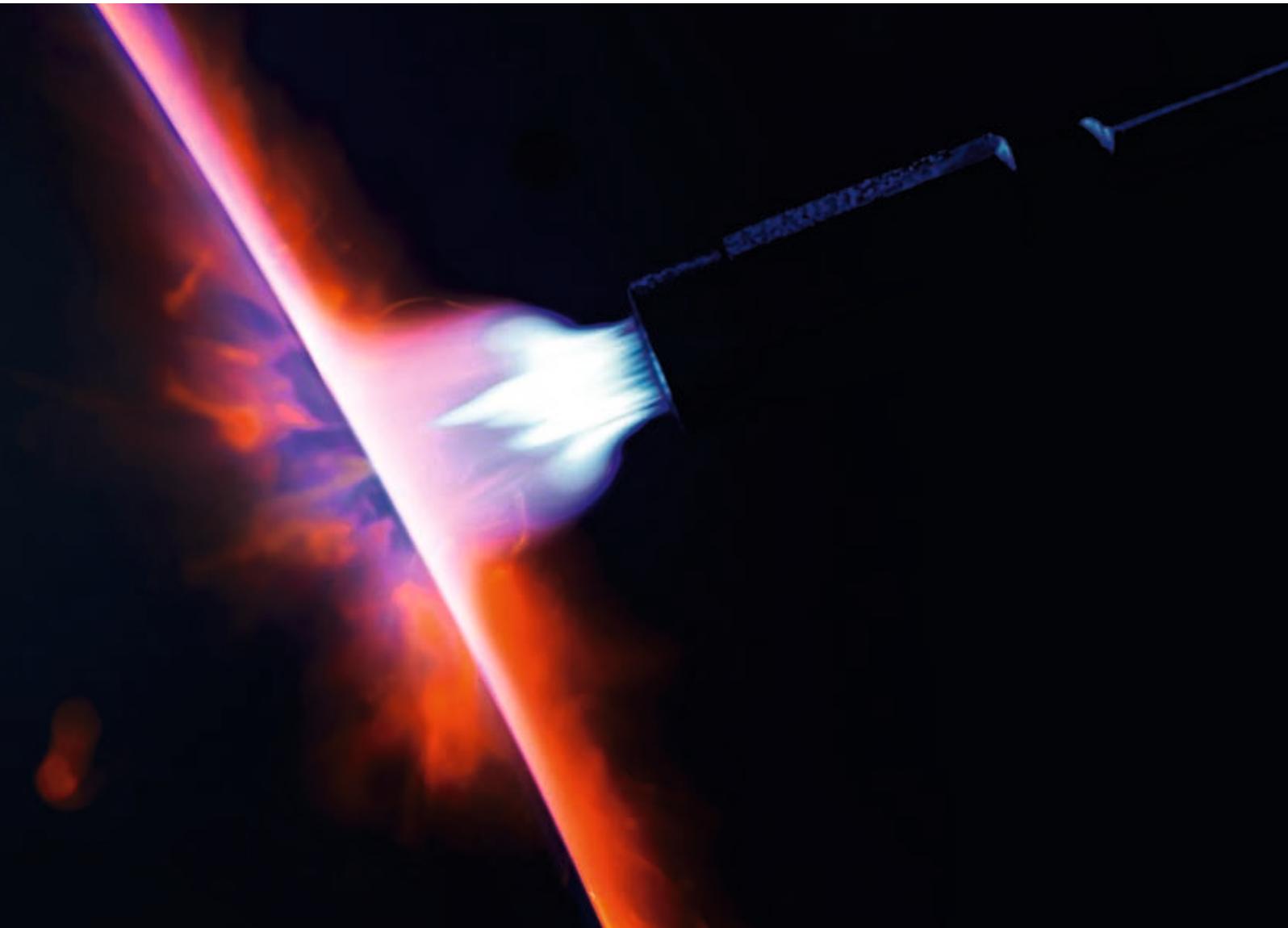


Crucibles for ultra-hard sapphire glass

- XL hard metal blanks
- Electricity and heat from the gas bottle



A word on the title

Molybdenum and tungsten are able to withstand extremely high temperatures in excess of 2000 °C. Temperatures of this magnitude can arise, for instance, when manufacturing sapphire glass or when the materials are used in growing crystals.



Indispensable materials

» High-tech materials produced using powder metallurgical technologies help to shape progress in the markets of the future.«

Dear readers,

How can we reduce CO₂ emissions from vehicles in the long term? How can the high-technology materials molybdenum and tungsten help to obtain even better images of the inside of our bodies? And why are these materials indispensable for the displays on our smartphones and TVs? 500 scientists and industry experts discussed these and other issues relating to our future at the 18th Plansee Seminar.

The focus was on materials made from refractory metals such as tungsten and molybdenum and hard materials made from tungsten carbide for tools and wear resistance solutions.

One thing is clear: Because of the wide range of properties they exhibit, high-technology materials made using powder metallurgical technologies help to shape progress in the markets of the future such as mobility, health, energy, lighting, electronics and entertainment. But for many applications, simply manufacturing materials from the customer's drawings has long been inadequate. Which is why our industry must dedicate itself to solving problems for our customers. To do this, we simulate the application and the entire manufacturing process.

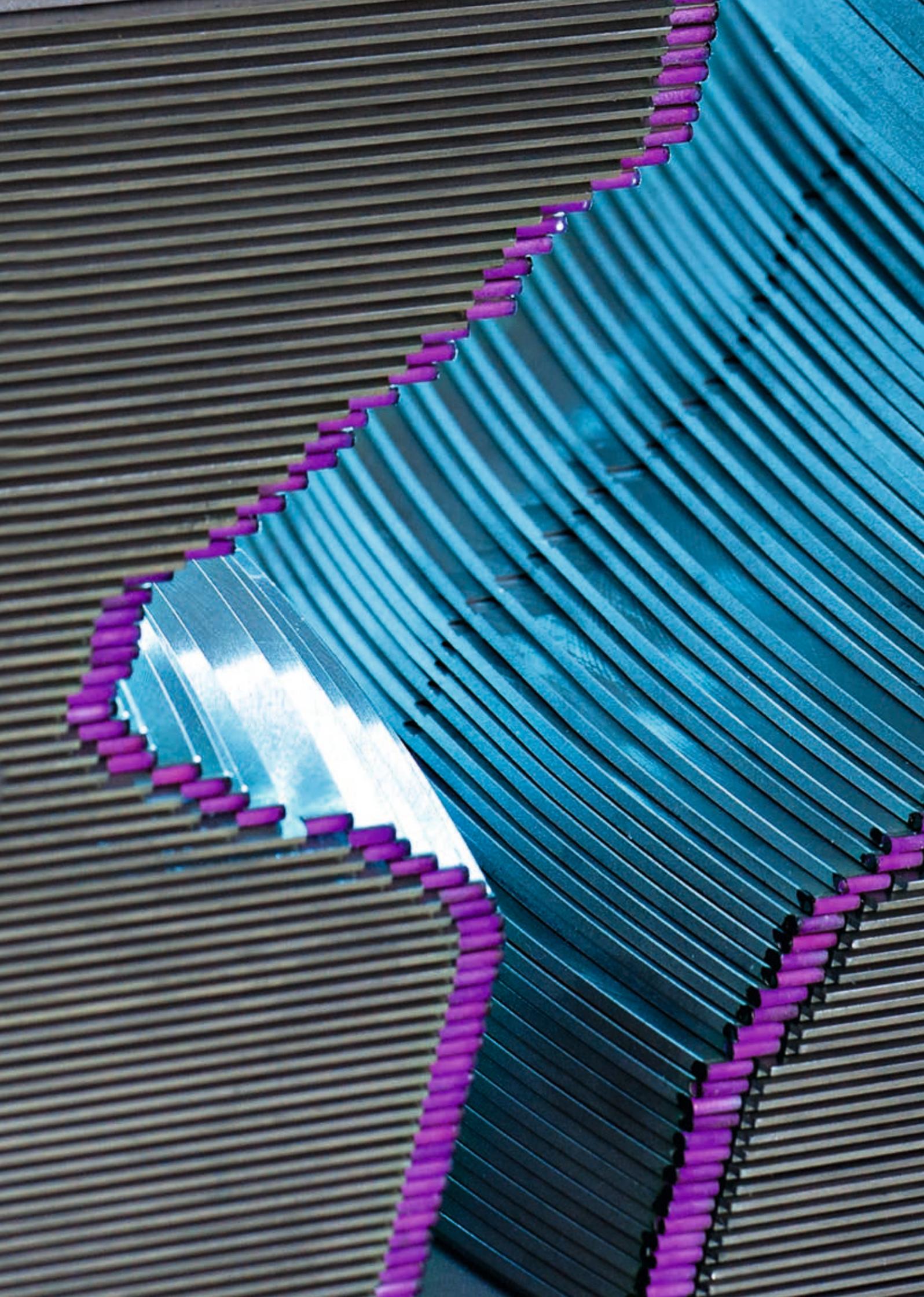


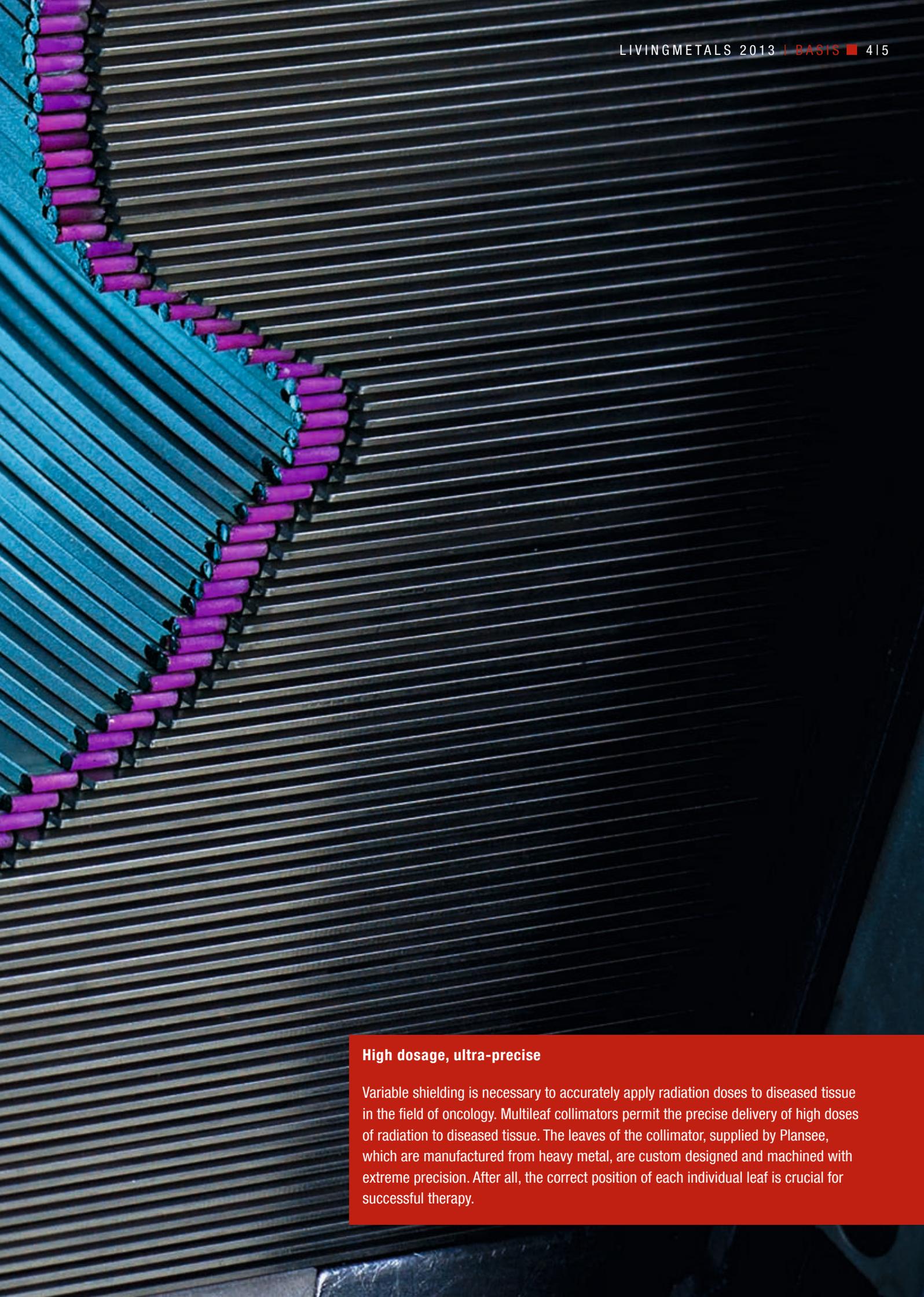
The insights we gain from this allow us to design and produce the necessary components and tools.

And there is another problem that needs to be solved: the supply of raw materials. The industry is backing calls for the responsible use of raw materials – from product design, through the development of energy-efficient manufacturing processes up to the establishment of closed-loop material cycles.

You will find that we have taken up many of these topics – from the perspective of the Plansee Group – in this issue of *livingmetals*. I hope you will be inspired by the contents of this edition.

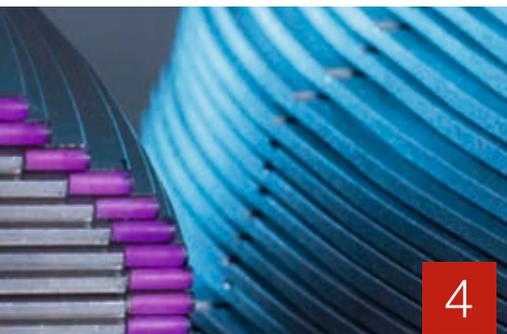
Dénes Széchenyi
Head of Group Communications





High dosage, ultra-precise

Variable shielding is necessary to accurately apply radiation doses to diseased tissue in the field of oncology. Multileaf collimators permit the precise delivery of high doses of radiation to diseased tissue. The leaves of the collimator, supplied by Plansee, which are manufactured from heavy metal, are custom designed and machined with extreme precision. After all, the correct position of each individual leaf is crucial for successful therapy.



4



14



22



8



20



24

livingmetals

No. 11 | 2013 THE MAGAZINE OF THE PLANSEE GROUP

3 EDITORIAL

4 BASIS

Variable: Shielding for radiotherapy

8 WORLD OF PLANSEE

Varied: New products and services

14 FOCUS ON SAPPHIRE PRODUCTION

Reliable: Crucibles for sapphire glass production

20 Impressive: Materials and components in smartphones

22 STORIES

Cost-saving: Lightweight hot zone saves energy

24 STORIES

Multi-layered: Coating expertise for thin-film solar cells

28 Decentralized: Electricity and heat from a mobile fuel cell unit

30 INTERVIEW

Tailor-made metal interconnects for high-temperature fuel cells

32 STORIES

Exactly the final shape: High-performance ribbon saw teeth

33 FACTS

Did you know that...? Interesting information about the Plansee Group



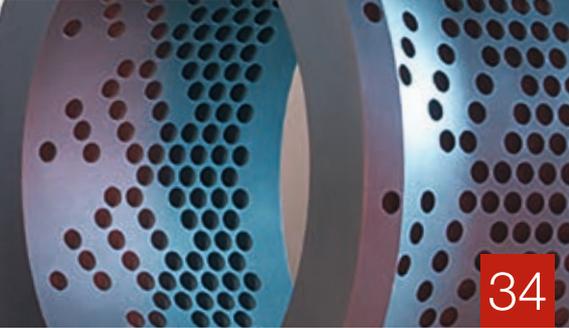
30



36



42



34



38



48

34 **STORIES**

Large-scale: Hard metal blanks for efficient manufacturing processes

36 High-performance: New powder types for the petrochemical industry

38 **PEOPLE**

Securing the supply of raw materials: Professor Helmut Antrekowitsch on backward integration, resource efficiency and recycling

40 **GALLERY**

In worldwide use: Innovative materials and application solutions

44 **COMPANY**

Second most successful year ever: The Plansee Group continues its expansion strategy

46 18th Plansee Seminar: Materials solutions for megatrends

48 **ALIVE**

Sailing: Power on the open seas

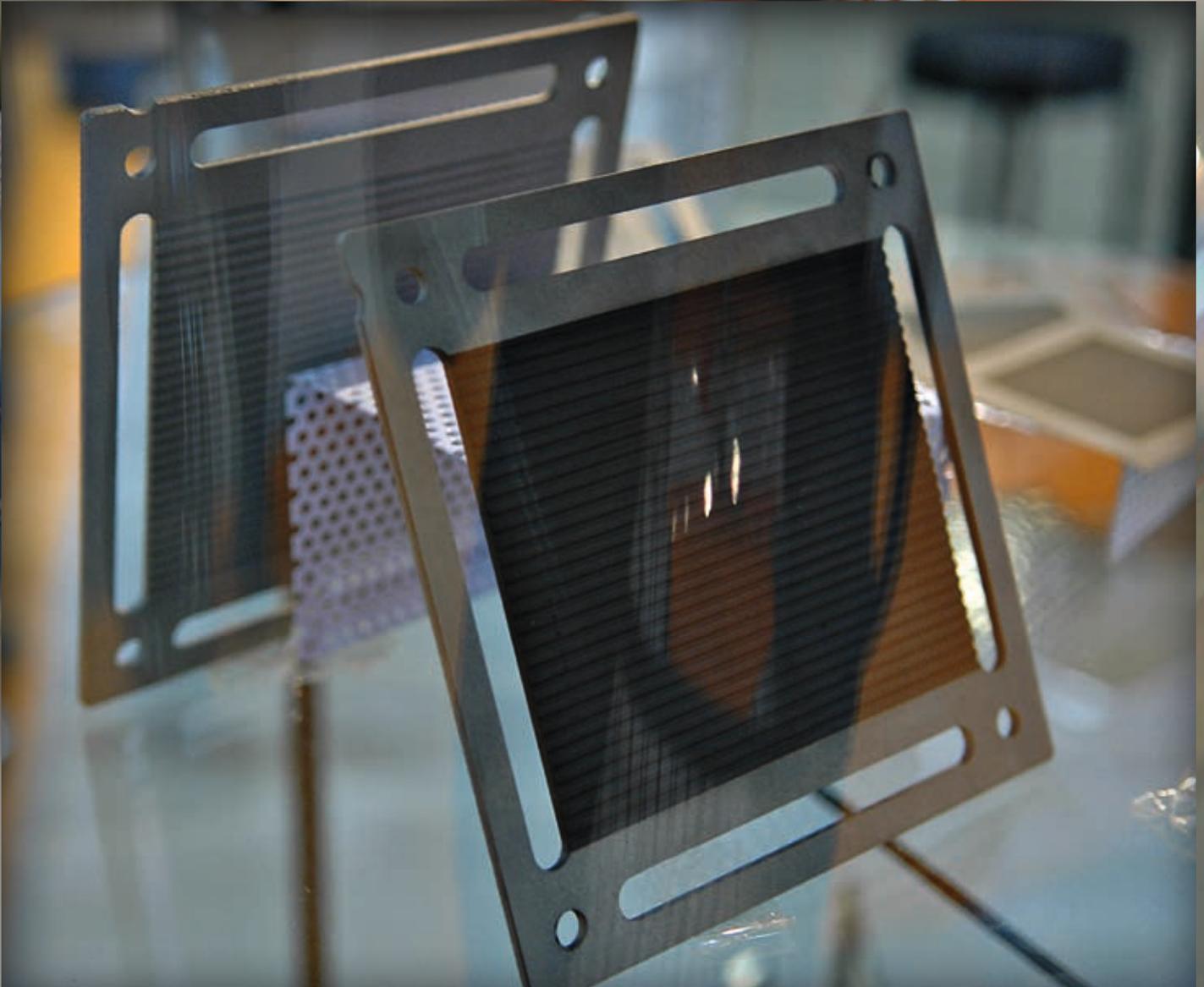
50 **GLOBAL**

Global presence: The Plansee Group at a glance

World of Plansee Group



Ordered by 8 PM and delivered anywhere in Europe by the next working day: WNT sells 45,000 precision tools for small and medium-sized cutting companies. With their new, largely automated stock picking system at their central warehouse in Kempten, Germany, WNT has created one of the most efficient logistics centers in the cutting tool industry. And with the founding of WNT India, they have ventured outside Europe for the first time.



Keeping in shape: High-temperature fuel cells run really smoothly at a temperature of 850 degrees Celsius. And the metal interconnects in the heart of the fuel cell have to be able to withstand such temperatures. The interconnects are manufactured by GTP in Towanda. The powder metallurgical technology used during manufacture guarantees that the necessary mechanical, chemical and physical properties, as well as the geometry, are permanently maintained. The commissioning of a second production line has allowed GTP to more than double their production capacity.



The last mile to the customer – due to customs requirements and transport costs – also represents a challenge for Plansee's coating materials. Shortly before they are used in coating plants, Plansee solders the tubular coating materials onto the carrier material. A manufacturing plant in Seoul in South Korea specializes in this processing step, known as bonding. This facility is therefore situated right on the doorstep of the big Korean display, electronics and solar technology companies that process these coating materials.



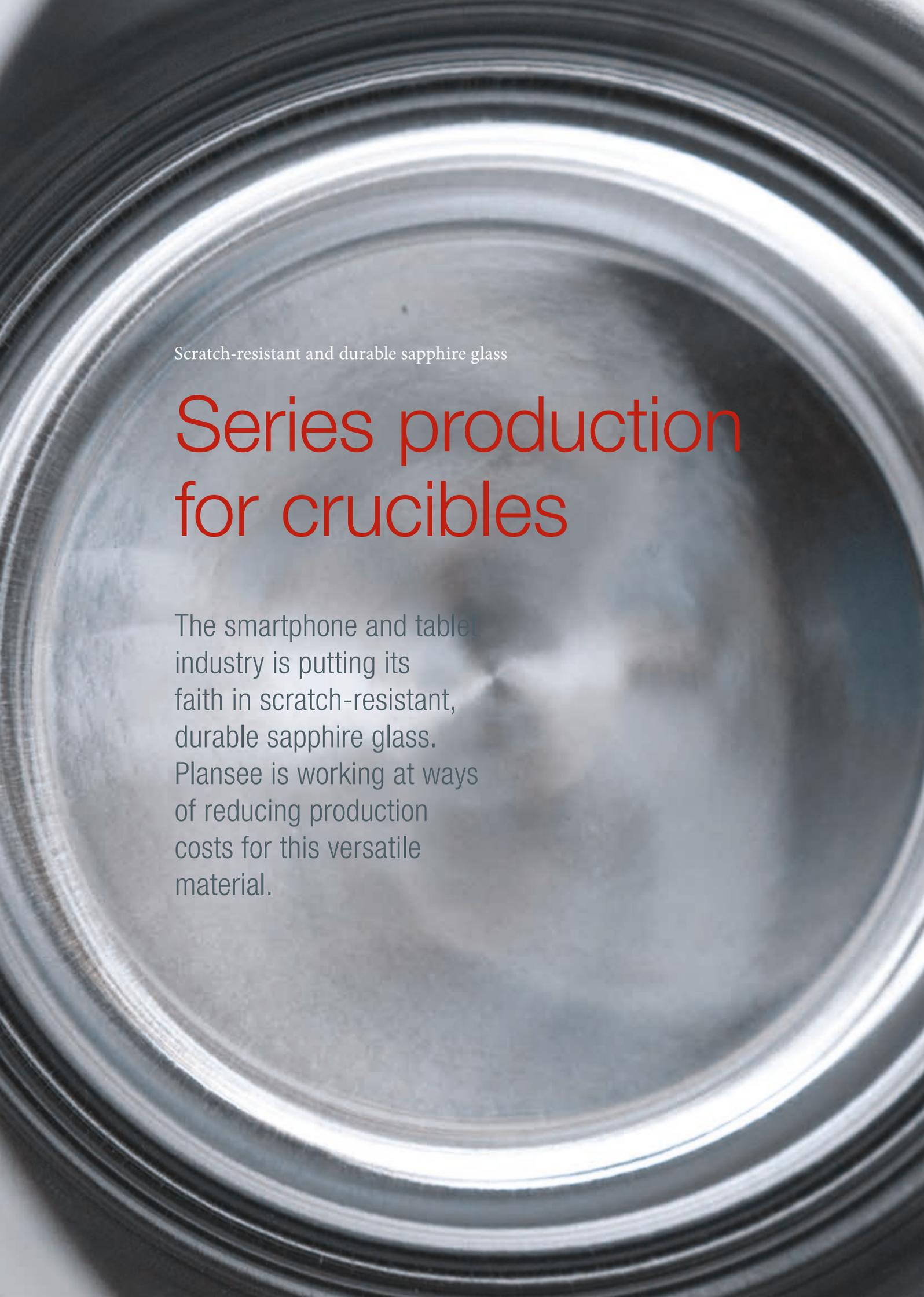
Through thick and thin: The German tool manufacturer Günther Wirth and Ceratizit have now joined forces. This has allowed Ceratizit to complement its product range with drills, end mills, reamers and customized special tools. Günther Wirth manufactures these round tools for (virtually) any application and operates its own hard material coating plants.



Good tools in demand: China's thirst for raw materials is unabated. Construction of tunnels, railways and roads continues apace. The greater the quantity of ore that is mined and the longer the planned highways and rail tracks, the more indispensable wear-resistant tools become. CB-Ceratizit has already increased production capacity in their Tianjin plant in order to meet the demand for particularly tough, wear-resistant hard metal inserts for the mining and construction industries. At the same time, the engineers are pulling out all the stops to develop new products and solutions for these sectors.



High performance, low consumption: New generations of injection pumps are making diesel engines even cleaner and more fuel-efficient. High-performance injectors provide the basis for efficient, low-noise combustion of the fuel. In collaboration with a supplier to the automotive industry, Ceratizit has developed hard metal components for injectors. The high-precision series components have a long service life, ensure accurate and constant direct injection of the fuel and withstand pressures of up to 2500 bar.



Scratch-resistant and durable sapphire glass

Series production for crucibles

The smartphone and tablet industry is putting its faith in scratch-resistant, durable sapphire glass. Plansee is working at ways of reducing production costs for this versatile material.

Perfect for the stringent requirements of sapphire glass production: Plansee crucibles made from molybdenum and tungsten.





*Crucibles from
Plansee support
reliable, reproducible
and energy-efficient
processes.*



Reusable crucibles: Plansee is constantly working to improve product quality and productivity and cut manufacturing costs.



► Traditionally, sapphire glass has been used for high-quality watches, as bulletproof glass or in the cockpit windows in the space shuttle. Surpassed only by diamond, sapphire is the second hardest of any transparent material. Up to now, however, sapphire glass has been very much a niche product, because the production and processing of the material were both complex and expensive. The booming LED market is the reason that costs are now beginning to fall. Every LED is mounted on an ultra-thin sapphire plate. Over the past few years, this high level of demand has given rise to a new industry sector focusing on the technology used to produce sapphire glass. Falling production costs have fired the imagination of product developers.

Widespread use of sapphire glass makes sense in any application where the glass needs to be particularly scratch-resistant and durable. Smartphones and tablets should be able to survive falling from a desk, and touchscreens for sales and information machines could be better protected against vandalism. And the covers on barcode scanners at supermarket tills need to have a long service life. Although smartphones with sapphire glass are already on the market as luxury items, the crucial question before they reach the mass market is how quickly can the industry reduce the costs for producing sapphire glass in the long-term. After all, the costs for chemically hardened glasses, which are in common use today are ten times lower than that of sapphire.

Crystal growth at high temperatures

In order to grow sapphire, powdered aluminum oxide is heated to 2100 degrees Celsius. This is done in tungsten or molybdenum crucibles which are first heated up to the melting point and then gradually cooled over a period of up to three weeks, resulting in a large sapphire monocrystal. This process demands a lot of the production technology. Exacting demands are placed on the crucible in terms of the extreme temperatures involved and the high purity and creep-resistance that are required. And such requirements cry out for Plansee's materials. Plansee has been producing crucibles for the niche markets mentioned above for many years ►

A portrait of Hermann Walser, a middle-aged man with glasses, wearing a dark suit, a light blue striped shirt, and a gold tie. He is looking slightly to the right of the camera with a neutral expression. The background behind him is a blurred blue and purple gradient.

Hermann Walser is responsible for sales at Plansee High Performance Materials.

An interview with Hermann Walser about how Plansee is helping its customers to reduce manufacturing costs.

Why is reliability so important in the manufacture of sapphire?

Hermann Walser: The manufacture of sapphire is an extremely sensitive process. A single cycle comprising heating and controlled cooling of the aluminum oxide involves costs of up to 15,000 euros. If anything goes wrong, the material can no longer be used and considerable damage can be done to the plant equipment. Reliable crucibles are a key aspect of managing the risks.

Crucibles from Plansee are not cheap. Why?

Hermann Walser: Because, together with the customer, we look at all the costs involved. Admittedly, the initial purchase cost of our crucibles is higher. But they guarantee optimum output and support reliable, reproducible and energy-efficient processes. In the final analysis, however, the overall manufacturing costs to the customer are significantly lower.

LED prices are constantly falling...

Hermann Walser: There is no doubt that the entire supply chain has to play a part. This is why Plansee is developing a reusable crucible that further reduces the costs per cycle. And we are also constantly working to improve product quality and productivity and cut manufacturing costs.

When is Plansee the preferred supplier for its customers?

Hermann Walser: When customers are certain that Plansee reliably meets every aspect of their requirements. Customers benefit from our innovative solutions and consistent product quality even if demand rises rapidly and to high levels. And they can rely on Plansee being able to meet their future requirements. Not only that, our scientists have the knowledge and methods to be able to thoroughly investigate any complaint. Cooperation of this kind often opens up opportunities to further improve the product or develop entirely new solutions.



Meeting high levels of demand: Plansee has recently started manufacturing crucibles in China as well.

► now. But the boom in the LED industry caused a rapid increase in demand and Plansee invested heavily in series production and further development of the technology. To prepare itself for the expected sapphire boom, Plansee has taken comprehensive measures to boost output, improve productivity and reduce overall costs for the customer. And one thing is clear: When the price of sapphire has reached an acceptable level, a huge market with demand levels many times greater than that of the LED industry, will open up.

Crucibles

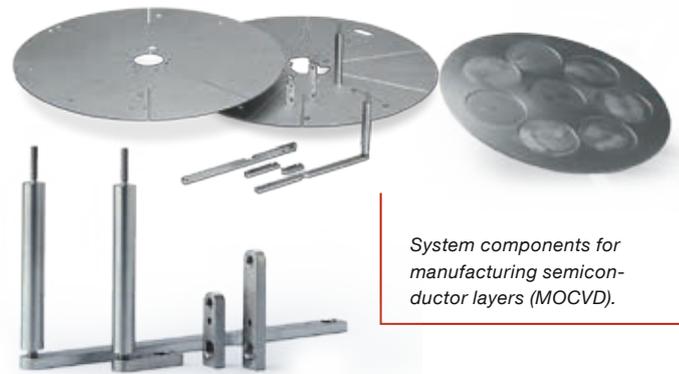
Formed molybdenum and tungsten crucibles have thin walls, a high level of creep-resistance and effectively prevent contamination of the sapphire crystal.

Plansee is able to manufacture very large, geometrically complex crucibles in large quantities.

Pressed-sintered crucibles are reused and have a uniform wall and base thickness and super-smooth surface, which means that the sapphire can be removed from the crucible without difficulty and without damaging the surface. Special process control within a narrow parameter range allows Plansee to guarantee extremely constant, homogeneous product properties. To meet the high level of demand, Plansee started production of pressed-sintered crucibles in a new plant in Shanghai, China, in the summer of 2013. ►



► A smartphone or tablet is made up of anything up to 60 elements and hundreds of components. Here, we give you an overview of the contribution made by Plansee with its materials and components.



System components for manufacturing semiconductor layers (MOCVD).



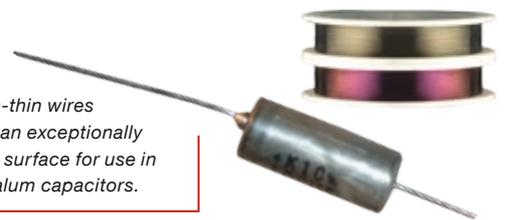
Crucibles and furnace components for manufacturing sapphire glass.



Coating materials for displays.



Molybdenum-copper plates for heat dissipation in LEDs.



Ultra-thin wires with an exceptionally pure surface for use in tantalum capacitors.

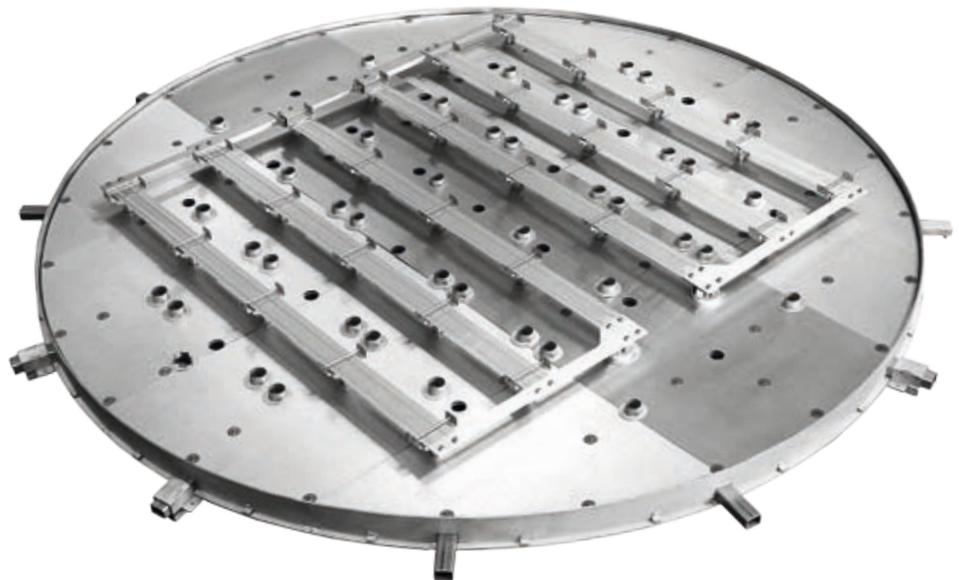


Molybdenum melting electrodes and tank reinforcements for use in glass manufacture.

System components for ion implantation, the most important production step in the manufacture of semiconductors.



*Lightweight with
tangible benefits:
Long-lasting, energy-
efficient hot zones.*



Heat treatment

Lightweight construction saves energy

Lightweight construction metal hot zones significantly reduce operating costs in vacuum furnaces.



The hot zone lies at the heart of every vacuum furnace where it performs a number of demanding tasks. The heating elements ensure the necessary temperature, charge carriers position the material in the furnace and the shield packs minimize the amount of heat that escapes from the furnace chamber.

Short heating and cooling phases

Metal hot zones have a number of positive effects in vacuum furnaces. The heating and cooling phases are short, the vacuum conditions are excellent (no porous materials) and there is a very uniform temperature distribution. Nevertheless, the high energy consumption associated with metal hot zones has often meant that they were not the preferred choice.

But times have changed: Ever since it became possible to operate solid metal hot zones with up to 25 percent less energy, they have been taking the world of vacuum

furnaces for heat treatment by storm. With a lightweight, molybdenum alloy design, Plansee are strengthening this trend and encouraging the replacement of the graphite elements that were generally used in the past. Although the use of graphite plates as insulating elements in vacuum furnaces saves energy, the graphite does not absorb heat well and only cools down slowly. Furthermore, the presence of carbon in the furnace is problematic when sensitive processes and materials are involved.

Hot zones compared

The new, lightweight units from Plansee not only require less energy, but also deliver better performance. This has been confirmed in trials. Two identical solid metal hot zones of size 600 x 600 x 900 millimeters were tested. On the one hand, a heavyweight version and, on the other, a newly designed lightweight version.

Compared with the standard version, the energy-efficient, lightweight design came off best on the following criteria:

- The hot zones are 15 percent lighter.
- The empty furnace heats up 20 percent quicker.
- Heat loss is reduced by 15 kilowatts.
- 25 to 30 kilowatt hours less power is needed to heat up and cool down the furnace.
- The cooling phase is 15 percent shorter.

Admittedly: The new, lightweight hot zone is not the cheapest on the market. But in terms of total cost of ownership for the customer, it has energy efficiency and a long service life on its side. ■

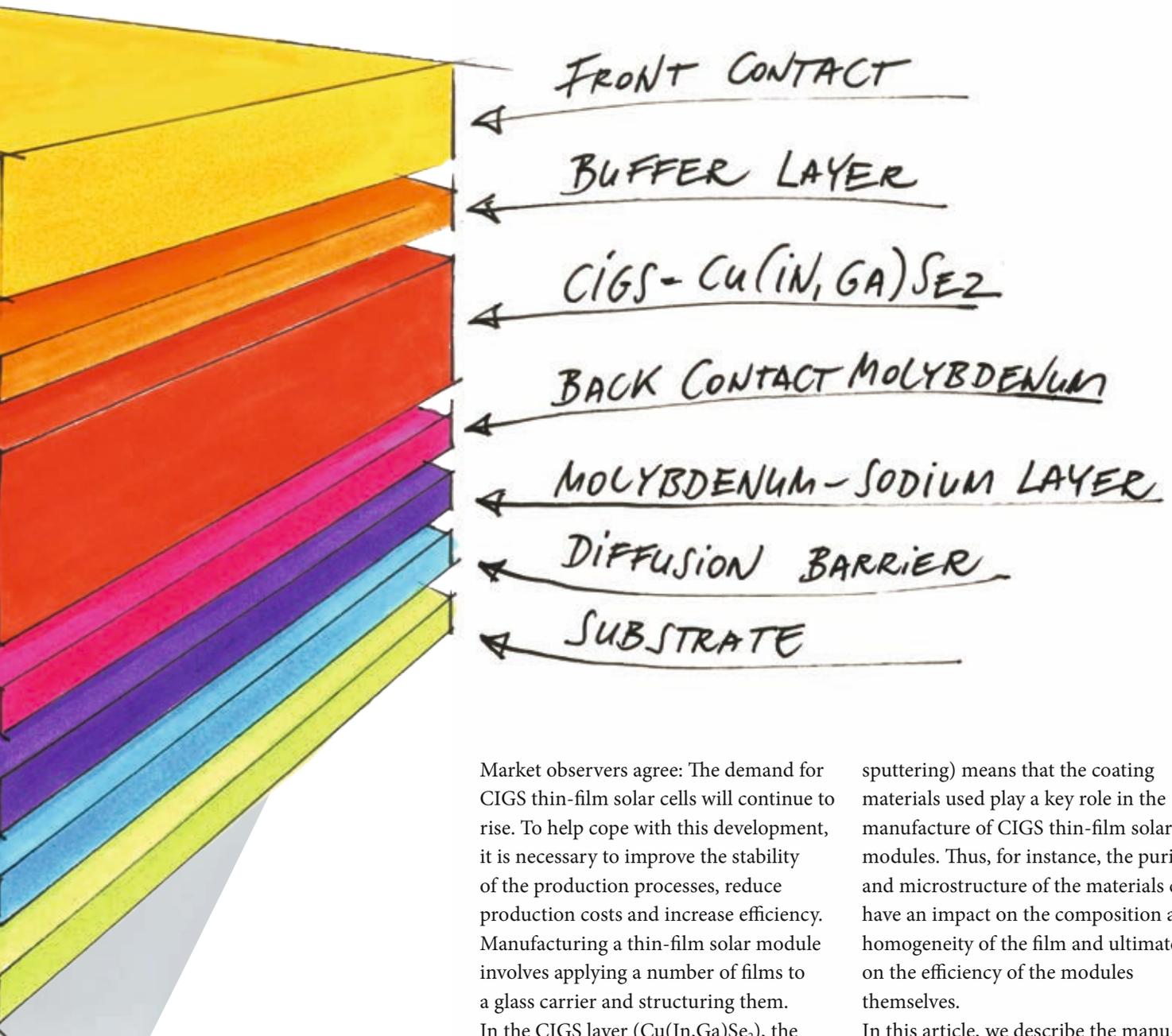
Thin-film solar cells

Let the sun shine in



500 nanometers. The molybdenum layer is as thick as five sheets of gold leaf, each 100 nanometers thick. The diagram shows the layer structure of a thin film solar cell.

Coating materials from Plansee further improve the efficiency of thin-film solar cells and enhance the stability of the production process.



Market observers agree: The demand for CIGS thin-film solar cells will continue to rise. To help cope with this development, it is necessary to improve the stability of the production processes, reduce production costs and increase efficiency. Manufacturing a thin-film solar module involves applying a number of films to a glass carrier and structuring them. In the CIGS layer ($\text{Cu}(\text{In,Ga})\text{Se}_2$), the incident sunlight (photons) is converted to electrical power. The considerable importance of the coating process (generally magnetron

sputtering) means that the coating materials used play a key role in the manufacture of CIGS thin-film solar modules. Thus, for instance, the purity and microstructure of the materials can have an impact on the composition and homogeneity of the film and ultimately on the efficiency of the modules themselves.

In this article, we describe the manufacture and use of coating materials from molybdenum, molybdenum-sodium (MoNa) and copper-gallium (CuGa).



*In the CIGS layer,
incident sunlight is
converted to electrical
power.*

► **Molybdenum as the CIGS back contact**

Molybdenum has become an established back contact material for CIGS solar cells. Its coefficient of thermal expansion allows it to adhere well to glass, while at the same time providing a sufficiently high level of electrical conductivity. Plansee's approach to manufacturing molybdenum coating materials is as follows: Molybdenum powder is pressed at room temperature and then sintered in a hydrogen atmosphere. The deformation step, for instance rolling, delivers the full density of the material, which then has a characteristic deformed microstructure. In addition, a low iron content is particularly important, because iron atoms that diffuse into the CIGS absorber layer have a negative impact on the efficiency of the solar modules. These properties can only be achieved to a limited extent using alternative manufacturing methods. During hot isostatic pressing, the pressing and sintering operations are carried out concurrently, which results in a somewhat lower density. Spraying the coating material onto steel tubes

layer by layer (vacuum spraying) only achieves a density of around 90 percent. Furthermore, material produced in this way has a far greater level of contaminants. The importance of tubular coating materials has grown in recent years because material utilization of more than 75 percent can be achieved during the coating process. This compares with only 30 percent for planar materials.

Sodium doping

Small quantities of sodium in the CIGS layer have a positive impact on the efficiency of the solar cell. Traditionally, soda-lime glass has been used as the substrate material which simultaneously provides the sodium source. During the production process, the sodium contained in the glass then diffuses into the CIGS layer. This process, however, is unstable and does not yield a homogeneous distribution of the sodium. As a result, the industry is increasingly turning to alternative sources of sodium. One particularly clever solution is offered by coating materials made from molybdenum-sodium (MoNa): A barrier

layer is applied to any carrier material, such as plastic or steel foil. This is then followed by a thin layer of molybdenum-sodium and finally the molybdenum back contact. The key advantage: A precisely defined quantity of sodium diffuses into the CIGS layer in a very stable process and is distributed uniformly. The precise control of the level of sodium doping makes it possible to increase the efficiency of the solar module.

Copper-gallium produced using powder-metallurgical technology

Plansee is also able to supply the copper-gallium materials needed to create the absorber layer. These can be manufactured using a melting process or powder-metallurgical methods. When a melting process is used, the resulting grain size is relatively large and leads to a rough surface during coating. If powder-metallurgical methods are used, on the other hand, the result is a fine-grained material which helps to create a smooth surface during sputtering. This property improves the homogeneity of the gallium content of the layer during the coating process. ■



What is a sputtering target?

People in the industry refer to coating materials as sputtering targets. They are supplied in the form of tubes or plates and are used in vacuum deposition equipment. In the coating process, atoms are ejected from the sputtering target and deposited evenly on the material to be coated.

Note: An extensive article on the subject is available at www.plansee.com

Electricity and heat from the gas bottle



Electricity and heat from the gas bottle?
A mobile fuel cell unit acting as an energy converter makes it possible.

Do you like your summer house nice and warm? And you don't want the refrigerator in your camper to drain the battery? And why start up the noisy auxiliary motor if you need some light at night on the open seas?

Miniature power plant on the open seas

The modern solution is a compact fuel cell unit that is not much larger than a microwave oven and can generate up to 500 watts. It is fueled by an off-the-shelf propane gas bottle. Connect it, turn the valve and switch on. The miniature power plant generates electricity and heat, if needed, at a whisper. The system produces more than 10 kilowatt hours of electricity per day. This means that an 11-kilogram propane gas bottle would make you independent of the power supply network for almost a week, irrespective of whether you are on the open seas or on an isolated campsite.

No noise, no vibrations and, above all, low operating costs. A kilowatt hour of electricity from the fuel cell unit from the German manufacturer new enerday costs

around 70 percent less than from a diesel generator. It is thanks to a fortunate coincidence that new enerday has been able to enter the market so quickly. Dr. Matthias Boltze, managing director of new enerday: "The fuel reformer and the key components of the overall system had already been developed. But we still didn't have the heart of the unit, the fuel cell stack, in which the gas and airborne oxygen react to provide electricity and heat. We did not wish to spend years developing our own stack, and instead rely on a number of different European stack platforms. The stack developed by Plansee and the Fraunhofer Institute was an ideal match right from the start." The principle behind the unit is straightforward: The stack is located in a box made of highly porous, ceramic insulation material. Here, electricity is generated from the hydrogen-rich gas, known as the reformat. This reformat is produced by a catalytic fuel reformer patented by new enerday upstream of the stack. This distinguishes the high-temperature fuel cell (SOFC) from traditional fuel cell systems that need

either an extremely complex system for producing hydrogen or pure hydrogen as fuel. Furthermore, the reformer technology developed by new enerday is suitable for converting both liquid and gaseous fuels. This is a key advantage and provides the basis for a modular system concept.

Plansee also chose to adopt this modular concept when developing their chromium-based interconnects for fuel cells. The interconnect provides the electrical and thermal connection between the fuel cell's anode and cathode and distributes fuel gas and air in the system. Because they are manufactured using powder metallurgical methods, the interconnects can be produced inexpensively in large quantities and in exactly their final shape.

A stable mix of materials

The mixture of 95 percent chromium and 5 percent iron ensures that the coefficient of expansion of the interconnect matches that of the electrolyte of the fuel cell.

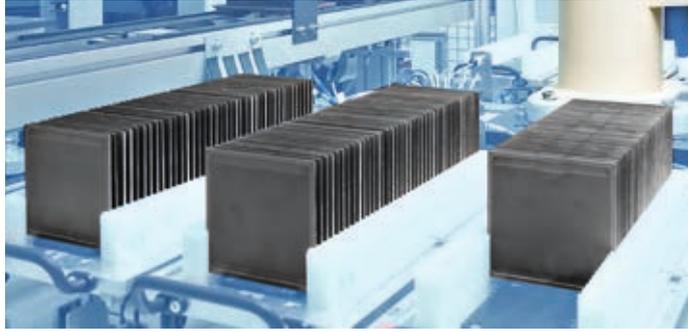
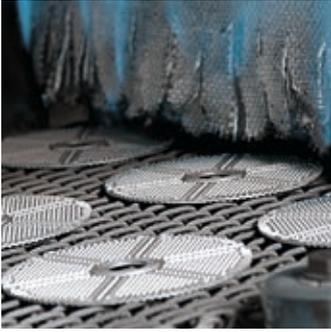


Decentralized power generation for a holiday home: The fuel cell converts off-the-shelf propane gas into electricity and heat.



This is important, because temperatures of up to 850 degrees Celsius arise during the electrochemical reaction in the fuel cell. During operation, the surface of the interconnect is exposed on one side to the oxygen in the air. While the opposite side has to withstand high hydrogen concentrations. But this is not a problem for the interconnects from Plansee. The high proportion of chromium guarantees that the properties and the geometry remain stable.

Together, the stack developed by Plansee and the Fraunhofer Institute and the fuel cell system from new energyday thus represent a perfect symbiosis for a successful concept for the mobile generation of power independently of the main power supply. ■



Extremely precise production technology for SOFC interconnects that produces parts in their exact final shape.

Interview

Extremely flexible design

A metal interconnect for different high-temperature fuel cell systems and applications. Dr. Andreas Venskutonis heads up fuel cell operations at Plansee and explains how the technology works.



livingmetals: High-temperature fuel cells are nowadays used in a wide variety of applications. Tell us how Plansee is adapting its range of products for this complicated technology.

Andreas Venskutonis: There is always demand for our products when materials need to withstand extreme stress levels. In the case of the high-temperature fuel cell, this happens in the stack, which is what we call the heart of the fuel cell. This is where the electrochemical reactions take place at 800 degrees Celsius. We developed the necessary high-performance metal components (interconnects) by further developing our alloy materials, coating expertise and powder-metallurgical technologies. Today, we are able to produce consistently

high-quality interconnects, cost-effectively and in large quantities.

livingmetals: Where are these interconnects used?

Andreas Venskutonis: In essence, our product, the interconnect, is always based on the same technology. But our customers throughout the world, including Asia and India, use these interconnects for a wide variety of systems and applications. These range from decentralized power generation plants with an output of hundreds of kilowatts through micro-combined heat and power devices (CHP) delivering up to 5 kilowatts right down to portable units supplying up to 500 watts of power.

livingmetals: For a long time, the service life of the interconnect acted as a brake

on the performance of the fuel cell stack. To what extent has the chromium interconnect helped make progress here?

Andreas Venskutonis: The service life of the interconnect was an absolute prerequisite before the high-temperature fuel cell was ready for market. There were a number of important milestones on the way. Firstly, there was the development of ceramic barrier coatings, which protect the electrochemical cell against corrosion. Another milestone was the harmonization of the thermo-physical properties of the ceramic cell and the metal interconnects using a special chromium alloy to prevent stresses from building up over the course of the many heating/cooling cycles. And then there was the further development

of the extremely precise powder-metallurgical manufacturing method to ensure that the interconnects are structurally identical. This approach to manufacturing guarantees that there are no variations from part to part and from lot to lot. This is crucial for the performance of the stack because the interconnects are connected electrically in series. And finally, we use new glass seals, which play a major role in allowing us to significantly improve impermeability.

livingmetals: Many stack manufacturers rely on tailored interconnects to get maximum performance out of their stacks. How does powder metallurgy contribute to meeting these requirements?

Andreas Venskutonis: The milestones I just described, combined with our net shape high-precision technology, mean that we are now in a perfect position to be extremely flexible in the design of our interconnects.

livingmetals: How can manufacturers of stacks for high-temperature fuel cells assess the performance of their interconnects themselves?

Andreas Venskutonis: In conjunction with the Fraunhofer Institute in Germany, we have developed an ESC stack that can be tested by any of our customers at any time.

livingmetals: What challenges do you think still have to be mastered before high-temperature fuel cells really begin to shake up the market?

Andreas Venskutonis: The stack is already here. The entire supply industry still has to evolve. And ultimately, greater quantities need to be produced to optimize the price per unit.

livingmetals: Are there any potential applications for the output of several hundred kilowatts that you mentioned earlier?

Andreas Venskutonis: Of course. One of our customers is already doing precisely that: Decentralized power generation plants with an output of hundreds of kilowatts. ■



SOFC experts: a meeting of minds.

SOFC workshop

Tangible benefits

The number of different applications for high-temperature fuel cells is growing. At the third Solid Oxide Fuel Cell (SOFC) workshop, experts discussed not only technical challenges, but also issues related to the market situation, standardization and marketing.

In olden times, traveling traders used to protect their salt from rain and thieves here overnight. And in June 2013, some 350 years later, 60 SOFC experts involved in research on high-temperature fuel cells came together at the old Salzstadel in Reutte/Austria for the third time. The experts discussed the market situation (how should the high-temperature fuel cell position itself vis-à-vis other combined heat and power cogeneration systems), standardization issues (the supply industry is demanding technical standards and uniform interfaces in order to achieve the target costs sooner) and the

question of how best to involve installation firms in marketing activities.

The constant stream of new applications being opened up by the SOFC is always interesting. The SOFC offers tangible benefits to ship designers who put an enormous amount of effort into reducing noise and vibrations from engines: Decentralized power supply for different parts of the ship, high efficiency, low emissions, low noise and negligible vibrations.

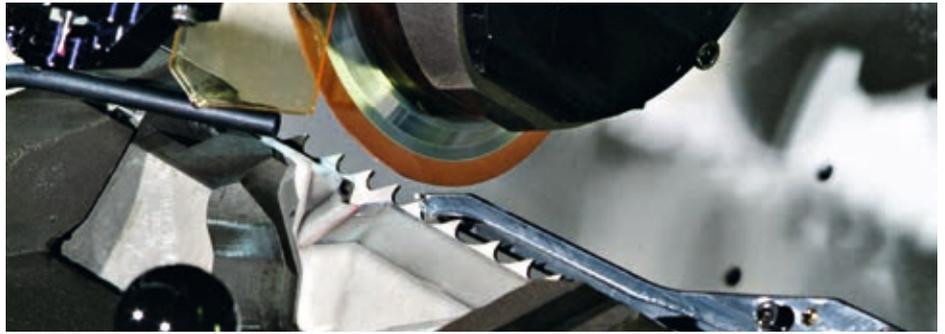
Storage technologies developed in the context of new energy policies are opening up another market opportunity for the SOFC. This came out in the discussions about high-temperature electrolysis. This involves using electricity to separate water into hydrogen and oxygen. Unlike conventional electrolysis at temperatures below 100 degrees Celsius, high-temperature electrolysis is performed at around 900 degrees Celsius. The advantage is greater efficiency, as less electricity is required to produce the same quantity of hydrogen. Even though this technology is still being developed, it has the considerable advantage that many of the components that have already been developed for the SOFC can be used. ■

Optimized band saw blades

The perfect tooth for the perfect cut

Anyone who constructs band saws for tough materials needs to use powerful saw teeth. Increasingly, these are manufactured in the precise form required for their final use – from customized hard metals.

The cutting industry is setting new standards: Increasingly, even band saw blades are being customized to suit the precise application.



The days when band saws happily cut their way through wood, stone or steel are still far from being a thing of the past. However, the automotive and aerospace industries are increasingly turning to materials that try to resist all efforts to machine them. In particular, these include aluminum and titanium alloys. Slow-moving saws and inaccurate cuts have no place in modern manufacturing processes designed to maximize productivity and precision. Everyday, off-the-shelf band saws are not the answer here. The vital consideration for technical buyers therefore is: That every aspect of the band saw right through to the saw blade is optimally suited to the cutting task.

When saw tooth meets material

The point at which the saw tooth meets the material is of crucial importance for the quality of the cut. This is where it

becomes clear whether the saw tooth is sufficiently hard and wear-resistant to cope with extremely tough materials. The hard metals manufacturer Ceratizit makes an important contribution to ensuring that it is. In the past, all saw tooth blanks were manufactured from the same type of hard metal. The cutting tools industry points the way ahead. In this sector, it has long been the norm to develop optimally adapted types of hard metal for each individual demanding application. This approach is now also being adopted for the development and manufacture of hard metal blanks for band saws. So much for the internal workings. However, the external shape of saw tooth blanks is also constantly changing. In the past, band saw manufacturers would mill and grind away up to 50 percent of the valuable hard metal blank during machining without even a second thought. Given

the scarcity and high cost of raw materials today, such an approach is unthinkable. The aim of hard metal manufacturers is therefore: To produce blanks that resemble the shape required for final use as closely as possible. Just as the spherical geometries that were originally used gave way to a cylindrical design for the blanks, this has in turn been largely superseded by a near net shape approach to blank production. And when it comes to future developments, it is once again the cutting tools industry that is leading the way. To further increase the performance and service life of band saw teeth, individually developed wear-protection coatings will soon be used to reinforce the beneficial properties of hard metals. ■

Did you know that...

30 kilowatt hours

That's how much electricity is saved for each heating/cooling cycle in a vacuum furnace if it is fitted with lightweight metal hot zones.

95:5

That is the ratio of chromium to iron in metal interconnects for fuel cells. This recipe for success guarantees an optimum coefficient of expansion.

650

millimeters This is the diameter up to which Ceratizit manufactures hard metal blanks for industrial applications where size and wear resistance are crucial.

50

percent This is the amount of material that used to be ground away when producing band saw blades. Nowadays, the aim is to produce the blanks as close as possible to the final shape.

14

languages

This is the number of languages "spoken" by the new WNT online shop. WNT sells machining tools in most European countries and in India.

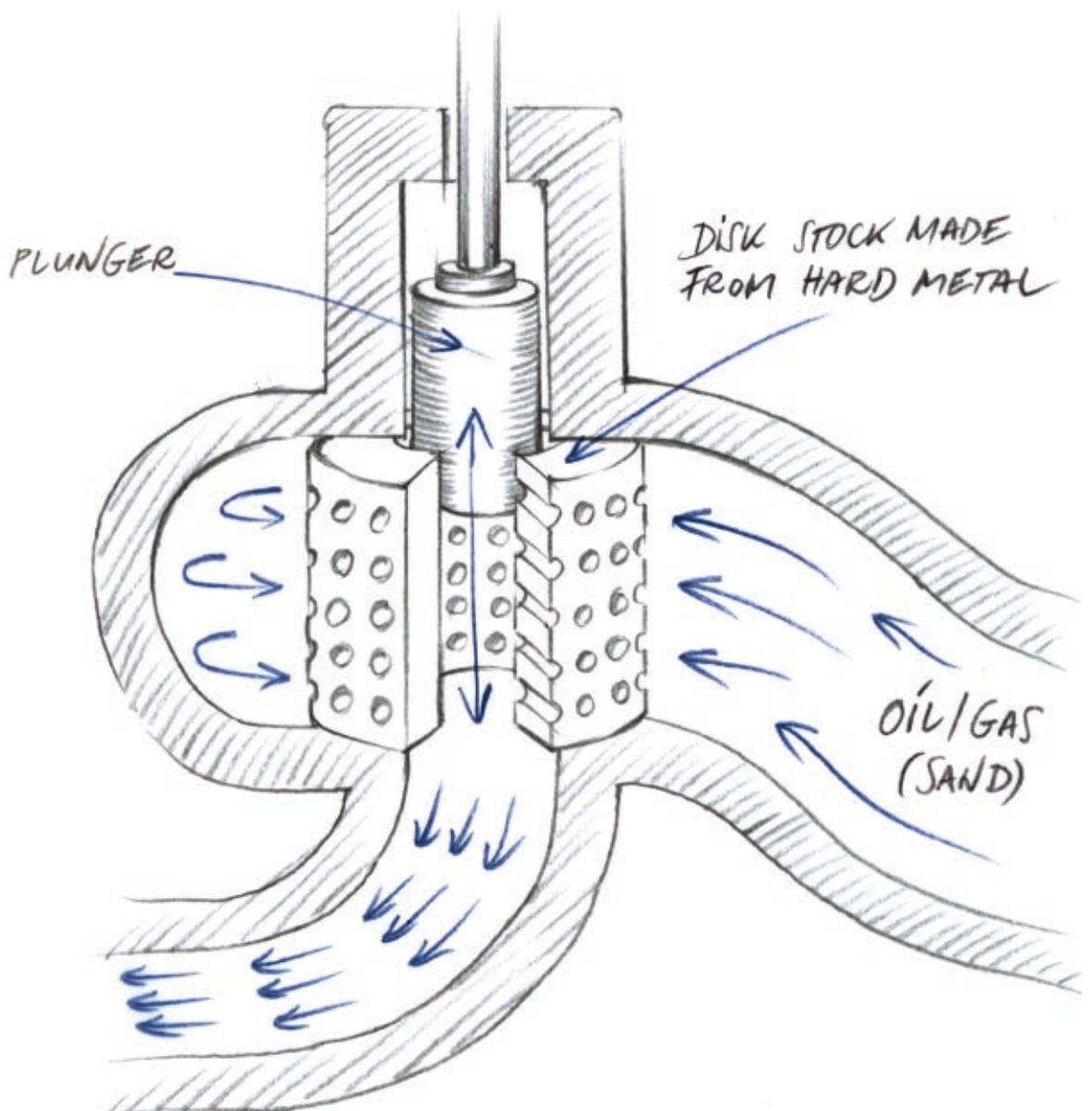
500 participants

The 18th Plansee Seminar was booked to capacity with 500 participants. Every four years, the Plansee Group hosts the largest specialist conference for refractory metals and hard materials.

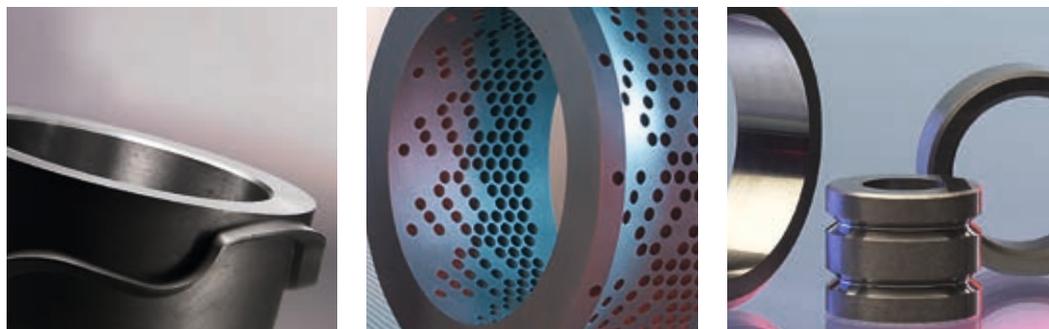
XL hardmetal blanks

For diapers, rollers and tamed gas

When industry gears up production for large quantities and efficient manufacturing processes, the tools need to grow as well.



Valve for the petro-chemical industry:
A hard metal plunger that moves vertically in the component regulates the flow and pressure of gas or oil.



Extra-large plant components made from hardmetal: Rotary cutter for hygiene products, control valve components, rolls for the steel industry (from left to right).

No matter whether it is in the fields of punching and rolling or pressure regulation, it is not just a question of wear resistance, but often of sheer size as well. The biggest challenge is that the body, which is pressed from tungsten carbide powder, must have an exceptionally homogeneous structure so that it keeps its shape after sintering. A glance at some of the industries in which hard metal blanks with a diameter of up to 650 millimeters are used.

Hard, fracture-proof rotary cutters

Hygienic rotary cutters made from hard metal have been used for years to manufacture diapers. The sharp edges of the rotary cutters cut the shapes from a long web of cellulose material. The hard metal must be so tough and fracture-proof that a rotary cutter is capable of making more than 250 million cuts. Over the past few years, the size of the rotary cutter has also begun to play a crucial role in addition to the properties of the hardmetal. This is because the demand for adult diapers has grown considerably. Whereas a blank with a diameter of 250 millimeters is needed to cut baby diapers, the hardmetal blank for adult diapers needs to have an external diameter of 650 millimeters.

Hundreds of drilled holes are needed as well as the preformed cutting edge. The cellulose is first sucked onto the roller using a vacuum through these holes. Once the product has been cut, it is stacked using compressed air. The holes must be drilled very accurately to make sure that this technique works properly. The blank is already very close to the required final shape, so that only a small amount of finishing is required on the part of the customer.

Corrosion-resistant valve components

Another field of application for large hard-metal components are valve components in the petrochemicals industry. The valve regulates the flow of gas and oil. This is an important function in oil production operations, because the gas and oil are pumped to the surface under enormous pressure. For example a valve cage has some 1500 holes to allow the pressure and quantity to be adjusted very precisely. As soon as the plunger is withdrawn from the valve cage, the holes are free to allow the gas or oil to flow at exactly the rate required. Because other materials such as sand are also pumped up with the gas and oil, the blank must be made of an extremely wear- and corrosion-resistant

material. That is why Ceratizit uses nickel binder grades.

Temperature- and pressure-resistant rolls

In hot-rolling mills, kilometer-long steel components are rolled several times to constantly reduce their diameter before they are finally drawn to form wires and pipes. Steel pipes are used in a wide variety of applications, such as axles of vehicles. Rolls made of hardmetal are used in the final rolling operations. These must be able to resist high temperatures and enormous pressures. This is because the steel components are by now moving through the rolls at speeds going from two to hundred and twenty meters per second. Ceratizit manufactures these rolls in a variety of diameters up to 450 millimeters.

XXL plants for hard metal blanks

Hardmetal manufacturers are up against it when their customers need such large hardmetal components. To start with, the plant must be designed to handle such large components. To make this possible, Ceratizit has invested in a new cold isostatic press. Ceratizit uses its decades of experience of large-format components and complex sintering processes to produce the customer specific parts in excellent quality. ■

Oil and gas industry

Tapping new reserves

Tungsten powders help to increase the performance of drilling tools and catalysts in the petrochemicals industry.



Renewable energy already plays an important role in power generation and will be crucial in meeting our energy needs over the long term. However, fossil fuels will continue to be an important element of the energy mix for the foreseeable future, heating our houses, powering our vehicles and meeting our demand for electricity. Ultimately, global demand for energy makes it necessary to locate and open up new reserves of oil and gas in places where this had previously been impossible. Tungsten-based materials from Global Tungsten & Powders help to improve the performance of drilling tools and catalysts in the oil and gas drilling and processing industries.

Ammonium metatungstate (AMT) is needed for manufacturing tungsten cata-

lysts, used for a variety of reactions in the petrochemical industry. AMT is a source of high-purity, water-soluble tungsten which is essentially free of alkali and other metallic impurities. The tungsten catalysts support a number of different reactions during the processing of crude oil. These include oxidation, hydroxylation, hydrogenation and polymerization. Tungsten carbide-based spray powders are used in the petrochemicals industry to increase the wear resistance of components such as check valves, sucker rod couplings and pump cases. Tungsten thermal spray powders are melted in a plasma flame and sprayed onto the surface that is to be coated. They are processed by subcontractors that specialize in coating or by OEMs.

GTP has been supplying manufacturers of traditional tri-cone drill bits with ready-to-press tungsten and tungsten carbide powder formulations for many years. But new drilling methods are now needed to exploit reserves of oil and gas that are difficult to access. Deeper drilling and the challenge of overcoming multiple and harder rock formations as well as considerable cost pressures drove the development of polycrystalline diamond compact (PDC) bits. These bits reduce overall drilling costs by decreasing the risk of destruction in the borehole and increasing resistance to wear. To help bit manufacturers achieve these improved characteristics, new tungsten powders needed to be developed. Working together with the manufacturers of these PDC bits, GTP has invested heav-



When new concepts for deep, complex drilling operations are needed, PDC bits using new tungsten compounds reduce the overall costs.



ily in order to develop the most suitable tungsten powder formulation for each specific application. Investments have been made in new production facilities and equipment, analysis and quality equipment and manufacturing systems. Process optimization continues to ensure constant powder quality and minimization of waste and costs. ■

Drilling methods in the petrochemicals industry

There are two fundamentally different drill bits used in the petrochemicals industry: tri-cone bits and PDC (polycrystalline diamond compact) bits. Tri-cone bits comprise three conical rollers with teeth arranged at an angle to each other. Bits of this type are used for drilling through soft and semi-hard rock. PDC bits have no moving parts and use diamond, ceramic inserts or hard metals to cut through harder rock formations. Since the end of the 90s, the petrochemicals industry has increasingly relied on PDC bits due to their high resistance to wear.

“Avoiding dependences”

Helmut Antrekowitsch, professor of non-ferrous metallurgy in Leoben/Austria, explains how companies can make use of recycling to deliberately boost their independence in the area of raw materials.

livingmetals: Why are companies thinking about the recycling of raw materials?

Prof. Helmut Antrekowitsch: Essentially, adequate reserves of raw materials are available around the world. Nevertheless, many of the important raw materials are concentrated in only a few regions worldwide, and the global market is also dominated by just a couple of commodities corporations. Dramatic increases in price have meant that raw materials now make up anything up to 70 percent of production costs in the metallurgy sector. This has been compounded by the fact that the raw materials policy in Europe over the past 20 years has sometimes been a catastrophe, with the extraction of raw materials being shut down in many places as early as the 80s and 90s. Now, many companies are bolstering the security of their raw materials supply through backward integration and recycling.

livingmetals: When does recycling become a viable option?

Prof. Helmut Antrekowitsch: Looking at it from a short-term perspective, recycling depends very heavily on global market prices for specific raw materials, which are extremely volatile. The result is that the extraction of metals from secondary raw materials, for instance, is not always profitable. But we also have to consider the importance of reducing strategic dependences in the field of product manufacture, particularly in the high-tech sector. In Europe in

particular, large quantities of secondary raw materials are generated, but only a small percentage is actually recovered. Significant amounts are still committed to landfill or are exported out of the European cycle. On the one hand, it is necessary to lobby for the necessary political conditions for profitable recycling, and on the other, it is crucially important that a recycling mentality permeates the whole of society. Another benefit of sustainable recycling is that it would prevent extreme price fluctuations caused by speculation or the formation of monopolies in the primary resources markets. The economically viable extraction of resources from secondary materials, however, also presupposes that recycling processes will develop more rapidly, because product life cycles and hence the life expectancies of products with a given composition and construction are becoming ever shorter, as can be seen by the speed with which CRT screens have been replaced by flat-panel screens.

What is recycling?

Recycling refers to the recovery of secondary raw materials. Things that are recycled include production waste such as scrap, slurry and other residual materials as well as products that have come to the end of their service life. “Urban mining” is a buzzword from the field of recycling and is primarily concerned with secondary raw materials in urban environments.



About Professor Helmut Antrekowitsch

Helmut Antrekowitsch is professor of non-ferrous metallurgy at the University of Leoben in Austria, and his work focuses on primary metallurgy, recycling and materials technology for non-ferrous metals. In 2012, together with his brother Jürgen, Helmut Antrekowitsch was voted Austrian of the Year in the category “Research”.

livingmetals: What role does resource efficiency play in your research?

Prof. Helmut Antrekowitsch: Absolutely crucial, although there are a number of issues here: How can we minimize the amount of raw materials and energy used and how can we maximize output? How can we optimize process control and the proportion of residual materials? Another challenge is posed by the networking of collection, processing and process technology as well as recycling-oriented product development. In this context, the simultaneous recovery of different metals has an important role to play, because this could substantially minimize the quantities of residual materials and input materials and also reduce the quantities committed to landfill. The “zero waste” principle is of great importance in this respect.

livingmetals: What do you mean by that?

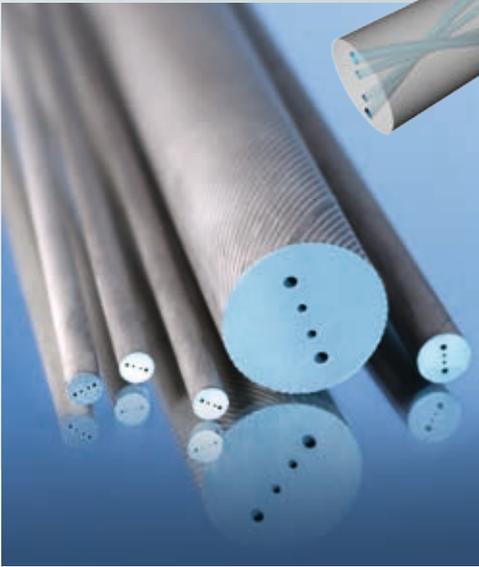
Prof. Helmut Antrekowitsch: Electronic waste, for instance, contains a large number of different materials (plastics, metals, inert materials, etc.). As a rule,

however, only the primary metals such as steel, aluminum and copper are recovered along with some precious metals that are only present in very low concentrations, but are of considerable value. Other critical raw materials such as rare earth metals, refractory metals, indium, gallium and so on are not recovered and are generally found in clinker and dust, which are currently not recycled. If the same recycling rates as are currently applied to the bulk of products also applied to these materials then all the materials could be recycled. This would make a decisive contribution toward reducing strategic dependences in the case of critical raw materials. To achieve this objective, we have to promote the development of appropriate technologies. This type of simultaneous recovery of materials also significantly reduces the hazardousness of the remaining residual materials.

livingmetals: Is the development of recyclable products making progress?

Prof. Helmut Antrekowitsch: At the moment, functionality almost always

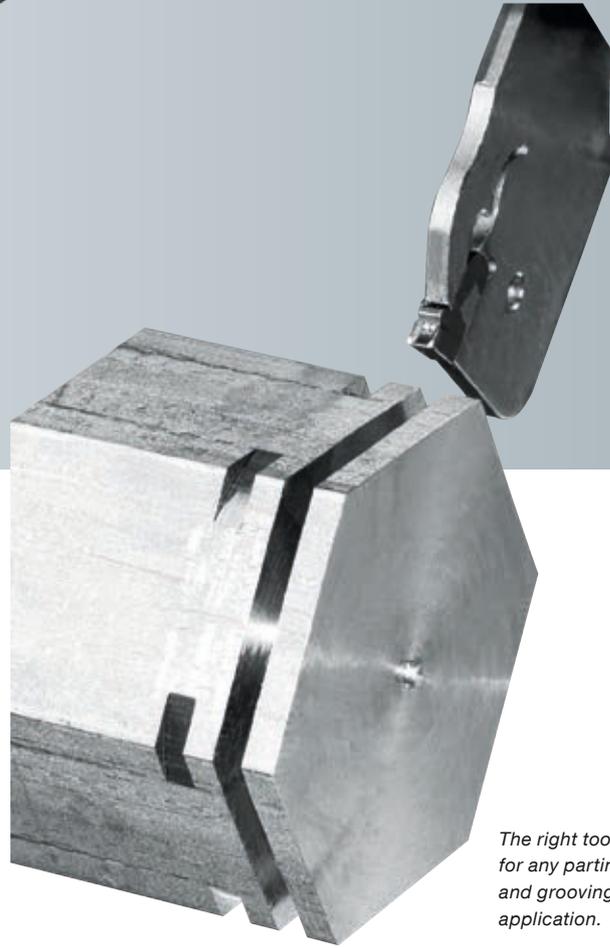
takes priority over recyclable design in the product development field. Not only that, high-tech products are often made from composite materials and are welded, glued and coated in a variety of ways, which makes it extremely difficult to separate the materials when the product reaches the end of its life. On the one hand, recycling technologies need to be improved to allow more selective recovery. On the other, labeling of the individual components and materials represents a first step towards long-term depollution and an acceptable recycling rate. These demands have already been largely met in the automotive industry and I expect to see similar developments soon in the electronics industry and other sectors. ■



"Built-in" cooling ducts in rod blanks.

The really cool bit

Solid metal bits are used for drilling holes in metal components in industrial applications. This can cause high temperatures at the cutting edge. Both the tool and the workpiece need to be cooled reliably to prevent damage to either. The cooling ducts, either straight or spiral, needed for internal cooling are already "built in" in the rod blanks supplied by Ceratizit. As of this year, Ceratizit has also been able to offer hard metal rods with four spiral cooling ducts. The outer ducts keep the entire solid hard metal bit cool and flush the chips out, while the inner ducts cool the cutting edge.



The right tool for any parting and grooving application.

Comprehensive parting and grooving

The right tool for any parting and grooving application. That is Ceratizit's claim. A precision parting and grooving system for machining small gearbox components, bearing rings and other small precision parts promises to make life easier for machine operators: A patented threaded bush allows the insert clamping screw to be adjusted

very simply on either side. This means that it is no problem to machine the workpiece in an overhead position. Wherever maximum precision is required for components with complex structures, Ceratizit has the answer with an axial parting and grooving system for extremely small diameters as of ten millimeters.



Even better service in the WNT online shop.

Even better WNT service

The completely rebuilt WNT online shop offers even better service than before. The newly improved shop boasts a range of 45,000 machining tools. At "toolingcenter.com", customers can see at a glance what products they have already purchased from WNT and can simply reorder these or any of the other of the 45,000 items stocked by WNT. The online shop makes life a

lot easier, particularly for established customers who know exactly what they want. And for all other customers, there is WNT's service pledge: Whatever their machining challenge, customers will be advised by experienced machining experts, whether by phone or on the internet, even at the customer's own plant or machine.



MaxiDrill drills hubs for wheel rims particularly well.

Wide and deep

High precision is needed here: The MaxiDrill 900 indexable insert drill is particularly good at drilling hubs for wheel rims. As the name suggests, two cutting inserts are used to drill into the material instead of a single drill bit. Since the introduction of the MaxiDrill 900 two years ago, Ceratizit has gradually extended its range of drilling tools which is now regarded as one of the most comprehensive on the market. The diameter of the indexable insert drills varies between 14 and 63 millimeters, and the maximum overall length of the drill is five times the diameter.



Transport container for radioactive material.

High density guaranteed

Radioactive isotopes must be stored and transported in particularly well sealed, high-density containers. Isotopes are radiating radioactive nuclides of chemical elements. They are used in many different fields, for example for radiotherapy in medical applications. Safes and containers made from tungsten-based heavy metal alloys absorb radioactive

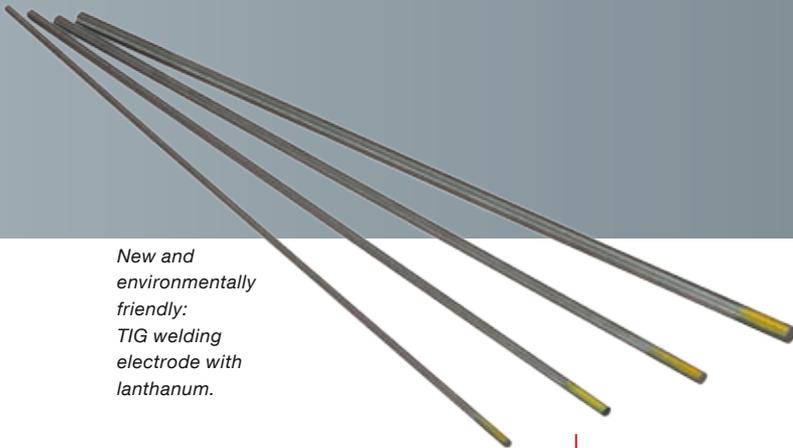
radiation reliably. They ensure that radioactive nuclides are securely shut away. Due to their high densities, even thin sheets provide reliable protection against radiation. Thanks to the ductility and high melting point of the materials, these safes and containers are able to withstand even the harshest mechanical, thermal and corrosive environmental conditions.



Hard metal only where needed.

Glued blanks for machining wood

Skirting boards get their characteristic profile from hard metal cutters. The blanks needed for shaping are finished by the tool manufacturer. To reduce the cost of the blanks while maintaining quality, Ceratizit only uses hard metal where the cutter comes into contact with the wood. After all, this is the only place where it is needed to guarantee a long service life and accurate cutting. Steel is used for the rest of the blank. The steel and the hard metal are permanently bonded with adhesive.



New and environmentally friendly: TIG welding electrode with lanthanum.



25 euro coin with an icy blue niobium core.



Goodbye for good!

Why use it if you can do without? For several decades, tungsten electrodes containing thorium were the first choice material for demanding applications such as TIG welding, plasma spraying or high intensity discharge lamps. But statutory regulations regarding the handling of thoriated materials have, over the past few years, led to increasing costs in production, packaging, shipping and disposal for both manufacturers and customers. This was reason enough for Plansee to decide to supply only electrodes made from environmentally friendly tungsten-lanthanum as of mid-2014. These have a number of persuasive characteristics: good ignition properties, a comparable service life and, above all, the fact that process

parameters do not need to be changed, for instance for plasma spraying. Direct comparisons between welding electrodes have even shown that although the ignition time of conventional electrodes is in principle as fast as the new, environmentally friendly electrode, the new development actually ignites faster on high-alloy steel. Another bonus: Endurance ignition trials have shown that the environmentally friendly variant is subject to far less wear than the old one. This has also been proven in several scientific appraisals and studies. A large number of Plansee customers have already made the change and are now thoroughly convinced of the benefits of using lanthanated tungsten electrodes.

Niobium in all its glory

Every year, the Austrian Mint or "Münze Österreich" brings out a silver-niobium 25 euro coin. The niobium core of this collector's piece is produced by Plansee and is always presented with a different design and in a new color. This year, this special coin sparkles in an icy blue and honors Austria's tunnel building expertise. To achieve the desired color, the niobium metal is treated as follows: An anodizing process forms an ultra-thin oxide layer on the surface of the niobium. The thickness of the oxide layer determines the color. The refraction of the incident light causes the oxide layer to shine in a range of different hues.



Dr. Michael Schwarzkopf at the 2013 annual press conference.

Second most successful year ever

The Plansee Group continues its expansion strategy

In spite of the flagging economy, the Plansee Group plans to continue expanding while simultaneously becoming more productive and innovative.

In the last fiscal (year ending 28th February, 2013), the Plansee Group generated revenues of €1.23 billion (compared with €1.52 billion in the previous year). This meant that consolidated group sales were down by 19 percent. The main reason for this was the sale at the end of 2011 of the PMG division (annual sales of €200 million). The sales figures also reflect cautious purchasing strategies on the part of our customers and a fall in the prices of raw materials. Chairman of the executive board, Dr. Michael Schwarzkopf said that “bearing in mind that we have had to operate in a global market environment characterized by uncertainty and that previously booming China provided little stimulus, we are extremely satisfied. In financial terms, 2012/13 even turned out to be our second most successful year ever.”

As in the preceding year, sales outside of Europe accounted for 52 percent of the Plansee Group total (America 31 percent, Asia 21 percent, Europe 48 percent). Half of Group sales were achieved in three sectors: mechanical

engineering, automotive and consumer electronics.

Focus on molybdenum and tungsten

The Plansee Group has gradually increased its holding in the Chilean company Molymet to 14 percent. The company has annual sales of US\$1.2 billion and 1620 employees. Schwarzkopf: “This reflects our continuing commitment to our strategy of focusing on the two high-tech materials molybdenum and tungsten.” Molymet is a listed company and is the world’s largest processor of molybdenum ore concentrates, with a market share of 30 percent. “In the last fiscal, Molymet increased its stake in the West’s largest processor of rare earth metals, the US company Molycorp, to 20 percent.”, said Dr. Schwarzkopf.

The Ceratizit division acquired a 50-percent holding in the German tool manufacturer Günther Wirth. The company employs 400 staff at five production sites.

The total number of employees at the Plansee Group fell by around 400 to 5710. As part of the process of streamlining the global production network, the Californian company Plansee Thermal Management Solutions in San Diego was sold and one of the production lines at GTP in Towanda (USA) was closed down.

More than €180 million invested

During the last fiscal year, the Plansee Group made investments of more than €180 million. This included investments in additional production capacity in Austria, Germany, the USA, China and India as well as the holdings in Molymet and Günther Wirth. The new Plansee High Performance Materials production plant in Shanghai is due to start production in the summer. Plansee spent a total of €29 million on product and process innovations.

Earnings satisfactory

Despite the fall in sales, the past fiscal year was successful financially. “We have learned from the financial crisis and



Plansee HPM is building a new cold rolling mill in Reutte, Austria.



Plansee India is expanding production capacity in Mysore, India.



Plansee HPM is building a new plant in Shanghai, China.



GTP is installing a second production line for SOFC interconnects in Towanda, USA.



The Plansee Group is increasing its stake in Molymet to 14 percent.



Ceratizit is acquiring 50 percent of the shares in the tool manufacturer Günther Wirth.



Ceratizit India is purchasing new production premises in Uluberia, India.



Ceratizit Austria is building new production plant in Reutte, Austria.



Ceratizit Germany is expanding production capacity for tungsten carbide powder in Empfingen.

have again been able to achieve our financial objectives. With equity capital of around €1 billion (59 percent of total consolidated assets) and a healthy cash position (negative gearing), we have proved that we can continue to conduct our business successfully even in difficult times,” stressed Dr. Schwarzkopf.

Outlook: Flexibility and expansion

The Plansee Group expects business to remain stable over the current fiscal year. Schwarzkopf: “We are not expecting any significant growth stimulus. The uncertainty in the financial markets and the sovereign debt crisis are simply too much of an obstacle.” He explained that business

planning would pose ever greater challenges under such conditions and that the Plansee Group would, as a result, focus even more strongly on continuing to improve their competitiveness, on a high level of flexibility, financial independence and attractive products and services. Dr. Schwarzkopf announced that the Plansee Group would continue to pursue their global expansion strategy throughout 2013/14. Dr. Schwarzkopf: “The potential for growth in the fields served by our materials is there. Our primary focus is on expansion in America and Asia. Merger & Acquisition activities will play an important role.” ■

Over the past fiscal, the Plansee Group has invested more than 180 million euros in additional production capacity and equity holdings.



*Professor of Management,
Hermann Simon.*



*Professor Diran Apelian
from the Worcester
Polytechnic Institute, USA.*

18th Plansee Seminar

“Materials solutions for megatrends”

At the beginning of June, the Austrian town of Reutte saw the world’s largest conference for the powder-metallurgical manufacture of refractory metals and hard materials, which attracted 500 scientists from 30 different countries. Here, we present a summary of the opening presentations.

Author and Professor of Management Hermann Simon used his opening presentation to talk about the importance of innovativeness for companies if they wish to be successful in the global market. From a global perspective, according to Simon, there are no saturated markets. Rather, the global market is a massive driver of growth and innovation. The foundation for success is what Simon refers to as the “hidden champions”, namely small to medium-sized companies. These are big exporters who are global market leaders, but rarely make the headlines on Wall Street Online or in the Financial Times. Simon spoke about the key factors behind the success of these companies:

Being better than the competition:

A hidden champion puts all its efforts into delivering top performance in all areas of its business. This applies to its objectives (to become a market leader), and its efforts to concentrate on a specific market, to achieve maximum value added and to conquer the relevant markets worldwide. This superiority is based on the idea of doing (many) little things better than the competition.

Being able to deliver innovation quickly and unbureaucratically:

The effort invested in innovation by hidden champions far exceeds the knowledge or expectations of their customers. Top management is fully involved, and intelligent thinking is more important than budgets. A strong

culture of cooperation means that innovations can be put in place far more quickly and cost efficiently. Hidden champions register five times more patents per employee than large corporations. And the costs per patent are only a fifth of those of the corporations.

Bringing together the market and the technology:

The iPod was not a new idea. But Apple were the first to package this idea in such a consumer-friendly way that it became a bestseller. And it is the same for many other innovations. The ideas are good, but they are not thought through properly from the perspective of the customer. Hidden champions have an excellent sense of the needs of their customers and meet them with tailored (technological) innovations.



*Professor Susanne Norgren
from Sandvik.*



*Dr. Dimitry Shashkov
from H.C. Starck.*

Throwing it away is not an answer.

But how can “monsters of complexity” such as smartphones be recycled? And is it possible to make money in the process? Professor Diran Apelian from Worcester Polytechnic Institute, USA, spoke about the sustainable recovery and recycling of resources. A quick retrospective throws light on the huge challenge faced by the recycling industry today: Whereas a computer chip only contained eleven different elements 30 years ago, this number has risen to 45 today. And such a chip could, for instance, lie at the heart of a smartphone, which requires many additional elements. Apelian called these collections of materials “monsters of complexity”, and they are seen as lucrative sources for urban mining. And with good reason: Between 200 and 300 grams of gold can be extracted from a tonne of discarded smartphones. In contrast, a tonne of gold ore yields only a few grams.

For Apelian, the crucial question is how to exploit this lucrative source. The plastics industry could show the way. Here, plastic waste is converted to fine granulate, classified using optoelectronic technology, and then sorted into different types. Apelian: “If it works in the plastics industry, it should also be possible for metals. Especially if you consider that the recycling of metals is a far more lucrative enterprise.”

Focus on modeling

Professor Susanne Norgren from Sandvik provided an overview of the main research topics in the world of hard metals. This includes the modeling of phenomena on a variety of scales and the ensuing correlation of the results: From atomic structures such as grain boundaries to microscopic properties such as internal stress and onto component structures and the macroscopic analysis of entire components. Modeling helps hard metal researchers to better understand the structure and chemical composition of hard metals, to characterize microstructures in great detail, to design interfacial surfaces and grain boundaries and to perform atomic calculations of interfacial bond strength.

Other research focuses on the microalloying of carbides, the development of hard metals with gradient structures and extremely fine-grained microstructures as well as the trialling of alternative metallic binders.

Increased performance and reduced costs

For Dr. Dimitry Shashkov from H.C. Starck, these are the two crucial levers to ensure that refractory metals remain the materials of choice in high-tech applications of the future. Shashkov: “Thanks to their properties, refractory metals are increasingly being used in demanding applications.” But not at any price. The industry will have to help

customers find new applications for refractory metals and use them more effectively in existing applications. With respect to costs, Shashkov went through all the production steps from raw materials procurement to recycling with a fine-tooth comb looking for savings. According to Shashkov, the greatest savings are possible when material manufacturers work closely with their customers to reduce the amount of refractory metals used in the final application. At the same time, it is important to improve the performance of refractory metals by developing new alloys, focusing on the microstructure level during materials design, and making more intensive use of coatings. Shashkov was more reticent concerning the use of additive manufacturing methods in the field of refractory metals. The advantages undoubtedly include reduced input material consumption, shorter production times and the possibility of creating complex shapes and producing prototypes far more rapidly. But he still sees a number of challenges: calculation of shrinkage behavior, avoidance of porosity in the materials and the question of whether these technologies will actually be able to reduce bottom-line manufacturing costs. ■

Sailing

Power on the open seas

A sense of adventure is one thing, but a little luxury is an essential part of any sailing trip. Navigation systems, radar and radio go without saying. And nowadays, nobody wants to do without a refrigerator, computer and television. Whereas previously anyone setting off into the wide blue yonder had to choose between solar panels, wind turbines or the noise of the boat's diesel engine, in future they will only need a fuel cell to supply sufficient power on board, no matter whether they are in the safety of the harbor or on the open seas.





The Plansee Group at a glance

Close to our customers, worldwide

Santa Fe Springs (California, USA)
Vista (California, USA)

Warren (Michigan, USA)
Towanda (Pennsylvania, USA)
Franklin (Massachusetts, USA)



Molymet (Chile)

The Plansee Group is represented worldwide by Centers of Excellence which focus on market needs and are located close to the Group's customers.

- ▶ 34 production sites in three continents worldwide
- ▶ Sales offices and representatives in 50 countries



Austria



Luxembourg



St.-Pierre-en-Faucigny (France)

Niederkorn (Luxembourg)

Mamer (Luxembourg)

Livange (Luxembourg)

Creutzwald (France)

Biel (Switzerland)

Seon (Switzerland)

Alserio (Italy)

Germany



Bulgaria



Italy



Hitzacker (Germany)

Empfingen (Germany)

Balzheim (Germany)

Lechbruck (Germany)

Reutte (Austria)

Liezen (Austria)

Bruntál (Czech Republic)

Gabrovo (Bulgaria)

Switzerland



Czech Republic



France



India



China



Taiwan



Mysore (India)

Bangalore (India)

Kolkata (India)

Zhangzhou (China)

Xiamen (China)

Tianjin (China)

Shanghai (China)

Seoul (Korea)

Japan



Wugu (Taiwan)

Tamsui (Taiwan)

Sakura (Japan)

Esashi (Japan)

Imprint

Proprietor and publisher:

Plansee Group Service GmbH
6600 Reutte, Austria
living-metals@plansee.com
www.plansee-group.com

Editor-in-chief/contact person:

Dénes Széchényi, Group Communications
Tel. +43-5672-600 2243

Contributions from:

Dr. Christoph Adelhelm, Barbara Heuß, Chris McKenna, Nadine Kerber, Dr. Bernd Kleinpaß, Dr. Andreas Lackner, Josef Langenwalder, Ulrich Lausecker, Sarah Melcher, John Schoonover, Dr. Lorenz Sigl, Stefan Skrabs, Dr. Michael Schwarzkopf, Dr. Andreas Venskutonis, Hermann Walser

Editing, Layout, Publishing:

mk publishing GmbH
Döllgaststraße 7–9, 86199 Augsburg, Germany
Tel. +49-821-3 44 57-0, Fax -19
www.mkpublishing.de

Photo credits: Plansee Group, mk publishing, Michael Paetow, Yi Luo, Deutsche Messe, DayStar Technologies, J.N. Eberle & Cie. GmbH, Jeanneau, NASA, Richard Pürcher, fotolia.de/pressmaster/Mihai Simonia/Sergey Nivens/Lars Koch/vitavalka/Wolfgang Cibura, istockphoto.com/morkeman, shutterstock/Captain Yeo/chalabala