2000s, it suddenly faced criticism – and was ultimately phased out. The reason: its poor energy efficiency. Only five percent of the electricity used is converted into light energy, the rest is wasted as heat. The use of new LED lamps saves up to 90 percent energy. That’s a compelling argument in times of the climate crisis.

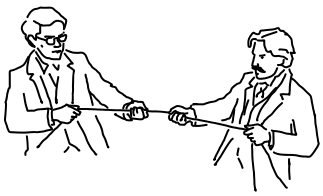
Australia was the first country to announce the end of the light bulb in 2007. Soon after, an EU directive stated that the conventional light bulb would also be phased out in Europe starting in 2009. Newspapers and magazines immediately published sentimental tributes to the lamp equipped with the tungsten wire. Süddeutsche Zeitung wrote: “The world is getting cooler.” Der Spiegel said goodbye with: “Wiry, hot, a superstar.” Kronen Zeitung kept it brief: “Burned out!” Deutschlandfunk even reported that enthusiasts were panic-buying hundreds of bulbs before they disappeared.

Like the light bulb itself, tungsten wire became a “product that was no longer needed” starting in 2009, as Michael Mark, Head of R&D at Plansee HPM, put it. After decades of extreme demand, it became a commodity with massive overcapacity. But precisely this oversupply was an opportunity. Specialists in the companies began searching for alternative uses. “Their thinking was very pragmatic,” says Alexander Tautermann, “along the lines of: We have this surplus fine wire – where else could its diverse properties help?”



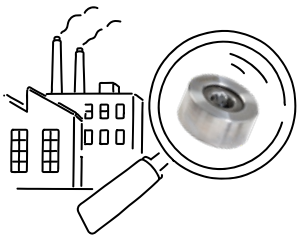
1889

Carl Auer von Welsbach uses osmium, a fracture-resistant metal with a high melting point, for the wires.



around 1900

Researchers experiment with wires made of a metal that is even more fracture-resistant and has a higher melting point, but difficult to process: tungsten.



1921

Paul Schwarzkopf founds a company in Reutte on Lake Plansee that industrializes tungsten wire production. Drawing dies, which are also made of tungsten, are used in the process.

post World War II

Light bulbs with tungsten wire are standard in households.

Risen from the Ruins – The Comeback of the Tungsten Wire

Overcapacity became a driver for innovation. Tungsten wire found a new use in modern digital medicine. Here, wires are needed that, despite minimal diameter, are absolutely resistant to breaking. That bend without losing their shape. And that are well tolerated by the human body. In all these aspects, ultrafine tungsten wire, with a minimal diameter of up to 0.01 millimeters, excels. “In medical robots, bundled tungsten wires are used for control during precise and minimally invasive procedures,” Michael Mark recounts as one example. Tungsten wires are also used as guidewires during catheter surgery. Used as the tips of surgical wire instruments, they help cut or ablate internal vessels with electrical impulses or high temperatures.

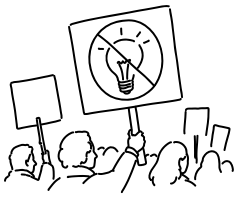
Another distinguishing feature of tungsten is its immense stiffness. In materials science, this is referred to as a high modulus of elasticity. This value describes how much a material deforms elastically under mechanical tensile stress. Rubber has a very low modulus. Steel has a high one. Tungsten has the highest among metals, five times higher than gold. “That enables the mechanical precision required in modern medical technology,” says Uwe Schleinkofer. “Simply put: tungsten wire doesn’t wear out.”

Fine tungsten wire also demonstrates its properties in automobile windshields. You won’t see it there – it would block the view. The glass contains ultra-fine embedded wires that function as heating elements wires to prevent fogging and ice formation. The fine wires are also used in shipping as protection against frost.

Since tungsten wire is once again more of a specialty than a mass product, the market has changed again. Major lighting manufacturers have switched to LED lamps and stopped producing filaments. Production returned to specialty companies. Plansee HPM is once again one of them – and has a major advantage over the competition: It always has enough tungsten in stock.

By far the largest tungsten deposits are in China, which supplies three-quarters of global demand. “Plansee HPM is the only tungsten wire manufacturer that is independent from China,” says Uwe Schleinkofer. How do they make it possible? “Almost 90 percent of the tungsten we use comes from recycling. It’s not an easy process, but we’ve mastered it.”

Is there a possibility that tungsten wire, given its adventurous and eventful history, will someday be obsolete? “Unlikely” – all three experts agree. The material is simply too uniquely diverse.

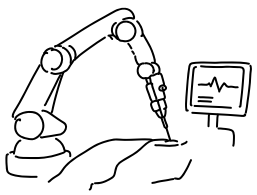


1996

The first white-light LED lamps hit the market, and criticism of the light bulb grows due to low energy efficiency.

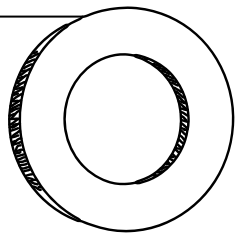
2009

An EU regulation determines the gradual phase-out of the conventional light bulb.



since 2010

Tungsten wire, no longer needed for lamps, finds application areas in future technologies such as medical robotics.



Tungsten Wire and Drawing Die

UWE SCHLEINKOFER
is Director of Research & Development at CERATIZIT and is responsible for developing innovative carbide solutions from the Reutte location. His goal: turn visions into market-ready products and create added value for customers.

ALEXANDER TAUTERMANN
is Director of Marketing Communication & Sales at Plansee HPM and has shaped the global communication and sales strategy of the business area for almost ten years. The customer is at the center of his day-to-day work.

MICHAEL MARK
is Head of R&D for Refractory Metals at Plansee HPM. The physicist has been with the company for twelve years and develops innovations for a wide range of customer applications with his team.

The Finest Threads That Save Lives

Human Hair

Fine Tungsten Wire

Fine tungsten wire is the Plansee Group's longest-standing product. It has been manufactured by the Plansee HPM business area for over 100 years. Initially used as filaments for electric lighting, it now plays a crucial role in medical technology. (More on page 50) The wire really shows its strengths in modern surgical robots: These high-precision systems assist doctors during complex procedures on the heart, kidneys, or lungs, for example. To do this, the wires must be biocompatible, extremely reliable, and ultra-fine: The fine tungsten wire achieves a minimum diameter of up to 0.01 millimeters. By comparison, a human hair is nearly eight times as thick. At the same time, the wire is extremely flexible, crack-free, and durable. Teams at our sites in Reutte and India, who collectively bring decades of experience to the table, work on its production. They ensure that an almost invisible product regularly helps save lives.

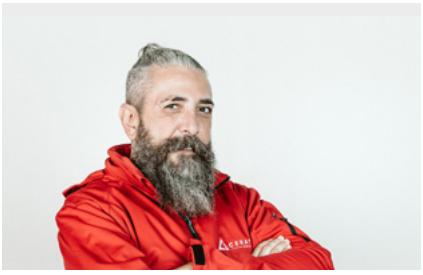
It Will Take Renewed Courage

The economic situation of European industrial companies is challenging and complex. A multitude of factors are causing costs to rise, uncertainty to grow, and markets to become tighter. Are companies still competitive? And what levers do they have at their disposal to improve their position? We asked Dr. Klaus Wohlrabe, Deputy Head of the Center for Macroeconomics and Surveys at the ifo Institute for Economic Research.

THE INTERVIEWEE

KLAUS WOHLRABE heads the survey department at the ifo Institute for Economic Research. For 22 years, his job has been to survey the atmosphere in the German and European economies. He seeks to understand earlier than others how the business cycle is evolving and which factors are preventing economic growth?

THE ARTIST



MASSIMO BENI is an IT Application Support Consultant at CERATIZIT in Luxembourg, where he has integrated SAP processes worldwide for over 30 years. He painted the cover image for this article. His artwork is a reflection of his professional approach: reducing complexity to its essence and transforming it into expressive clarity.

Competitiveness

There is currently a lot of talk about the disadvantages of Europe as a business location in global competition. Is there any truth to this?

Europe as an economic region is indeed currently facing an extraordinary spike in structural challenges. Companies are faced with a number of issues – all at the same time: decarbonization of their production processes, digital transformation including artificial intelligence, the demographic-driven shortage of skilled workers, and an increasingly uncertain geopolitical environment.

To what extent are Germany and Austria particularly affected?

Both economies are highly industrial- and export-oriented. In addition, there are location-specific burdens such as high energy prices, growing regulatory requirements, lengthy approval processes, and shortcomings in transport and digital infrastructure. These factors weaken the international competitiveness of exactly those industries that have so far formed the backbone of economic success in Germany and Austria.

How do geopolitical tensions and trade barriers affect competitiveness?

Both are additional stress factors. The fragmentation of the global economy, trade conflicts, sanctions, or industrial policy measures from other economic areas increase uncertainty, costs, and planning risks. Global value chains become more susceptible to disruptions, procurement and logistics become more expensive, and investment decisions become more difficult. In addition, China is now operating on par with the West, even among upscale products. As a result of this multitude of factors, the competitive position of European providers in world markets is under pressure.

Is there a lever to improve this position again?

Competitiveness is only created in the long term if investments in research, new technologies, digitalization, and scaling are facilitated. What matters less is the individual funding measure, and what matters more is a combination of sufficient access to capital, fast approval processes, predictable regulatory frameworks, and technological openness. For example, decarbonization can only become a strength if it is combined with innovation, productivity gains, and globally competitive cost structures.

How does the Plansee Group handle this?

Chairman of the Executive Board Karlheinz Wex responds to the challenges and courses of action outlined by the ifo expert.

Digitalization and artificial intelligence?
Digitalization has been a central element for us for decades in becoming more efficient and competitive. Artificial intelligence helps us further automate standardizable tasks and expedite the development of new applications.

Geopolitical tensions and trade barriers?
Conflicts create uncertainty among our customers, and trade barriers complicate our ability to conduct business globally. All of this has a noticeable impact on demand and is ultimately a strain on overall economic development.

US tariffs and "America First" policy?
The USA is a key sales market for us. Tariffs make our products manufactured in Europe more expensive and weaken our competitive position. For technological reasons, we cannot manufacture all of our products locally in every region. I am convinced that open markets are ultimately more beneficial for everyone involved in the long run.

So climate protection must also be worthwhile economically.

Yes, because without this three-part balance, Europe risks falling further behind the USA and China. In general, we need more courage and a willingness to take risks again. Recently, parts of German industry have tended to rest a bit on their laurels.

Climate protection & cost-efficiency?
For us, these go hand-in-hand: sustainable action is not only crucial for the environment and society, but also for the long-term success of a company.

What political measures at the national level could provide positive momentum for industrial companies in Germany and Austria?

In the short term, it would help if national governments provided tax incentives for investments, significantly reduced bureaucratic hurdles, and expedited planning and approval processes. Corporate investments in particular have been very weak of late. More needs to happen here, because a lack of investment weakens tomorrow's competitiveness. Policymakers should also take steps to reduce energy and electricity costs for industry and strengthen the transport, energy, and digital infrastructure. Initiatives to secure enough skilled workers are also essential. Here, topics such as training, continuing education, and a more pragmatic immigration policy play a role. Interestingly, many of these measures do not require entirely new programs. What matters more is that policymakers consistently prioritize and efficiently implement the instruments that already exist.

Inflation and high energy prices?
Energy costs in Central Europe continue to be significantly higher than before the war in Ukraine. Labor costs in Austria and Germany have also risen at above-average rates. This impairs our competitiveness at these major production sites – not only globally but also compared to other European countries.

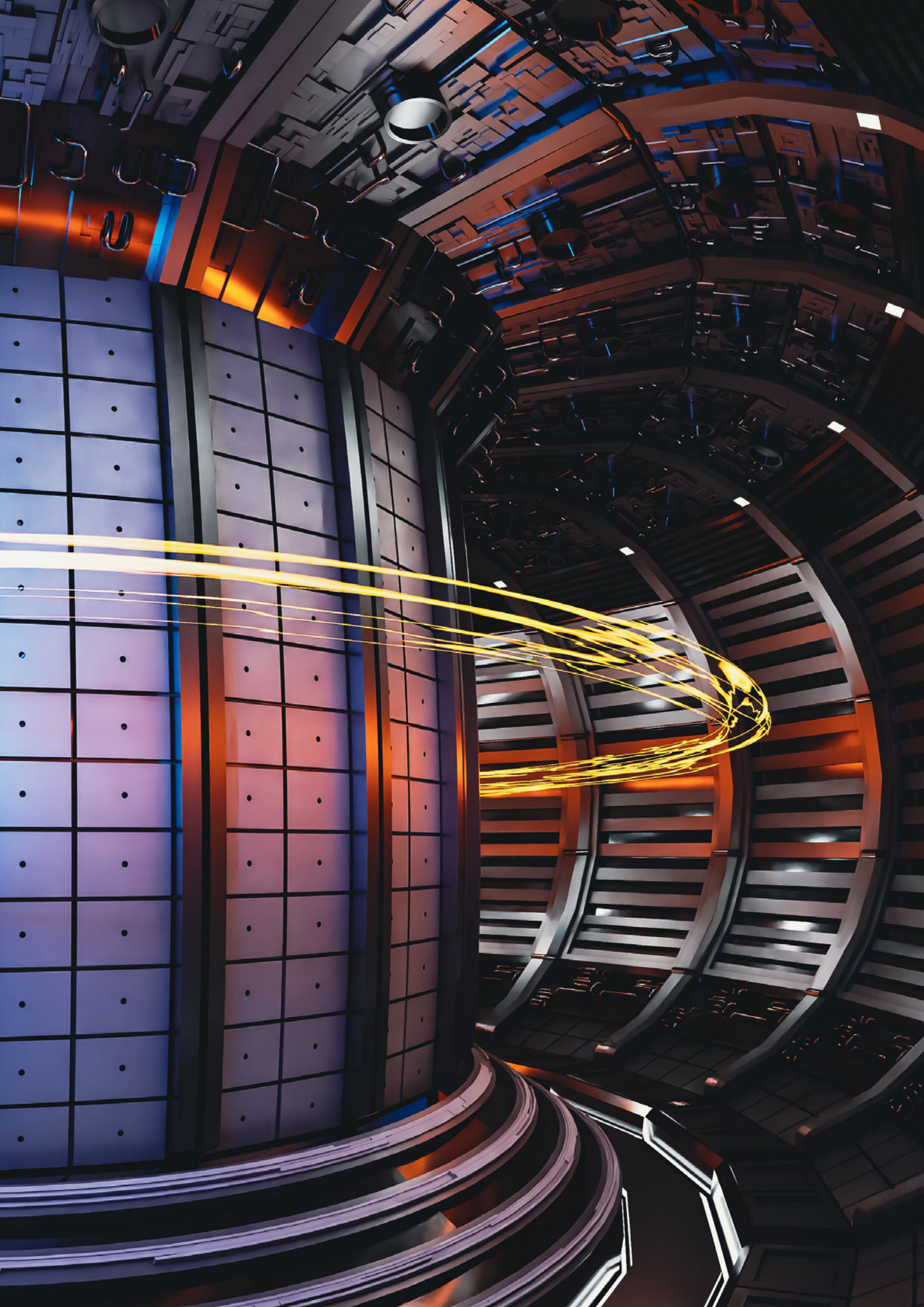
To what extent is it necessary for industrial companies in Germany and Austria to reorganize their value chains?

Particularly when it comes to critical raw materials, intermediate products, and key technologies, it is advisable to rely more on European or Western value chains. There is currently an awakening taking place in this regard, accompanied by the realization that dependence on China is very high, especially for many critical raw materials. The goal should not be self-sufficiency, but rather strategic resilience and flexibility. This is achieved by building robust and diversified supply chains with reliable partners. While this necessary diversification of supply chains will be associated with higher costs and tie up organizational resources for companies in the short term, in the long term companies will reduce dependencies and increase supply security. At the same time, Europe's economic stability and geopolitical capacity to act will also improve. In terms of costs, it is crucial that companies design their strategies for greater resilience efficiently. Otherwise, costs will rise permanently compared to other economic areas – and it will become even harder for industrial enterprises to remain competitive.

Diversification of supply chains?
Our top priority is to ensure a stable, independent, and sustainable supply for our customers. For our tungsten production, we ensure an independent supply situation for all major regions of the world – based on three pillars: collecting tungsten scrap, enhancing and optimizing our recycling technologies, and long-term purchase agreements with mine operators. We have also secured the supply for our molybdenum production – mainly through our 20 percent stake in Molymet, the world's largest processor of molybdenum concentrates.

On the Path to Energy Transformation

Nuclear fusion is considered one of humanity's greatest dreams: nearly inexhaustible energy, much safer than nuclear fission. This principle has been operating in the sun for billions of years. Yet on Earth, under completely different conditions, researchers have reached the limits of what is physically and technically possible. Extreme temperatures, enormous forces, and materials that must permanently withstand these conditions pose tremendous challenges for this form of energy generation. What role does tungsten play in the process, how close is the research to practical implementation, and where do the hurdles still lie? This is a journey in six stages.
The starting point is our sun.



1

Inside the Sun

The sun is a gigantic power plant that generates enough energy for an entire planetary system. How it does this is now very well understood.

There is always something happening inside the sun: hydrogen fuses into helium. This is highly unusual, since positively charged hydrogen nuclei normally repel each other. However, the enormous pressure, the temperature of 15 million Kelvin, and a quantum mechanical effect ensure that two colliding hydrogen nuclei eventually merge into a single helium nucleus in several steps. The total mass of the resulting helium nuclei is slightly less than that of the hydrogen nuclei; the resulting mass difference is converted into energy. You can still feel this energy some 93 million miles away when people, literally, recharge through sunlight exposure.

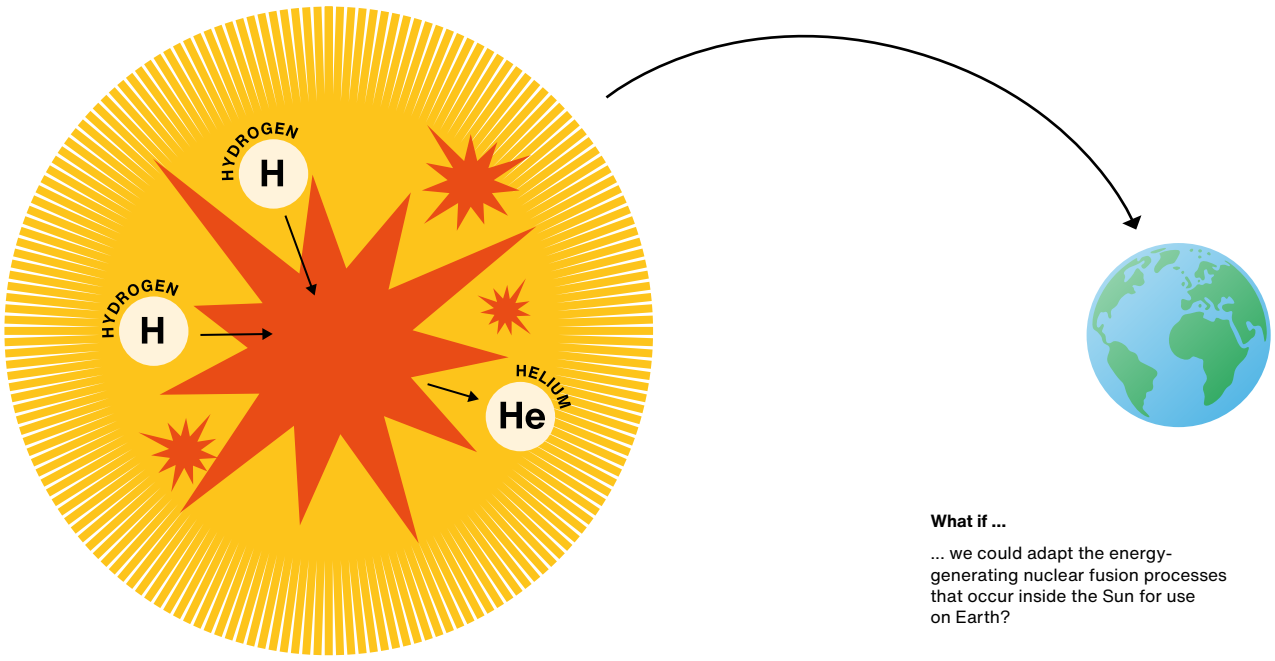
2

The Sun's Method on Earth

So what if we adapted the method from the sun's interior for use here on Earth?

Before we go any further, let's take a step back: Isn't it risky to use a second form of atomic energy alongside nuclear fission, as is utilized in nuclear power plants? "No, this form would be safe," says Dr. Arno Plankensteiner, Director of Corporate Research at Plansee HPM, a business area of the Plansee Group. "Nuclear fusion does not produce uncontrollable chain reactions and only creates medium-level radioactive material, which has a much shorter half-life than the highly radioactive waste from fission."

"Would be," said Arno Plankensteiner – in the subjunctive. Because after years of research, it's clear: as ingenious as the idea is to bring the sun's method to Earth, implementing it is difficult. "Physics is ready," says the Plansee HPM expert. "But technology is hitting its limits."



What if ...

... we could adapt the energy-generating nuclear fusion processes that occur inside the Sun for use on Earth?

3

The Lightning Chamber

Instead of fusing hydrogen atoms like in the sun, on Earth it makes sense to fuse a few grams of a gas mixture made of the elements deuterium and tritium. The gas mixture is introduced into a giant, evacuated container shaped like a torus – imagine a giant donut or inner tube. There, the mixture is heated to up to 150 million Kelvin. At this temperature, electrons and atomic nuclei separate. This creates an electrically conductive plasma – a state of matter we all know from lightning during thunderstorms. Surrounding the torus-shaped plasma chamber are superconducting electromagnets that generate a very strong magnetic field. They ensure that the plasma is confined in the chamber and does not come in contact with the container walls. This is crucial, because even brief contact with the wall would immediately cool the plasma – and the process would collapse. The nuclear reaction occurs when deuterium and tritium fuse to form helium. Neutrons are released, carrying enormous kinetic energy. This energy is converted into heat in the outer shell of the container, which in the next step is converted into electrical energy via a turbine. The entire process is highly complex and susceptible to disruptions. The current record, however, is impressive: In February 2025, the French research reactor WEST succeeded in keeping the plasma "burning," as researchers call it, for a little more than 22 minutes. During this time, the interior of the container reached an almost unimaginable level of heat. "There are gigantic heat flows. We're talking about 20 megawatts per square meter," says Arno Plankensteiner. What's needed is a material that can act as the "first wall" and is able to absorb this energy and transfer it out of the container without sustaining damage. "That's the design criterion," says Plankensteiner. "This material must withstand stresses that don't exist anywhere else in industry." Also important: The material itself must not be toxic and must be available in sufficient quantity on Earth. For example, this is not the case with beryllium. "Which makes this promising candidate unsuitable," Plankensteiner adds.

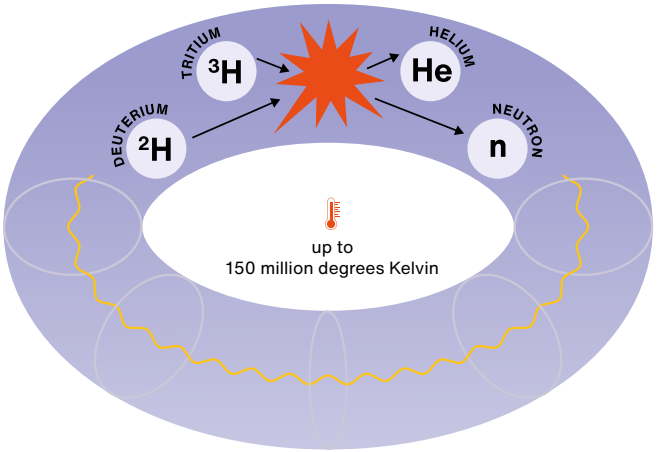
4

The Winner Is – Tungsten

Enter tungsten. It has the highest melting point of all metals: 6,192°F (3,422°C). It also has high thermal conductivity and shields against high-energy radiation, which is important because the material in the reactor is constantly bombarded by neutrons.

Since the early 1990s, Plansee HPM has been researching the use of tungsten as the material for the "first wall," which is essentially a high-performance heat exchanger. A genuine business with a future. Except: When will this future become the present?

Arno Plankensteiner tempers excessive enthusiasm, saying that it could still take several decades before the first commercial fusion reactor is built. There are more optimistic scenarios, but "since there are still many problems to be solved, which are all interrelated, it's wise to have realistic expectations."



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W
Tungsten

as a material for the "first wall"

- the highest melting point of any metal
- high thermal conductivity
- high shielding effectiveness against high-energy radiation

Physics is ready.

Arno Plankensteiner

5

A Long-Term Goal

Nevertheless, the public sector is investing billions in nuclear fusion, and a growing number of private companies are getting involved in the research, development, and construction of fusion reactors – without making profits yet. Behind this is the realization that energy supply is one of the biggest challenges of the future, and nuclear fusion may be an answer. In October 2025, the German government decided to increase funding for fusion research, aiming for the world's first commercial fusion reactor to be built in Germany. But even politicians know: Fusion is not a short-term solution. "Significant technological challenges still must be overcome on the path to the first fusion power plant," the German government stated. It will take a joint effort by industry and science for this to succeed.

ARNO PLANKENSTEINER is Director of Corporate Research at Plansee HPM in Reutte, Austria, and has been with the company since February 1998. He studied mechanical engineering at the Vienna University of Technology and received his doctorate there in numerical engineering methods and material mechanics.

6

Incidental Discoveries

It's common in research, while pursuing one goal, to discover insights that are also valuable elsewhere – what you might call "incidental discoveries." For example, Plansee HPM gained valuable knowledge while developing heat exchangers capable of withstanding the heat flows from nuclear fusion. One such aspect is understanding how materials behave under extreme conditions. "These insights helped us not only develop heat exchanger components that withstand extremely high surface temperatures, but also determine material properties that we wouldn't have identified without the demanding requirements of nuclear fusion. They're now used in areas like medical technology," says Plankensteiner.

Besides tungsten, carbon fiber-reinforced graphite is also a material considered for the fusion reactor. What researchers learn about its properties is used wherever it's already commercially applied, such as in the brake discs of large aircraft or the rocket engines of Europe's Ariane launch vehicles.

Valuable "incidental discoveries" also result during the development of the technology needed outside the plasma vessel of the fusion reactor. "For example, we need energy technology, plant engineering, and measurement technology to convert the thermal energy from the fusion into steam and then into electricity," says Arno Plankensteiner. Alongside major companies and research institutions, well-funded start-ups are becoming increasingly involved, bringing with them unconventional ideas and bold approaches. "This creates networks that, in turn, generate new knowledge – for example, measurement techniques for extreme conditions using sophisticated sensors to analyze and control the complex processes inside the plasma vessel," says Plankensteiner.

In Brief

New Horizons

Supporting young people on their journey toward a professional future is the focus of the Sindbad mentoring program. The fourth season kicked off at the Reutte location in winter. Eight colleagues are assisting eight students from the region as they transition from school to the next phase of training or work. Over the course of a year, the mentoring pairs get to know each other, gain shared experiences, and explore future opportunities – ranging from help with job applications and company visits to simply being a good listener.

Making Health Visible

Health at the workplace is more than just a topic of conversation. In December, a cross-departmental project team at the Kempten location organized a four-day health week in cooperation with other sites and with support from Techniker Krankenkasse as the health partner. The event focused on mental health, nutrition, exercise, and workspace design. Expert lectures and practical activities—from reaction tests to mindfulness stations – provided inspiration for strengthening health in everyday work and beyond.

Bronze for Our Trainees

In November, Austria's best young professionals gathered in Salzburg for AustrianSkills, the national job championships. For three days, it was all about precision, concentration, expertise, and qualification for international competitions. Among the participants was Sophie Hikel, an apprentice at the Reutte training center. In the Chemical Laboratory Technology category, she earned third place, missing out on victory by just a few points: a mere four points out of 800 stood between gold and bronze.

Fighting Environmental Pollution

For World Cleanup Day 2025, 433 employees worldwide joined forces for a collective campaign against environmental pollution. Together with family and friends, 778 participants gathered at 15 locations – from Romania to Brazil, from India to Luxembourg. In and around these sites, 7,659 kilograms (over 16,800 pounds) of waste was collected. Depending on the region, the cleanup effort was supplemented with environmental education, school cleanups, or initiatives against digital data waste.

Award-Winning Research Partnership

The Vienna University of Technology, Oerlikon, and the Plansee HPM business area received the 2026 Houska Prize for a joint research project. The project took first place in the “University Research” category. The focus is on innovative, micrometer-thin coatings for high-temperature applications that make gas turbine components more resistant to heat, oxidation, corrosion, and erosion, thereby extending their service life by more than 50%. The project was led by Helmut Riedl (TU Vienna) together with Peter Polcik (Plansee HPM) and Klaus Boebel (Oerlikon).

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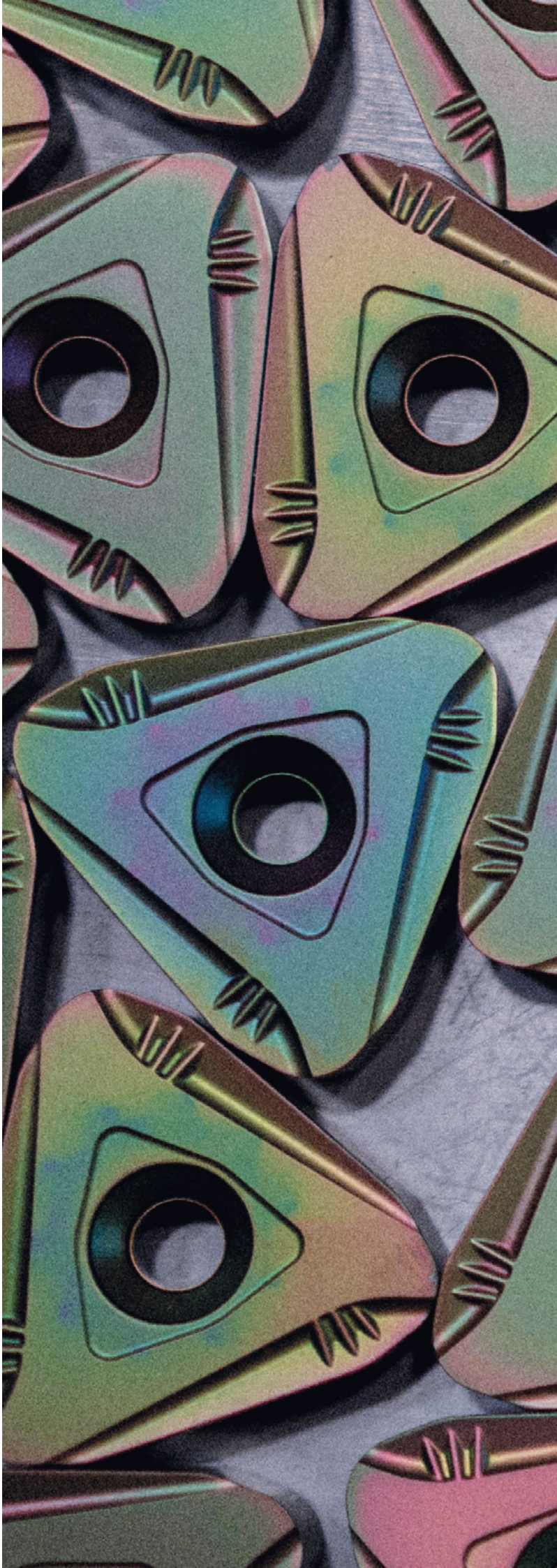

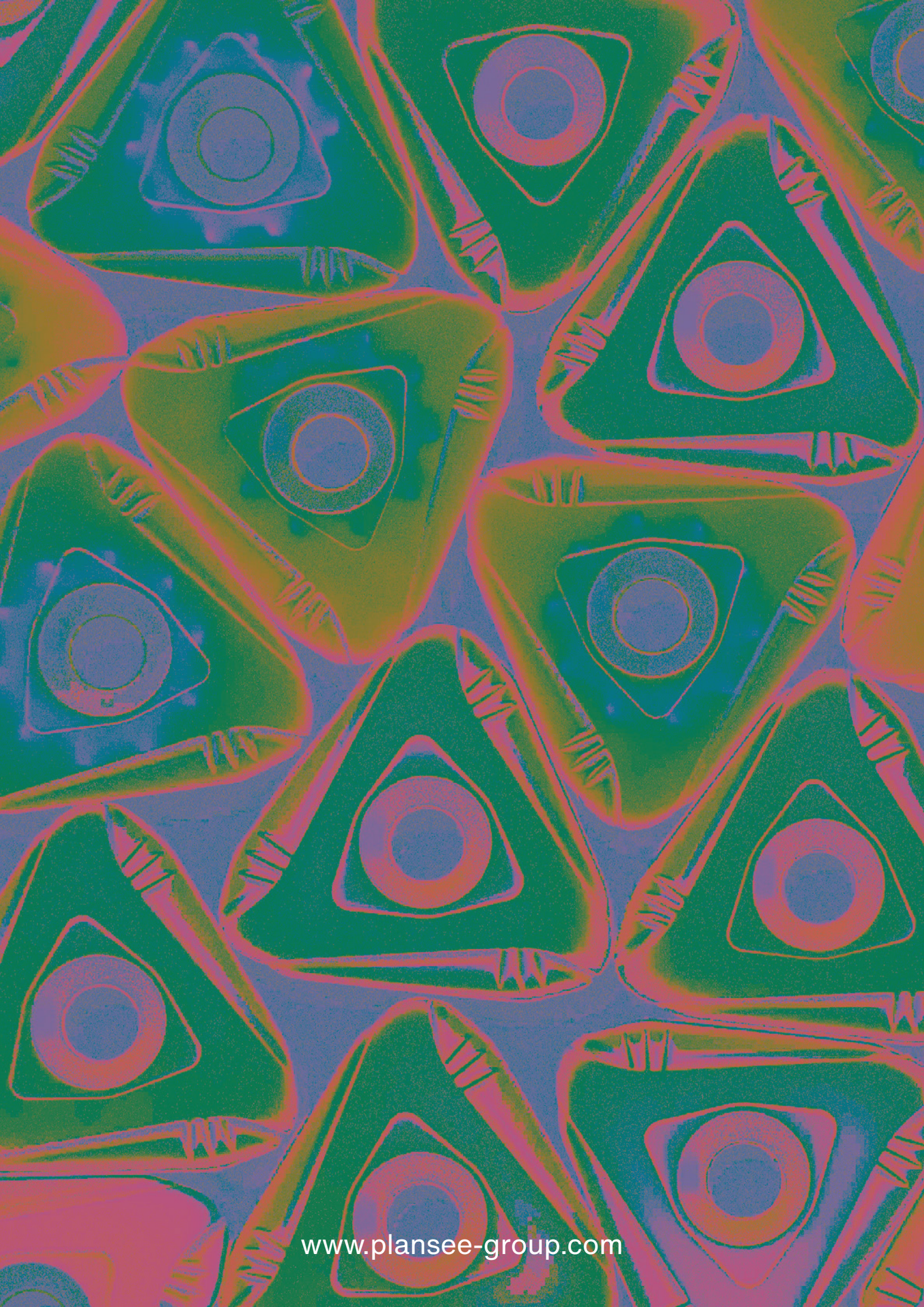
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