

BEYOND SURFACES

Prof. Paul Heinz Mayrhofer, TU Wien

COATINGS

Layer players: these experts pursue coating perfection

Breaking boundaries: on the verge of new laser cladding applications

In the fast lane: these surface treatments are driving automotive

oerlikon



«When we talk about coating, then we don't just mean the layer itself. We see and understand the requirement involved, give thought to a solution – and look for ***the best answer that must be both ecologically and economically sound.***»

«JUST COAT IT» IS SO YESTERDAY

Faster, more durable, lighter, more economical – these properties are readily used to characterize the products of our modern world. At Oerlikon, our association here is primarily that of resource efficiency: reduced losses due to friction, less wear, less material employed, less fuel consumed, to cite some examples.

This is where our coatings play to their strengths. But not only that: Whereas they used to be problem solvers and were included in functional considerations, today they are also a design element. For us, efficiency in this context also means thinking outside the box. Where can we offer added value beyond the mere coating? How can the entire manufacturing process be fine-tuned for more expediency in the customer's interest? This is why the range of services we offer no longer comprises coatings alone. We give thought to the Before – meaning how the surfaces can be best prepared for a coating. And we give equal consideration to the After – meaning what is the best post-treatment for the tools or components that will enhance the customer benefit. Both the pre-treatment and the post-treatment are an integral part of our service for customers, which begins with fundamental consulting and does not stop with our delivery service.

Our heart beats for technology, for our systems, our materials, and our processes. In research and development, questions dealing with surfaces that are “smoother” and harder, have greater temperature stability and just generally exhibit continuously improving mechanical properties, are our daily bread. The same holds true for our partners in industry and at universities with whom we join forces in the search for new solutions, with the end goal of making those solutions industrially exploitable in a manner that serves our customers' goals. The passion behind a task like this is one of the things Prof. Paul

Heinz Mayrhofer, Chair of Materials Science Research at the TU Wien, relates to us starting on page 6.

Challenges and inspiration alike result from long-standing partnerships with industry, such as with Kazuyuki Kubota, Head of Manufacturing Department and visionary for coating technologies at Mitsubishi Hitachi Tool Engineering, Ltd. in Japan. For more than 30 years, we have been pursuing answers to the same question side by side: What can we make possible next? On page 26, Kazuyuki Kubota shares a few of his visionary ideas with you.

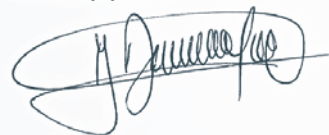
A shared idea also bonds us with a division of Daimler AG in China, the Beijing Benz Automotive Co., Ltd.: How can we best protect our environment from pollution? That we sometimes even need to “rediscover metal” to do so is reported in our story on page 10.

This is precisely what sums up Oerlikon for me: a pioneering spirit that has remained unbroken for decades, always seeking out the best solutions for our customers and for our world.

It's my desire to share this enthusiasm with you through the articles in our magazine BEYOND SURFACES as our customers tell about their very specific solutions and our staff and partners report on their passion to make things “faster, lighter, more durable, and more efficient.”

I wish you great reading enjoyment on this journey of discovery.

Cordially yours,



Marc Desrayaud
Head of Business Unit
Balzers Industrial Solutions, Oerlikon



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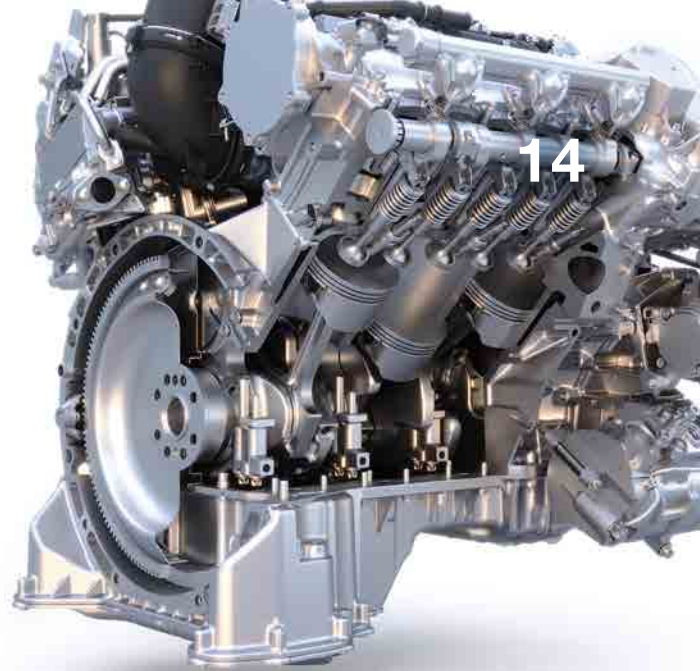
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«Without materials science, there wouldn't be any technology.

The development of mankind has always been linked to materials. There's a good reason why entire epochs are named after them: Stone Age, Bronze Age, Iron Age, ...»



«God made the bulk,
**SURFACES WERE
INVENTED BY THE DEVIL»**

Researchers like Paul Heinz Mayrhofer make significant contributions to the expanded use of intelligent coatings in industry. During a visit in Vienna, the materials scientist explained what this is about and the role of Oerlikon Balzers in this area.

By Gerhard Waldherr

Mayrhofer is a specialist in hard coatings. He has received a series of awards for his work. In 2011 the prestigious Christian Doppler Research Association awarded him a seven-year laboratory grant, which he is completing this year at TU Wien.

We have just arrived in a basement room in which a part of the Christian Doppler Laboratory, Application Oriented Coating Development, is set up. It is supported by Oerlikon Balzers and the Tirolean Plansee Group, which manufactures powdered metallurgical materials. Nestled between colorful hoses, wires and gray cabinets stand numerous pieces of equipment to which Mayrhofer and his students have given female names. One is called Angie, another Ylvi, and another is named Noreia after the Celtic goddess of ore.

Mayrhofer displays a cathode made of tantalum. The material is atomically evaporated in the equipment using a high input of energy. The method employed is called Physical Vapor Deposition (PVD). The particles which are thereby released attach themselves to the materials and elements in their proximity. If they should happen to come into contact with drills, spindles, piston rings or the like, these objects are given a coating which can be significantly thinner than a human hair and nearly as hard as a diamond.

The largest piece of equipment that the professor and his staff use for research purposes is called INNOVA and has been provided by Oerlikon Balzers. It is located in the old quarters of the TU on Karlsplatz at a distance of five minutes on foot.

Room ACEG31. There is a sign outside: PVD Laboratory. Inside stands a squarish box that looks like a monstrous oven with soot-covered heating coils. Up to six cathodes with different materials can be employed

in the INNOVA. The material is transformed into a vaporous state by means of an arc evaporation process, but also using cathode sputtering. The trajectory of the ions can be controlled using electromagnetic coils. This helps them find the right place to attach themselves. The professor says: "You need to have an exact understanding of the materials right down to the atomic level."

More on this follows in Mayrhofer's office. There are models of crystals on the cabinets. The wall is adorned by a large whiteboard with a sketch consisting of chemical abbreviations, letters and numbers, all connected by circles and arrows.

Prof. Mayrhofer, would you let us in on the secret behind the formulas on the board?

We are currently dealing with tungsten carbide and tungsten nitride. The idea is to incorporate tungsten in a hard, firm layer. On contact with a sulfurous environment and high pressures, it develops a lubricant. Its effect would be comparable to that of molybdenum sulfide.

Essentially, you create materials that do not exist in that form in nature, right?

That's right. Our objective is to develop materials with higher strength and greater toughness, but also improved thermal stability. Usually, however, these properties are mutually opposed. When you improve the hardness of a material, it is usually at the cost of lower toughness. And vice versa.

And what would be an example for a layman?

Gold is a soft metal, as we know, which can be deformed very easily. A knife made of gold would make no sense because it would be dull after the first cut. That doesn't happen with a ceramic knife. However, the →

Vienna, Technical University, Getreidemarkt 9. It is a cold Tuesday in March, nine o'clock in the morning and Univ. Prof. Dipl.-Ing. Dr. mont. Paul Heinz Mayrhofer is punctual. He is a friendly man with a youthful demeanor, who listens benevolently and answers patiently. Mayrhofer mentions that he has office hours at around noon and a lecture at 2 p. m.: "Shall we?"

Indeed, we shall. There is a good deal to see and even more to discuss.

Professor Mayrhofer is the director of the materials science research department at the technical university in Vienna, known as the TU Wien. He studied in Leoben in Styria and has researched in the US state of Illinois, in Sweden and in Aachen, Germany.

«The surface is always a complex matter because it is subject to so many influences.»

ceramic knife would break immediately if it fell to the ground. So we look for combinations utilizing the strengths of materials so that their drawbacks can be compensated.

Why did you choose a profession like this?

In my school in Burgenland, Austria, we took a career aptitude test in the 8th grade. It indicated that I should pursue a technical profession. A cousin of my mother was a shop teacher at the polytechnic school in the city of Eisenstadt. He was of the opinion that I should choose materials technology as my field of study. A number of teachers at the polytechnic school came from the university for metallurgy and mining in Leoben where I then studied materials science.

What's so fascinating about materials science?

Without materials science, there wouldn't be any technology. The development of mankind has always been linked to materials. There's a good reason why entire epochs are named after them: Stone Age, Bronze Age, Iron Age, ...

In what materials epoch are we living today?

As a materials scientist, I would have to say: in the Silicon Age. Silicon is a semiconductor, so we could also say the Semiconductor Age. However, for communications in the modern world, i. e. for smartphones, computers, laptops and so forth, you also need rare-earth metals. This is still a relatively unknown field.

Which materials are the special focus of your research?

A class of materials that I have dealt with throughout my career is that of the nitrides. They are the chemical compounds which result when nitrogen combines with metals. A compound with which my name is connected worldwide is titanium aluminum nitride.

Which materials might be of significance in the future?

What has been moving into focus more and more of late are the borides, or chemical compounds of boron with metals which display ceramic properties. They are even harder than nitrides, but, naturally, are also much more brittle.

Materials consisting of two elements, such as binary nitrides, carbides or borides, are considered to be well researched. What potential do materials consisting of three or more elements have?

We refer to these as ternary, quaternary or multinary compounds. These allow considerable improvements in material properties. At the same time, the complexity involved in the development of multinary systems like these is greater. Put differently: It takes much longer to thoroughly research and understand these compounds.

For example?

Titanium nitride is a common compound of two elements that has been in use now for a long time. The disadvantage: It forms a porous oxide layer. But if aluminum is added

to the titanium and the nitrogen, the material properties change significantly. Aluminum also forms an oxide layer, however it is stable and dense. Titanium aluminum nitride is a material which develops higher strength when stressed through temperature or mechanically, making it especially suitable for drilling, cutting or milling tools.

If you combine all of the known elements, the possibilities are innumerable.

That's right, the permutations result in millions of approaches. As a researcher, you are faced with questions your whole life long and it never stops, especially with coatings. The surface is always a complex matter because it is subject to so many influences. The physicist Wolfgang Pauli used to say, "God made the bulk; surfaces were invented by the devil."

You have an INNOVA from Oerlikon Balzers in your lab. What do you use it for?

We use the INNOVA to ensure that our process development is as industry oriented as possible. The objective is resilient, stable coatings. As we do so, we work with fundamental aspects of research findings. What works. Where and how it works. What spectrum of possibilities exists. We also use complex computer simulations with which the properties of the coatings can be calculated at an atomic scale and thereby improved. Oerlikon Balzers specialists then refine our findings for customer applications.

How would you evaluate the interaction between research and industry in general?

Research and industry go hand in hand. Research needs the applications from industry. Industry needs the findings and knowledge from research. The two are inseparably connected.

¹ The rare-earth metals include a total of 17 chemical elements from the third group in the Periodic Table (with the exception of actinium) and the lanthanides. They find use especially in key technologies, such as LEDs, lasers, optical fiber cables or in medical technology.

You are the academic dean for mechanical engineering, industrial engineering and materials sciences. Can you comment on the added value of this interdisciplinarity?

Take a turbine, for example. In it, the materials operate at their limits. The turbine blade must be exceptionally tough; it must not break under any circumstances. At 1300 degrees Celsius, of course, it needs a ceramic coating. That is materials science to the max. Mechanical engineering supplies the technical framework. And the industrial engineer has to ensure that the turbine can be produced cost effectively. For it all to work, everyone needs to understand all the others.

Back to materials science. If I were to compare the field with a world map, is everything known and charted or are there still blank spots?

My gut feeling says there are still many blank spots. In our field, we tend to be at the beginning of the discoveries because we don't even know most of the element combinations yet.

Where does research stand? Are we still at Marco Polo or already at Christopher Columbus?

Neither one. With reference to materials science, we only know parts of Europe. With regard to all the other continents – to keep with the metaphor – we probably don't even know they exist.

A flexible all-rounder for ambitious uses

INNOVA is the preferred coating system size for most production requirements and is perfectly suited for small to large quantities.

It is the all-rounder for PVD coatings. The name INNOVA has become a synonym for performance, reliability and versatility.

Find out more about INNOVA:

 www.oerlikon.com/en/innova

Prof. Paul Heinz Mayrhofer, born in 1972, lives in Neckenmarkt, Burgenland with his family.

AUTOMOTIVE EMISSIONS MOTIVES

Aluminum is key to the sustainable automobile. **Beijing Benz Automotive** relies on the technologies of Oerlikon Balzers when punching and casting the metal.

In the land where iron was born, metal stamping is being reinvented.

You might not think that automotive origins would be uncovered in archaeological sites whose artifacts date to the 5th century BC. After all, this is the century when Pheidippides ran 42 kilometers from Marathon to Athens – a distance he could have covered much faster if he'd had access to a rental car. But in that same era, the ancient Chinese had already processed iron, and they went on to invent the method for making steel. We couldn't get behind the wheel or onto the highway today without the work of those pioneering ironworkers.

And speaking of pioneers: You also might think of cars as an early 20th century invention. But in fact, the first motorized ("horseless") carriage appeared in 1886 – the work of two German gentlemen named Karl Benz and Gottlieb Daimler.

Given those twin histories of innovation, it's no surprise that automotive R&D thrives at Beijing Benz Automotive Co., Ltd., a Mercedes-Benz subsidiary. Today, the company's priorities include initiatives that promote environmental protection. Major OEMs have issued requirements for vehicle weight reduction as a means of increasing fuel efficiency and reducing emissions. To comply with those demands, the company must reduce the weight of sheet metal parts as much as possible without compromising rigidity and strength.

The obvious material to achieve these goals is aluminum, but the company faces many challenges in developing this solution. "These changes will place high requirements on molding, such as the molding of aluminum alloy," says Li Shanshan, Stamping Senior Manager, Manufacturing Engineering. "The relevant parameters may not simply be copied from the existing parameters for steel molding. We need to start all over again."

Advancing technology, protecting the environment

The team relies on Oerlikon Balzers as a partner in this reinvention of automotive metal forming and design. Surface technologies such as Pulsed-Plasma Diffusion (PPD) are proving to be game-changers in improving both the stamping process and the durability and maintenance requirements of parts. Beijing Benz Automotive has applied the PPD treatment process to the molding of some key components, such as the side and fender, of the best-selling C-Class automobiles on the market.

"It is actually able to improve the wear resistance of our dies, and hence reduce scratches and wear between the sheet and die in the production process," Li Shanshan says. "This can indirectly extend the service life of the die and therefore reduce the workload of our offline die maintenance, especially in terms of die care."



«The Pulsed-Plasma Diffusion treatment process reduces scratches and wear between sheet and die during production which leads to **less workload of our offline die maintenance.**»

Li Shanshan, Beijing Benz Automotive Co., Ltd.

The carbon-based BALINIT TRITON STAR coating technology delivers an additional competitive advantage in aluminum sheet stamping by “reducing the adverse effect of aluminum scraps on our product quality,” which “is very helpful in ensuring normal production,” says Zhang Dongwei, Stamping Process Supervisor, Manufacturing Engineering. “We used this coating technology on two aluminum parts for our E-Class model to solve the aluminum scraps issue that is prone to occur during production. In Europe, the application of this technology is likely standard use. In China, however, we may have been the first OEM to have used this technology.” →



A roadmap for continued innovation

There are more firsts ahead, in China and throughout the world. The automotive industry is pursuing strategies for making environmental protection as much a part of its identity as individual mobility and distinctive style already are.

Demand for vehicles is accelerating in emerging markets. The United Nations projects that the planet's population (currently 7.6 billion) will reach 8.6 billion by 2030, 9.8 billion by 2050, and stand at 11.2 billion in 2100, meaning that billions more consumers are on the way. And as the urbanization trend packs more and more people and vehicles into metropolitan areas, air pollution has created an urban health crisis.

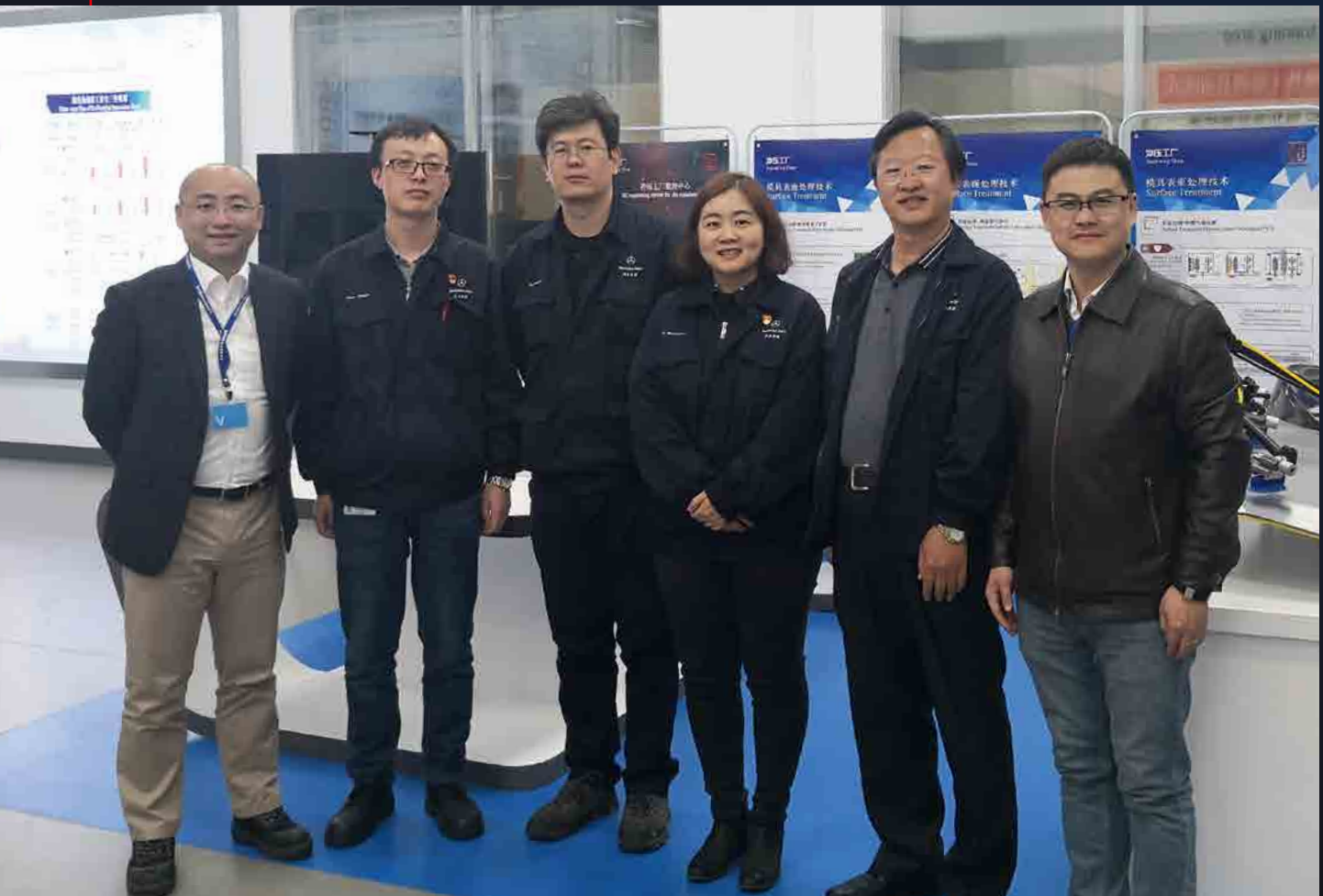
For Beijing Benz Automotive, these trends signify a need to lead the industry not just in automotive innovation, but also in environmental responsibility and stewardship. The company therefore is committed to employing technologies that redefine best practices in metal stamping, forming, and surface treatment – practices whose end benefits support the automotive industry's contributions to the beginning of a cleaner, healthier, and more sustainable world. Its partnership with Oerlikon Balzers creates the opportunity to develop OEM solutions that can take current advances even farther.

“This approach to collaboration is a hallmark of our team's approach to R&D,” says Henry Guo, Head of Tools at Oerlikon Balzers China. “The more

the engineers understand the challenges their customers face and the standards the industry is establishing, the better equipped they will be to introduce innovations that deliver enhanced production, improved fuel efficiency, and meaningful gains in the reduction of carbon emissions.”

By working together, the two companies are already realizing the potential that surface treatment technology has to achieve these results. As they continue to define industry challenges and pursue more advanced solutions, they are well positioned for a productive ongoing relationship.

From left: Mr. Henry Guo, Oerlikon Balzers China, Mr. Chen Wengui, Mr. Xu Honghai, Ms. Li Shanshan and Mr. Zhang Dongwei from Beijing Benz Automotive Co., Ltd., Mr. Leo Huang, Oerlikon Balzers China.





The Future of Industry 2ND MUNICH TECHNOLOGY CONFERENCE ON ADDITIVE MANUFACTURING

**SAVE THE
DATE!**

From the way we reduce carbon emissions to the way we replicate nature's creative processes, additive manufacturing (AM) is fueling a revolution, layer by layer.

What opportunities will it create? What will it take to win in this new landscape? Answering these questions productively and profitably requires conversation and collaboration.

The 2nd Munich Technology Conference on Additive Manufacturing (MTC²) will advance idea exchange among world-renowned decision makers and leaders from industry, academia and politics. The main focus of the conference is the industrialization of additive manufacturing. Participants will consider the challenges of different markets (aero-

space, automotive, medical etc.), the entire process chain as well as its individual parts. Further questions the conference will look at include:

- › How can we speed up the industrialization of AM?
- › Which materials are being used today and in the future?
- › What are the main cost drivers? What does a cost roadmap for AM look like?
- › What is possible to print, what are limitations?

MTC², hosted by Oerlikon together with the Technical University of Munich and other partners, will be held **October 10–11, 2018 in Munich, Germany.**

For more information, visit
www.munichtechconference.com



LIKE GREASED LIGHTNING

Coatings play a central role in the automotive industry. Their use helps **reduce fuel consumption, lower emissions and increase wear resistance.** In engines, we find a wide variety of coating technologies.

Despite growing sales, the automotive industry must confront and master profound changes: Emissions standards are becoming stricter, more efficient vehicles are in demand and e-vehicles are on the rise, as are networking and digitalization.

Progress toward the goal of making engines more efficient means they are becoming smaller all the time. They

have fewer cylinders, and these are subject to higher pressures and place more stress on the smaller parts. Exhaust gas recirculation, start-stop systems and turbochargers also contribute to increased corrosion in the engine. Suitable measures make it possible to meet these challenges: BEYOND SURFACES offers twelve examples of how engines are being improved through use of Oerlikon

coatings. They help to increase the performance and service life of engine components as well as reduce friction and wear. This improves both fuel and oil efficiency and lowers emissions. More than half of the ten largest automobile manufacturers employ coating solutions from Oerlikon.

1

Clearance control coatings for reduction of clearance



4

Laser hardening of complex shapes



2

OD and ID surface coatings for friction and wear reduction



5

Direct coating of connecting rod big end bearing



3

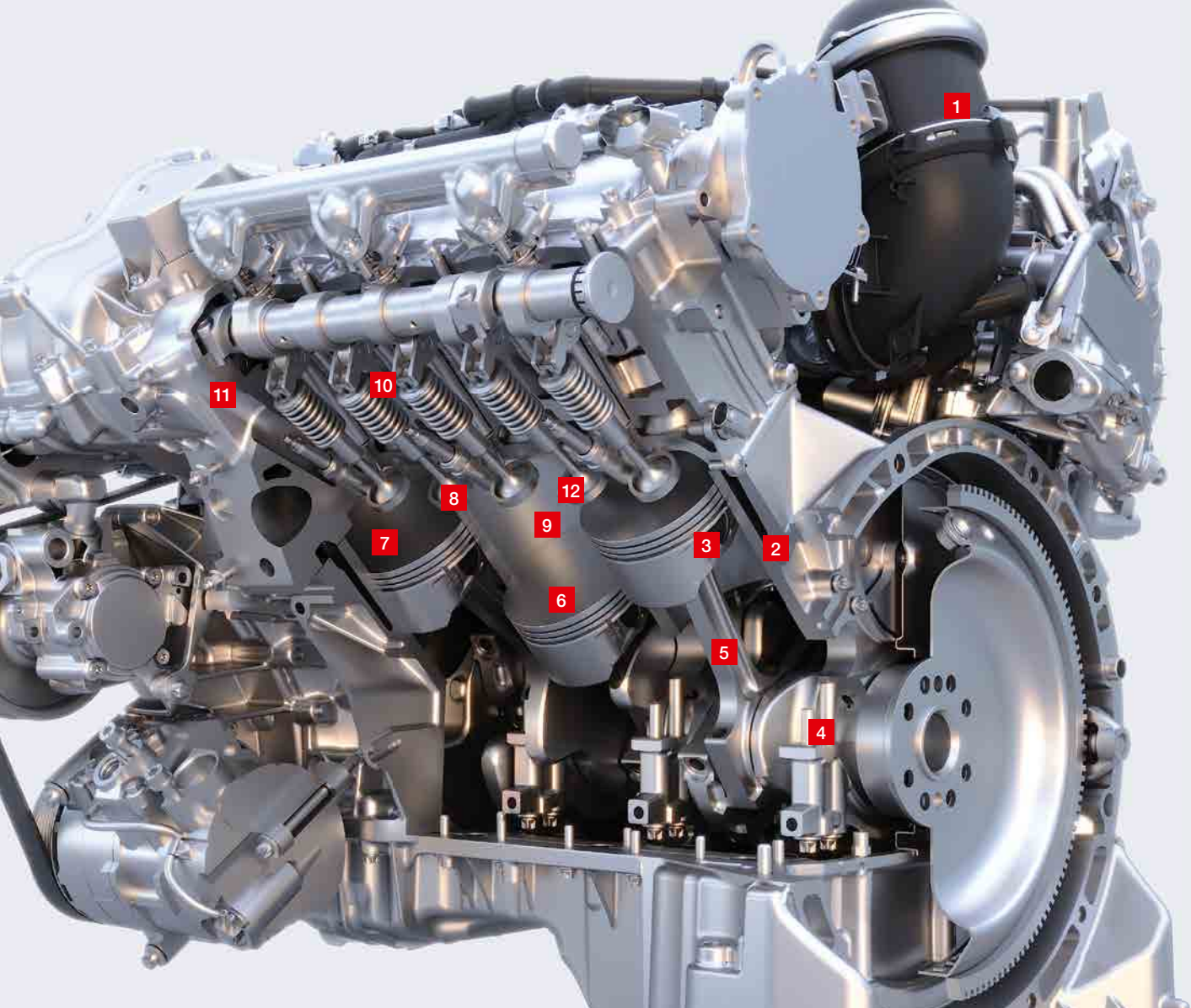
DLC coating for wear protection and friction reduction



6

Thermal barrier coating for insulation







7
Thin film oxide coating for protection from scaling




10
DLC coating for wear protection and friction reduction




8
Laser cladding to improve design freedom




11
ID laser cladding for wear protection



9
SUMEBore coating for friction and wear reduction and corrosion resistance



12
Thermal barrier coating for insulation of combustion chamber



TRULY **INGENIOUS**

In **laser cladding**, a material's surface is melted while at the same time another material is applied. Although the technology is already 30 years old, it has been booming since the beginning of this decade. We spoke with **Dr. Arkadi Zikin, Global Technology Leader for Laser Cladding at Oerlikon Metco**, about the tremendous potential this process holds.

Dr. Zikin, more and more industry sectors are discovering the advantages of laser cladding. What are the strengths of this method?


In comparison to plasma welding, the energy influx of the laser into the materials to be welded can be controlled and dosed very well. What happens is this: Whenever we connect two materials by melting the surface of the base material and applying another material, the materials become mixed. This means that with conventional welding processes, such as MIG welding, we obtain different surface properties than those the applied material would have by itself. Depending on the quality of the base material, it is therefore difficult to reproduce the result. In order to obtain a defined surface, conventional methods typically require several layers to be applied one on top of the other. With laser cladding, however, the mixing of the materials is only one tenth of that which results from MIG welding. Because of this, we can achieve the desired properties in the component with a significantly thinner

material build-up. Moreover, the laser's energy can be controlled with exceptional precision. Consequently, even the smallest areas of only 0.2 mm in diameter can be processed, and very little energy is required to melt the surface here. Or, to put it differently: Due to the additional capacity for focus, the laser can achieve energy densities that would be very difficult to obtain using conventional thermal processes. This also means that the supporting component is exposed to a great deal less thermal stress, which results in a lower risk of warpage.

How did your discovery of this technology come about?

During my studies, I worked with multifunctional surfaces and saw the ongoing potential for developing many new areas of application using laser cladding. I found that truly exciting and thought about how I could use my knowledge to make a contribution. After completing my studies and subsequent doctoral work, I went to work for a German job-shop specialist for laser welding. All the theory in my head was one thing. But there I was able to implement my →

«The flexibility of this technology fascinated me. With a laser, you can work **very delicately, but you can also deal with large surfaces.**»

A portrait of Dr. Arkadi Zikin, a man with curly brown hair, wearing a dark grey blazer, a blue shirt, and a patterned scarf. He is standing in a laboratory or industrial setting, with his right hand resting on a piece of machinery. In the background, there is a large white robotic arm and a complex mechanical assembly with various wires and components. The lighting is bright and focused on the subject.

Dr. Arkadi Zikin
Global Technology Leader for
Laser Cladding, Oerlikon Metco

knowledge on the machines and learn an unbelievable amount while doing so. The flexibility of this technology fascinated me. With a laser, you can work very delicately, but you can also deal with large surfaces. That makes it possible to find solutions for many different tasks.

And then came the move to Oerlikon.

(Smiling) I've always been drawn to places where I can learn new things. In Oerlikon, I've found a company that is at the cutting edge of technology. I welcomed the opportunity to further develop the area of laser cladding internationally as an expert. Moreover, participating in opening up as yet unknown areas of application with this technology – and perhaps even using entirely new materials – is definitely very attractive. As the Global Technology Leader, I am the technical point person for all questions dealing with laser cladding. This enables me to make contributions for our customers as well as here in-house, regardless of whether the issue is equipment assembly, new materials in development or service support on site.

Laser cladding has been around for almost 30 years. What do you see for the future?

I see three directions of development. The first from my perspective would be “high-speed laser cladding”. At the Fraunhofer Institute in Germany, work is being done on “EHLA – extreme high-speed laser cladding”. Using this method allows feed rates that are 100 to 250 times faster as compared to current laser cladding, and the very thin (yet at the same time very dense) coatings can be built up. This is especially of interest from an ecological perspective because coatings that today are still being applied by galvanic means

«In cooperation with ETH Zurich we are currently **exploring individual laser cladding process parameters and developing new fields of application** for laser cladding.»

(meaning they are not very environmentally safe) can be replaced by this method.

A second approach would be an increase of the laser's power. This now already allows larger surface areas to be melted and coated – squares with a side length of up to 45 mm for example. Or greater film thicknesses of two or three millimeters can be realized in only a single pass. This type of laser cladding promises to deliver even better surface properties than are known today for special applications.

A third would be that laser cladding is being positioned for use in the field of additive manufacturing. The background for this is provided primarily by alloys based on titanium, aluminum or copper that are very difficult to process using currently widespread welding procedures. I see an attractive potential here for laser technology. This would allow very complex structures to be built up layer for layer. A keyword here would be 3D printing.

Another application direction is essentially very similar, for example in the automotive industry: Large structures,

such as lightweight construction engine blocks, will undoubtedly still be cast. But in assemblies like these, there are areas that must possess special properties, for example valve seat rings, which are exposed to high thermal and mechanical stresses. Instead of pressing these rings made of special metals in place as is done today, they could be built up directly on the cast structures by means of laser cladding.

All in all, we are currently in a very exciting time with this technology. I'm quite certain that in the next few years many new areas of application will open up for laser cladding.

What are you currently working on in your research at Oerlikon?

Innosuisse is the Swiss agency for the promotion of innovation. In January 2018, it assumed the function of the previous Commission for Technology and Innovation (CTI). Through one of its projects, we are currently developing new fields of application for laser cladding in cooperation with the Swiss Federal Institute of Technology (ETH Zurich). The topic is “Laser Hard Coating”. It deals with the objective of reducing the wear of components subject to

extreme mechanical stress using new coatings as well as experimenting with materials that are difficult to apply. In this collaboration with ETH, we are attempting to explore the relationships between the individual laser cladding process parameters and the different materials at a depth that would not be possible for either of us on our own. We are contributing our coating systems and our know-how to this project and are engaged in a lively exchange of information. The initial results are very promising.

(Read more about the joint research project on page 20 and 21.)

Why should customers look to Oerlikon for their laser cladding needs?

There are plenty of companies that sell coating equipment or powders. We want to understand our customers first and foremost. Especially in the case of laser cladding, a deeper process understanding is of great importance. We are pleased to be able to work together on customer applications and to help find solutions to new challenges. I think the overall package at Oerlikon is very good: We have the right materials and the right coating technology for different applications and offer the necessary support wherever it is desired.

Thank you very much for the interview!

Oerlikon offers services in the area of laser cladding in diverse industry sectors, from medical technology to gas turbines. Read more here:

www.oerlikon.com/en/laser-cladding-services



Dr. Arkadi Zikin

Dr. Zikin completed his master's degree at the Tallinn University of Technology (Estonia). Research work subsequently led him to AC2T research, the Austrian Excellence Center for Tribology in Wiener Neustadt, where he earned his doctorate in the context of a collaboration between the technical universities of Tallinn and Vienna and AC2T. He wrote his dissertation on the topic of "Advanced multiphase tribo-functional hardfacings". Since September 2015, the laser-cladding expert has been with Oerlikon.

FINE TUNED COATINGS

Today, many industries use laser cladding to coat metal parts in order to make them **more wear and corrosion resistant**. In collaboration with the industrial partner Oerlikon, ETH Zurich develops in an Innosuisse project methods to fine-tune the coating properties. **Jona Engel, Doctorate at the D-MATL Laboratory for Nanometallurgy**, shows first promising results.

What are the latest trends in laser cladding?

Current applications of laser cladding are e. g. the coating of machine parts in mining and construction, as well as the repair of pumps and turbine blades. Embedding carbide particles into the laser cladding is a new process that improves the performance of the coating and enables new material combinations e. g. with the toughness of high-performance alloys (super alloys) and the hardness of carbides and hard-metals. Another advantage of laser cladding compared to conventional welding is the robust automation of the process. Our industrial partner Oerlikon Metco wants to broaden the field of possible applications of this process and to fine-tune the achieved properties. For this, a better understanding of the laser cladding process is necessary.

How do you achieve a better understanding of the laser cladding process?

We need three things: First, simulations that predict what happens during the process; second, experiments that validate the simulations; and third, benchmark testing of the part performance.

Here at ETH Zurich, we have the unique possibility to do joint research in all three areas. My colleagues from the Institute of Machine Tools and Manufacturing have expertise in mechanical engineering and take care of the

simulations. I am part of the Laboratory for Nanometallurgy and have a background in materials science. In my experiments, I use advanced technologies to characterize the coating material and to analyze how the whole part performs. Oerlikon Metco appreciates this interdisciplinary approach and has collaborated with our group for many years.

What kind of advanced technology do you apply for your experiments?

By using electron microscopes and in-situ testing, we can see many more details in the microstructure of the coating. We found out that parts that appear to be similar after the first simple tests are actually quite different if we look closer. Our analyses reveal how the differences on the microscopic level lead to different material and part performances. In materials, performance depends directly on the microstructure. We change the coating properties in two ways. First, we investigate new material combinations. Second, we alloy the feedstock material at very high heating and cooling rates in the laser cladding process and are able to reach unprecedented microstructural features. With small-scale and in-situ mechanical testing, we can find the properties of all phases and optimize the processes in terms of performance. My colleagues use these experimental results to improve the simulations.



How can you fine-tune the coating properties?

In the laser cladding process, we can design the material properties by using the laser as a local heat source. By adjusting the process parameters, we can guide a heat flow through the work piece. This way, we can control how much the embedded hard particles dissolve and what kind of microstructure develops in the matrix. A great advantage of laser cladding is the fast processing that allows to process the material far away from equilibrium. This fast processing window gives us many

opportunities to tune the microstructures and the final properties of the material. In short: We shift the current focus in additive manufacturing from geometry to local properties.

What are the next steps?

We have now coated first parts on an industrial scale, like e. g. large pipes and rolls for rolling mills. The next step will be to test the coated parts for specific applications. With these results, our partner Oerlikon Metco will be able to offer a wide variety of coating solutions tailored to specific applications.

ETH zürich

The Department of Materials at ETH Zurich is one of the best in its field worldwide and enjoys an excellent reputation among its national and international partners.

www.mat.ethz.ch

ETH News for the industry:

www.industrynews.ethz.ch



«In materials, **performance depends directly on the microstructure.**»

Jona Engel,
Laboratory for Nanometallurgy,
Department of Materials, ETH Zurich

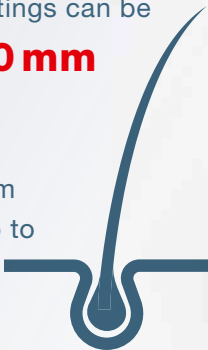
Increased productivity, prolonged service life, cost savings and higher sustainability – **surface technologies from Oerlikon** make all this possible and are employed in a broad range of industries.

Depending on the method and area of application, coatings can be

0.5 μm to 10 mm thick.

This means thin-film coatings can be up to

160 times thinner than a human hair.



Coated tools enable a drilling speed of

210 m/min instead of
80 m/min.

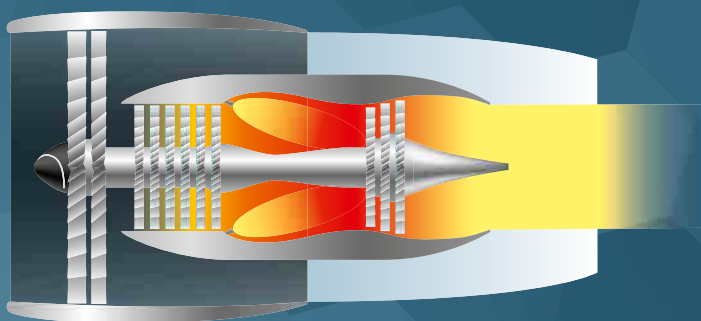
The tool service life is increased by

67%. This represents about
1 000 instead of
600 drilled holes.



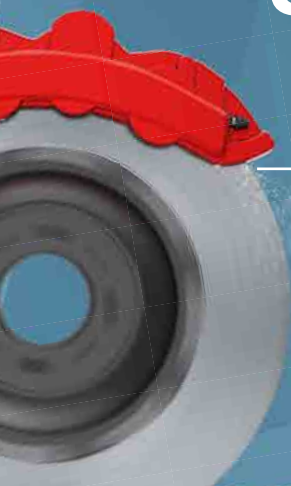
Coated components inside jet
engines must be able to withstand
temperatures in excess of

2 000 °C.



Coatings on cast-iron brake disks prolong their
service life by

300%.



Brake dust emissions are
reduced by

50%.

Different surface technologies are used depending on the application:

PLASMA NITRIDING

1. A nitrogen-hydrogen gas mixture is ionized in vacuum.
2. Nitrogen diffuses up to 15 μm into the edge zones of the base material.

PVD (PHYSICAL VAPOR DEPOSITION)

1. A highly pure, solid coating material is dissolved at 150–500 $^{\circ}\text{C}$ or is sputtered through ion bombardment.
2. The gas and the metal vapors commingle and precipitate as a solid coating.

PACVD (PLASMA-ASSISTED CHEMICAL VAPOR DEPOSITION)

1. Gas which contains elements of the coating material is introduced into the vacuum chamber.
2. The ignition of a discharge arc creates free carbon and hydrogen atoms which then form a metal-free film.

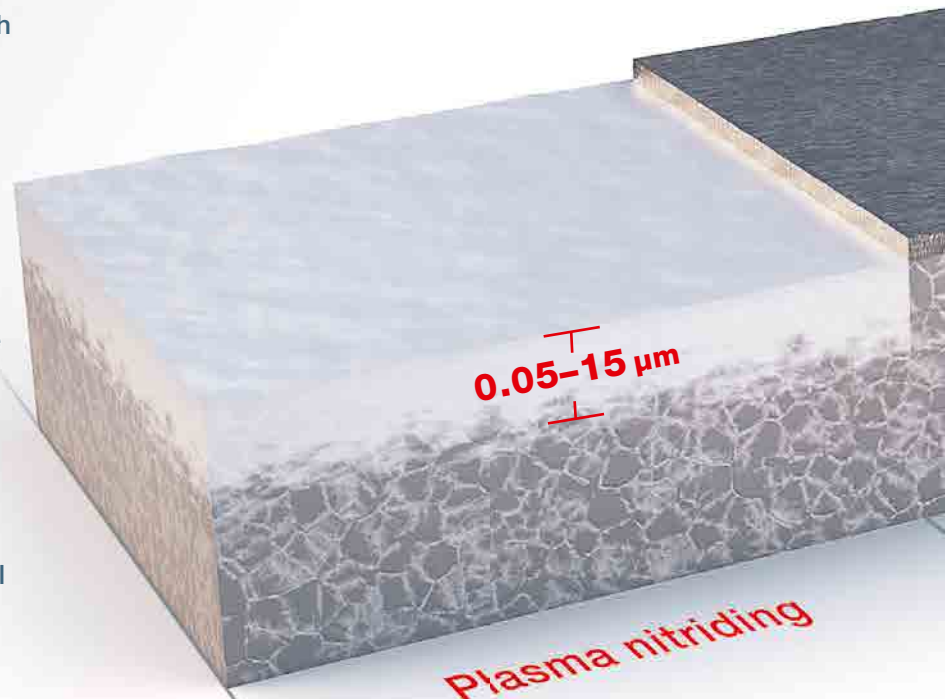
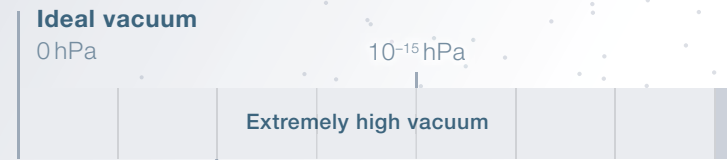
THERMAL SPRAYING

1. Materials in the form of powder or wire are melted at high temperatures.
2. With the addition of kinetic energy, the droplet-shaped spray particles are thrown from the melting area onto the components to be coated.

LASER CLADDING

1. The base material is subjected to local melting and is coated with a material in powder or wire form.
2. The two materials combine to form a metallurgical compound.

A comparison of typical working pressures



Large Hadron Collider CERN
 10^{-10} hPa

10^{-10} hPa

Ultra high vacuum

Low Earth orbit
(200 to 2,000 km)
 $10^{-8} - 10^{-7}$ hPa

10^{-5} hPa

High vacuum

PVD coating
 $10^{-6} - 0.1$ hPa

Medium vacuum

Plasma nitriding
0.5-6 hPa

1 hPa

Low vacuum

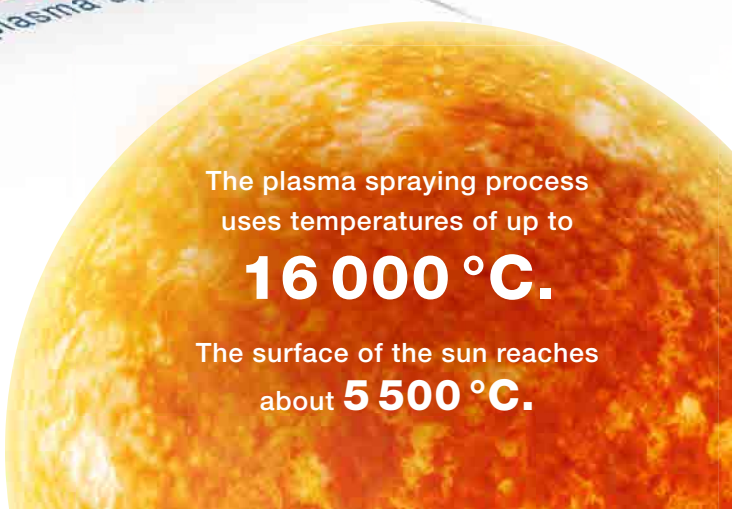
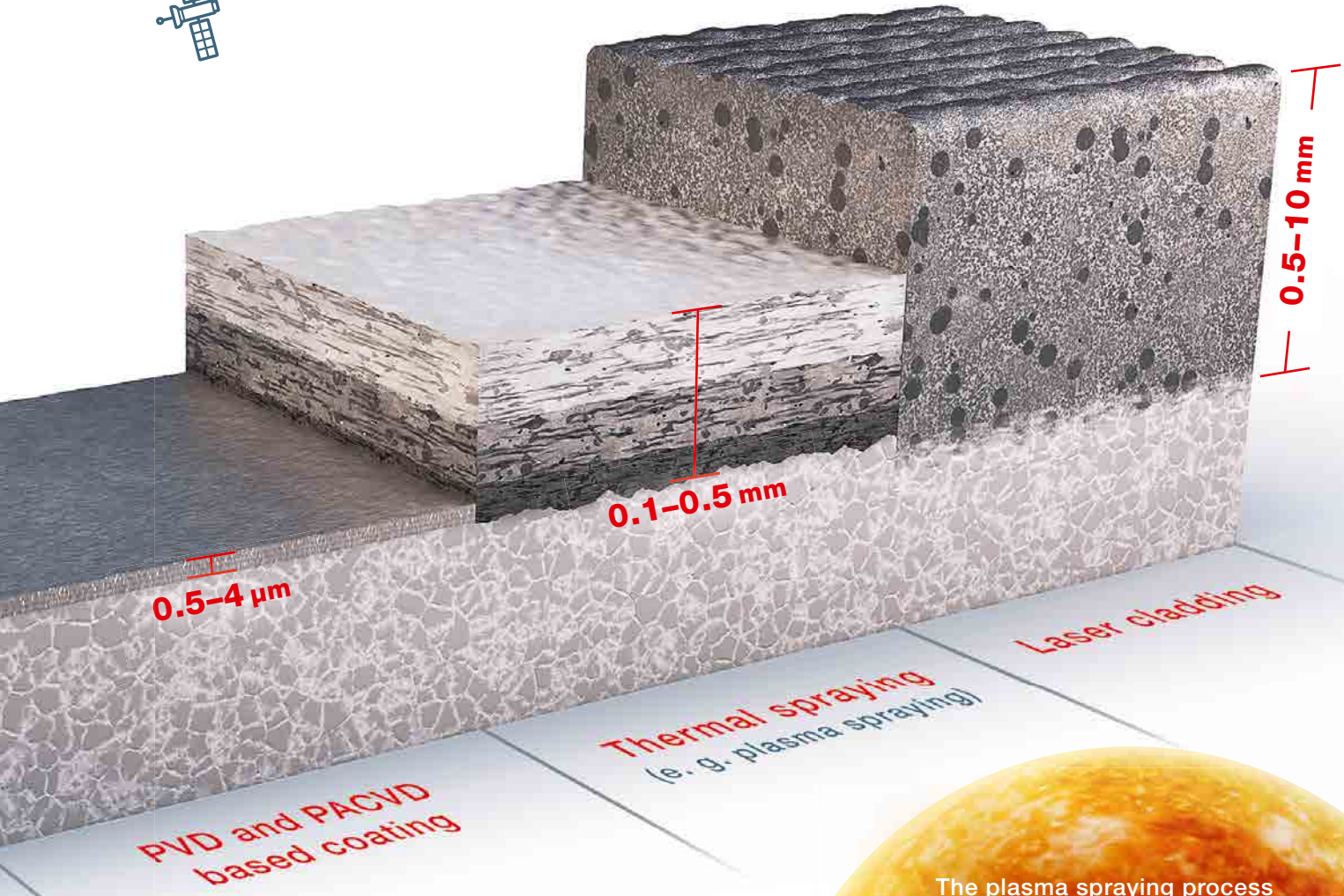
Normal pressure
1 013 hPa

Low pressure
300-1 013 hPa

PACVD coating
1 hPa

Vacuum plasma spraying
50-400 hPa

Atmospheric plasma spraying & laser cladding
Normal pressure



The plasma spraying process uses temperatures of up to

16 000 °C.

The surface of the sun reaches about **5 500 °C.**

30 YEARS OF «WHAT'S NEXT?»

By Randy B. Hecht



Many of us fantasize about living in the future. But at Japan's Mitsubishi Hitachi Tool Engineering, Ltd., **Kazuyuki Kubota, Head of Manufacturing Department and Head of Coating Technology, actually works in the future.** This isn't science fiction. He hasn't mastered the art of time travel. But when it comes to coating systems and technology, Kubota never stops anticipating the next breakthrough in requirements, capabilities and performance.

This makes partnering with him something like playing with a chess master whose mind is always working three moves ahead. Some companies might find that intimidating. But the team at Oerlikon Balzers finds it inspiring. Yes, it's rewarding to bring products to market that "meet or exceed" customers' expectations. But it's more interesting when each product launch motivates the customer to envision the next stage of expectations and performance standards.

To put it another way: the pace of change is so rapid these days that it's no longer possible to use state of the art technology – only technology

«We want to develop new coatings with special compositions that are **beyond the range of the conventional nitride coatings** in the existing market.»

Unstoppable innovator:

Kazuyuki Kubota from Mitsubishi Hitachi Tool Engineering.

that's state of the art for now. Each advance establishes the foundation for the next one. And customers like Kubota drive the Oerlikon Balzers team to work continuously on being first to market with what's next.

Exacting standards, clear-cut results

The right coating can improve a tool's precision, resistance to friction and abrasion, and durability. It can also strengthen a company's reputation. For decades, Mitsubishi Hitachi Tool Engineering has relied on coatings to optimize the performance of its machinery and forming tools as well as its leadership position.

The company, which manufactures and sells tips along with cutting and forming tools made of special steels or carbide alloys, has an obligation to its own customers and a commitment to growing with them. Each new generation of tools employs the latest coating technology to ensure that the company retains its competitive edge in this market. It has collaborated with Oerlikon Balzers for more than 30 years in pursuit of these goals.

More than a decade ago, during development of the new Arc technology, Oerlikon Balzers introduced the INNOVA system, which enabled Kubota's team to reduce the time required to develop and manufacture many new coatings and products. Most recently, Mitsubishi Hitachi purchased the latest advance, INLENIA, a line of coating systems that Oerlikon Balzers designed for ultra-smooth surfaces. The solution attracted Kubota's interest because of benefits such as making customization possible thanks to the

precise, independent scalability of pulse duration, shape, and density. This represents a significant advance in HiPIMS (high-power impulse magnetron sputtering).

"HiPIMS is useful for products that require low particle coating, which is one of the features and advantages of this technology," Kubota says. "To expand our business within these product lines, we are considering installing additional systems. We want to use this system as the foundation of further research and development."

Tomorrow's challenges, in focus today

But his longtime partners at Oerlikon Balzers knew that even as Mitsubishi Hitachi put the INLENIA system's potential to work, Kubota would be thinking about further advances in the technology. He continues to monitor emerging coating system developments and is already considering where to make future investments in those next-generation systems. →

Inspiring collaboration:

Kazuyuki Kubota and Wolfgang Kals, Head of Marketing & Product Management Tools from Oerlikon Balzers in front of an INLENIA kila.

“We want to develop new coatings with special compositions that are beyond the range of the conventional nitride coating in the existing market,” he says. “At the same time, we also consider that another technology is necessary to make these new coatings act properly and functionally on the cutting tools, as well.”

PVD (physical vapor deposition) technology is another area where there is “room to progress and be improved,” he says. “Applying HiPIMS technologies to our products is just the starting point of this progress. By using this technology, we can generate additional hints and ideas for future technologies. Our collaborative work and relationship with Oerlikon Balzers supports our search for such a new technology.”

It’s a search that shows no sign of ending – because every time these partners achieve an objective, they ask themselves what new challenge

they can take on. Of course, the engineers at Oerlikon Balzers have an internal drive to build on their record of breakthroughs. But there’s something empowering and inspiring about having a customer who’s always wondering what can be done to improve current products and solutions. It is through collaboration with clients such as Kazuyuki Kubota and his team at Mitsubishi Hitachi Tool Engineering that Oerlikon Balzers

optimizes its capacity for exploring each successive advance in coating systems and exploiting the full potential of these technologies. And that’s what “working in the future” is all about.

Find out more about the coating systems INLENIA kila and INLENIA pica:

www.oerlikon.com/balzers/en/inlenia

«Applying HiPIMS technologies to our products is **just the starting point of this progress.** By using this technology, we can generate additional hints and ideas for future technologies.»

Innovation is IN OUR DNA

Investors, customers, media and university representatives met in Lucerne for **Oerlikon's Innovation Day.**

By Gerhard Waldherr

The economic success of Oerlikon “would not be possible without innovation.” These were the words CEO Dr. Roland Fischer used to open Oerlikon's Innovation Day 2018. The reason: “Innovation is in our DNA and is firmly rooted at the core of the company.” So why don't we talk about it a bit more often? Why not present to investors, customers, scientists, media representatives and young talents what actually lies behind the business reports, market shares and stock market analyses?

Fascinating technology

That idea was the genesis of the event, which was held at the Culture and Convention Center in Lucerne on April 10, 2018. It provided a forum for discussing fascinating technologies that produce astounding results. The 100 attendees had the opportunity to participate in talks on these technologies. Between sessions, they could see the advances for themselves via photo displays projected on the wall behind the podium. Wind turbines. Aircraft. Cars. Tools. Medical technology. Airbags. Seat belts. Engines. And much more. The common denominators in all of these: Industry 4.0, big data, productivity, effectiveness and profitability, but also sustainability. →

«AM is the first production technology which is **capable of using all of the available data.**»

Florian Mauerer

Head of Business Unit Additive Manufacturing, Oerlikon Group

Prof. Johannes Heinrich Schleifenbaum of the RWTH Aachen University began his talk with the Trundholm sun chariot from the Bronze Age and the Ulfberht sword from the Middle Ages. He did so to demonstrate how “decisive materials have been in the history of mankind.” The 21st century, said Schleifenbaum, is experiencing the next material technology revolution in the form of additive manufacturing (AM). “Through the chemical composition of the materials, the microstructure, surface and geometry, we are able to manufacture things that were previously unthinkable.” Exactly where this journey will lead, said Schleifenbaum, no one can say, but he reckons with at least a “ten-fold increase in possibilities.”

Florian Mauerer, Head of Business Unit Additive Manufacturing at Oerlikon, picked up on these keywords and elaborated on them from his own perspective. “All known production technologies,” he said, “are old, simple and use relatively little

information.” By contrast, AM is the “first production technology which is capable of using all of the available data.” The result, for instance, is that a device can be produced from 12 parts instead of 855, or that manufacturing can achieve waste reduction of 92 percent. Mauerer explained the AM production chain at Oerlikon, from the design to the post-processing. His conclusion: “We are the only ones offering this complete process.”

Other talks dealt with rapid alloy development, intelligent yarn factory monitoring, thin-film coating using S3p technology, synchronizer solutions in transmissions and the future of electromobility. There was plenty of multiplication going on here as well. Five times faster. Twice as hard. One hundred times more durable. And horizons were expanded. Dr. Bernd Matthes, CEO of the Drive Systems Segment, delivered convincing figures for his assertion: “Electromobility is coming, and not only in passenger cars.”



«Innovation doesn't mean merely having ideas, but also implementing them in products that *improve and simplify the lives of people.*»

Prof. Dr. Michael Süß

Chairman of the Board of Directors, Oerlikon Group

Innovation is more than just an idea

It was a sunny afternoon that could have been well-spent differently in Lucerne's historic center or on the shores of Lake Lucerne. Nonetheless, the audience also exhibited a thirst for knowledge after the talks in the hall in front of the auditorium. There, Oerlikon's most recent developments were presented either as models or originals. Dr. Helmut Rudigier was in particular demand as a conversation partner. As Chief Technology Officer, he is responsible within the Oerlikon Group for the coordination of research and development and the facilitation of synergies between technologies and products. Rudigier himself was also enthused: "It amazes me to see what technological depth and breadth we have as a business."

Afterward, the speakers and visitors met on the sixth floor of the center with a view of the lake, piers and boardwalk. Prof. Dr. Michael Süß, Chairman of the Board of Directors, said: "Innovation doesn't mean merely



Drills coated with BALIQ UNIQUE shine in a new color spectrum and facilitate differentiation, classification and visualization of products. In addition, abrasion levels can be detected by the color's condition.

having ideas, but also implementing them in products that improve and simplify the lives of people. Our task is to support our customers as they do precisely that." And that is why you will find Oerlikon in many products people use on a daily basis.

For Süß innovation is not a solo undertaking. He emphasized the importance of cooperative efforts with

universities all over the world as well as with companies like GE Additive or Boeing. His closing comment also reflected this well: "No one is perfect, but a team can be. I think that Oerlikon as a team is quite near to perfection."

Watch the event's video:

www.oerlikon.com/stories/innovation-is-in-our-dna

AT YOUR SIDE

Even closer to our customers

1

NEW CUSTOMER CENTER IN BIELEFELD

MORE EFFICIENCY. MORE KNOW-HOW. MORE FUTURE.

By Gerhard Waldherr

The new Oerlikon Balzers customer center in Bielefeld is the largest of its kind in Europe – and serves customers more comprehensively, efficiently and quickly.

Yes, it actually happened. One is often asked about it when visiting East Westphalia. There are comics, books and movies about it. The matter has even been presented in theaters. The theory: Bielefeld doesn't actually exist. The "Bielefeld Conspiracy" was a topic of conversation during an event celebrating the opening of a new Oerlikon Balzers coating facility in – yes, you guessed it! – Bielefeld.

As 200 guests learned during opening remarks, the "conspiracy" stems from a party joke. But the city's new Oerlikon Balzers facility for tools is quite serious: with 6,000 square

meters of floor area, it is the largest of its kind in Europe. Guests at the event included customers from all sectors and representatives from the press and politics. For mayor Pit Clausen, it was a welcome opportunity to present Bielefeld, which is home to a labor force of 150,000 covered by social security and welcomes an additional 65,000 commuters each day. It is the economic center of the region Ostwestfalen-Lippe (OWL, which translates to East Westphalia-Lippe). And Oerlikon Balzers's new customer center is a perfect fit, said Clausen: "It's truly new, innovative and sustainable."

Factors of success

Marc Desrayaud, Head of Business Unit Balzers Industrial Solutions, had just explained that the city and the region played an important role in making the decision to merge the previous locations of Hildesheim, Spenge and Herford to form a North German center. Bielefeld is situated equidistant from these three cities geographically. Moreover, OWL is also home to well-known German companies such as Bertelsmann, Miele, Dr. Oetker, Seidensticker, Schüco and Wincor Nixdorf. That ensures a solid infrastructure and the availability of well-trained personnel. "These are important factors for successful business operations," Desrayaud said.

Comprehensive technology portfolio available

Bielefeld is the 108th Oerlikon Balzers customer center worldwide and the



«In 2018, we will already reach the order volume ***that was actually targeted for 2020.***»

Hendrik Alfter

General Manager Oerlikon Balzers Germany

most modern of its type. “We are able to offer a comprehensive technology and product portfolio here,” says Desrayaud, “which includes all the necessary systems and the most innovative technology, meaning we can significantly reduce delivery times.” Of course, this also applies to the Oerlikon Balzers S3p technology (Scalable Pulsed Power Plasma) with the BALIQ product family, which ensures wear-resistant, extremely smooth and dense coatings. What’s more, 29 different BALIQ UNIQUE colors are available to customers in Bielefeld. Fittingly, the slogan of the opening celebration was: “More efficiency. More know-how. More future.”

The Bielefeld facility began operations in winter 2017. Consequently, Hendrik Alfter, General Manager of Oerlikon Balzers Germany, was able to draw up an initial balance statement. “In 2018, we will already reach the order volume that was actually targeted for 2020,” said Alfter. This is due to the fact that German tool manufacturers are in great demand and continue to be among the world market leaders.

Close collaboration with customers

“Germany is the location for innovation, making it the core territory for our business strategy,” said Desrayaud, who added that in Germany, Oerlikon Balzers can “develop and optimize new processes which we can

then transfer to other locations.” In other words: What works in Bielefeld will go around the world. Customers with international operations in particular appreciate the fact that they can rely on the same Oerlikon Balzers quality and individual client care on every continent. “We want to make our customers happy everywhere and all the time,” said Alfter. “If I make my customer happy, I also make my management happy.”

Lectures during the two-day event demonstrated just how closely Oerlikon Balzers, industry and customers cooperate. Topics covered included electromobility, steel, plastics and additive manufacturing, about which Andreas Berkau of Oerlikon AM gave a talk. All of these are applications in which coatings from Oerlikon Balzers are employed. Alessandra Doëll,

Head of Communications, said: “If our logo was on everything that Oerlikon Balzers’ coatings is used in, the world would be red.”

At the conclusion, the visitors were able to inspect the inner workings of the new facility. On gray floors with yellow markings for the safety paths, they proceeded from goods reception to the cleaning, polishing and loading areas and on to the coating equipment. The meticulous structuring and organization of the workflow is impressive and it is facilitated by a highly modern, automatic guided vehicle system. Desrayaud says: “Bielefeld is a pilot facility, making it essentially a beacon for the future. Everything we accomplish in Bielefeld will ultimately be implemented in the Oerlikon Balzers customer centers around the world.” So the city not only exists – it is a place in which to thrive. →



1

2 Increased presence in Malaysia New coating center formally opened

At a celebration in March that included a large opening ceremony with numerous guests of honor and customers, Oerlikon Balzers launched the new coating center in Johor (Malaysia). There, two existing service facilities were merged in the interest of creating a new, modern customer center with significantly more production floor space. Investments were also made in equipment employing the latest in technology to meet automotive, aerospace, medical and mechanical engineering sector customers' needs even better. "To accomplish this, we have reinforced our team with additional experts at the coating center in Johor Bahru. This enables us to achieve further expansion of our range of services and meet more needs of business customers from Malaysia and Singapore," said Marc Desrayaud, Head of Business Unit Balzers Industrial Solutions.



Opening ceremony for the new center in Johor, Malaysia.

3

2

3 10 years of growth and an inauguration of new production facility in India

On March 2, Oerlikon's Business Line Friction Systems celebrated its 10-year anniversary along with the opening of a new production facility in Chennai, India. The business line manufactures innovative transmission synchronizers, high-performance carbon friction linings and transmission components. With consistent growth over a decade, the existing facility ran out of production space. The new facility is more than double in size and also provides component and transmission facilities to enhance application and development engineering, which gives the company a competitive advantage. "With this new plant we will further strengthen our leadership in supplying our partners with high-quality products," said Dietmar Köster, Head of Frictions Systems.

A photograph of Peter Ambühl, a man with dark hair and glasses, wearing a grey patterned button-down shirt. He is sitting in an office environment with a window and blinds in the background. The text 'Helping others ACHIEVE SUCCESS' is overlaid on the left side of the image.

Helping others
**ACHIEVE
SUCCESS**

Peter Ambühl
Training Manager,
Oerlikon Metco

«The time spent here was probably the ***best investment we made this year.***»

These are the words Marc L. Zirkle, former General Manager at Impreglon Inc., used to praise the Oerlikon Metco training team. One man is the focal point of all the activities here: **Peter Ambühl, a mechanical engineer who serves as Training Manager at Oerlikon Metco** in Wohlen, Switzerland. He has related to us what he considers to be of importance in his job. →



“Passionate about training” – that describes Peter Ambühl, Training Manager at Oerlikon Metco. As soon as you meet him, you can feel his openness and the pleasure he takes in relating to other people. What motivates him? “Contact with customers, that’s just plain my thing!” he explains with a smile. “I love technology just as much as I love contact with people. And I enjoy passing on my knowledge and experience to others. I’m able to combine these two passions in my job.” He has certainly found his calling in being a trainer.

Deepening knowledge

Oerlikon Metco’s training focuses on topics that deal with coating and repairing surfaces. The training can be customized to emphasize each customer’s needs. Instruction covers diverse technologies, products and applications, each presented in this context: “Why do I coat something? How do I do it, and what do I need to be able to do so? But the operation, maintenance and servicing of coating systems is covered just as concretely,” Ambühl says. Training topics dealing with the metallurgy lab, such as the testing or evaluation of sprayed coatings, are also in frequent demand.

Individualized courses

Training courses at Oerlikon Metco are tailored to specific customer requirements. For some, business management aspects – such as how to design processes for greater efficiency – are what matter. Others want to concentrate on the functionality or quality of the coating. Another area of interest is how they can extend the service life of components. Ambühl and his team cover these matters as extensively as customers require. The goal of these training initiatives? “Essentially, it’s quite simple: Our objective is to deepen the knowledge of our

«We were welcomed and felt at ease with everyone.
We are very pleased and appreciate all the support Oerlikon provides.»

Scott Cousland
 Process Engineer, Cosworth

customers and to help them achieve greater success in connection with the use of our products and services,” Ambühl says.

To achieve that goal, he places priority on a good deal of interaction in the training room: “Dialog, not monolog, is my approach. That enables me to respond to each individual, and I come alive.” This approach encourages optimal participant engagement, comfort, and learning.

Praise motivates

There is no full-time training team at Oerlikon Metco. Instead, in-house experts who apply their knowledge practically on a daily basis are sought for the individual training topics. “That is why we recommend that our customers come to visit us at our site in Wohlen. Here we also have the coating equipment available with which we can experiment or even sometimes intentionally create ‘poor’ coatings. For the course participants, that always proves to be very instructive,” Ambühl says. “This helps us awaken an understanding for the process as well as motivate and encourage them. For me, that is the key to success in learning. Naturally, we also visit our customers for training purposes at their own premises, if desired.”

One great motivating factor Ambühl enjoys in return is the positive feedback he receives regularly from course participants. And when, as happened recently, a participant ventures that he “hasn’t learned so many new things since his doctoral studies,” Ambühl knows he is in the right job and finds his work tremendously rewarding.

The key to success

But why should a company invest in employee training? Ambühl has a ready answer for this question, and it

is as simple as it is reasonable: “Well trained employees are the key to the economic success of any business enterprise. That’s because efficient processes are only possible when the people involved along the way are able to introduce improvements in a targeted way.” To sustain that level of performance, they must have the necessary knowledge so that operating costs can be reduced and operating safety and reliability can be increased. When looked at this way, every investment in the training of employees pays off. Of this, Peter Ambühl is clearly certain.

Always new objectives

He also lives by the motto: “Standstill is lost ground.” That is why, in addition to videos, e-learning is also at the top of his wish list. He has developed his own tool for this, and it is already in use in-house.

Highly motivated and always developing ideas to further expand and professionalize the training program, Ambühl is clearly energized by his

«I don’t think I’ve learned so many new things *in such a short time since my doctoral studies.*»

Dr. Ing. Goetz G. Feldmann,
Rolls-Royce Germany

work. “I can’t imagine anything more fulfilling than what I do in my career. And I’ve always said that I won’t quit being a trainer until the time comes that I can no longer learn new things myself.” Next year, he will celebrate 30 years of service at Oerlikon Metco.

The content of Oerlikon Metco’s training courses

is designed to be optimally suited to participants’ special needs and knowledge levels.

They combine theoretical training with practice-oriented instruction on the coating systems in Wohlen or at the customer’s site.

Are you interested in a training course? Find out more here!

 [www.oerlikon.com/
metco/training](http://www.oerlikon.com/metco/training)



A BOTTLE

EVERYONE IS FAMILIAR WITH

Soft drinks, fruit juices and mineral water: they can all be packaged practically and easily in **PET bottles**. Once the bottles are empty, they are disposed of and can be either recycled or burned with other residual wastes. Their uses are practical, yet their fabrication is complex and challenging. **BALINIT coatings from Oerlikon Balzers** establish the prerequisites for efficient production.

The victory march of PET bottles began about 30 years ago. They get their name from the polyethylene terephthalate of which they are made. This material's formability is the foundation for a production process whose first step entails the fabrication of a blank known as a "preform". In the second step, the blank is put into a production machine where the stretch blow molding method is used to form it into the shape of a bottle.

PET bottles have today become commonplace. Just as with many other items in the consumer goods sector, however, they too are subject to high cost pressure. Consequently, their production must be streamlined to make it as efficient as possible. Likewise their

recycling must be done consequently, for example through deposit systems.

Fast Cycle Times as a Factor for Success

This can be accomplished only through the use of extremely complex tooling technology. MHT Mold & Hotrunner Technology AG is a specialist in tools used in the manufacture of PET preforms. Fast cycle times and high throughput quantities really matter. In a production step that lasts only five seconds, their tools allow the manufacture of up to 192 preforms for PET bottles.

With its international reach, the firm supplies its products to manufacturers of beverage packaging as well as of con-

tainers for the food and pharmaceutical industries. For these customers, cycle times reduced by only fractions of a second mean significant cost advantages in their mass production processes. This is why MHT designs its tools and parts with a special focus on enabling the most efficient operation and the fastest manufacturing processes possible. The coating technologies provided by Oerlikon Balzers play a significant role here.

“Uncoated cores have long since ceased to be an option for us. The improvement in production quality is absolutely sensational,” says Klaus Wegmann, MHT Plant Manager.

What’s more, the wear-reducing coatings also increase the service life of tools used in mass production operations. “This enables us to achieve optimal results in these applications – which are the fruit of a good 20 years of outstanding collaboration with Oerlikon Balzers,” says Christian Wagner, Chief Executive Officer, MHT.

The Right Coating: Resistant to Extreme Stresses

The production process, with injection pressures of 500 to 1,000 bar, is repeated millions of times over. The stress to which the tools are subjected is commensurate. The preform contours are achieved by the core, a key component that shapes the internal contours and the neck ring (the bottle neck and the threads for the screw cap).

This is where the advantages of BALINIT DYLYN come to the fore: The silicon-infused DLC →



Always with best practice in mind: Christian Wagner, CEO MHT, (l.) and Michael Bilo from Oerlikon Balzers with BALINIT-coated mold cores.

«Uncoated cores have long since ceased to be an option for us. ***The improvement in production quality is absolutely sensational.***»

Klaus Wegmann
Plant Manager, MHT



Black and strong: BALINIT DYLYN offers the best in wear and corrosion resistance as well as an exceptionally smooth surface on the two-part neck ring.

(Diamond-Like Carbon) coating offers the best in wear and corrosion resistance as well as an exceptionally smooth surface in the injection molding process. This ensures better interplay between the parts on the neck ring, reduces friction, and facilitates cleaning and the removal of deposits or build-ups that result from the increasing use of additives in the plastic.

When high-end results are in demand, BALINIT DYLYN is also used for the cores. The standard approach for these, however, is a titanium nitride coating, BALINIT A. This coating improves the removal behavior of the preform, protects the special micro-structure of the component and offers protection against the sometimes high mechanical stresses that result from cleaning, all with no difficulties.

Find out more about our BALINIT coatings:

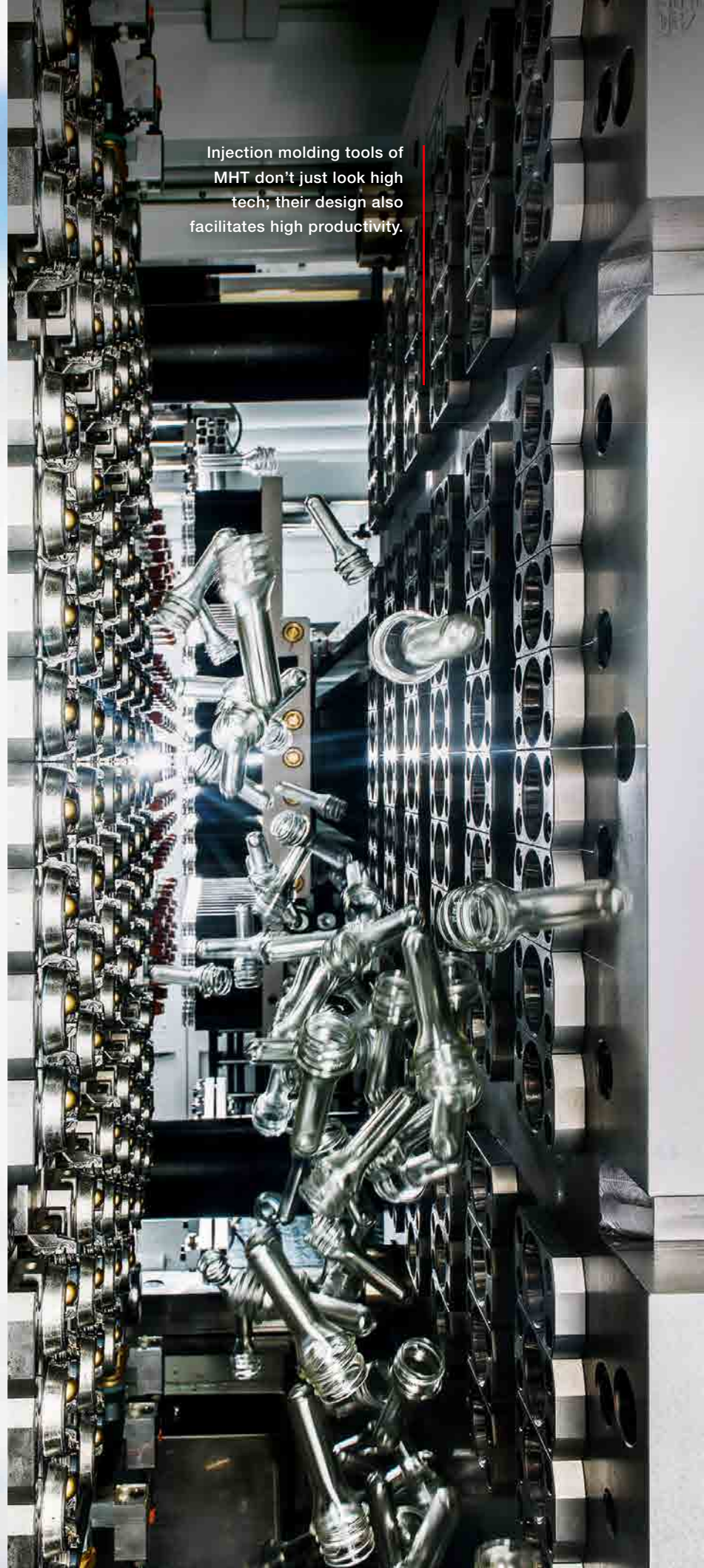
www.oerlikon.com/en/balinit



Mold & Hotrunner Technology AG was founded in 1996 and manufactures high-precision injection molding tools and hot runners for the packaging industry. The company delivers tools with up to 192 cavities for all notable machine types for the manufacturing of PET preforms. 140 employees work at the main headquarters near Frankfurt (Germany) as well as at locations in the USA, Brazil and China.

www.mht-ag.de

Injection molding tools of MHT don't just look high tech; their design also facilitates high productivity.



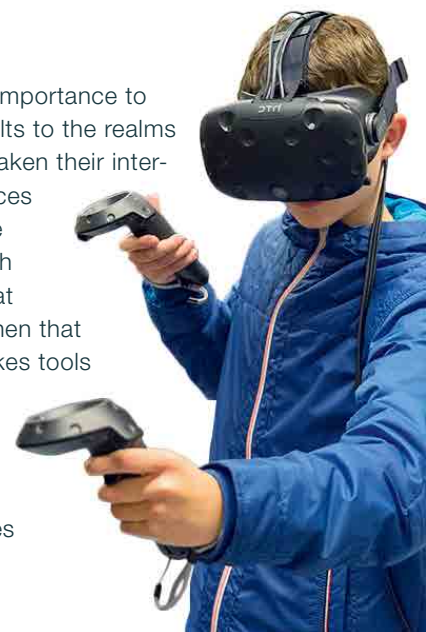
THE FASCINATION OF TECHNOLOGY

NIGHT OF SCIENCE AT THE TH BINGEN

Ah! Oh! Whoosh! Bang! Roar! The sciences evoke awe. We stare as vortex rings of smoke more than a meter in diameter float through the room as if blown by a giant puffing on a huge cigarette. A racing simulator gives us goosebumps by letting us experience the feel of Formula 1 speeds. And virtual or mixed reality glasses put us directly into fascinating artificial 3D worlds.

Around 4,000 visitors experienced what physics and technology can do during the fourth Night of Science at the Bingen University of Applied Sciences (Germany) last October. The occasion was a festival of experiments and spectacles unleashed – and Oerlikon Balzers was a part of it all as a sponsor.

For Oerlikon, it is a matter of great importance to introduce teenagers and young adults to the realms of research and technology and awaken their interest in a technology or natural sciences career path. After all, what could be more exciting than working with high tech coatings only microns thick that are harder than steel? Especially when that work has such broad impact. It makes tools more durable, helps to reduce fuel consumption in motor vehicles and aircraft, enables Swiss clocks and watches to run longer and retain their renowned precision, and makes medical implants safer and better.



BALIFOR

THE SMART SOLUTION FOR HIGH-PERFORMANCE APPLICATIONS

The automotive industry is constantly pushing the limits of the technologically feasible to offer customers lighter, faster, environmentally friendlier and reliable cars. To achieve this goal, the collaboration with suppliers and partners such as Oerlikon is key: car manufacturers can benefit from their know how and can jointly develop the best solution for customers.



Oerlikon Balzers sets new standards for the automotive industry with BALIFOR. The brand provides the complete coating portfolio for automotive components with a range from DLC to MoN to ta-C solutions.

BAIFOR M: **Molybdenum-nitride coating**

If you need stable conditions in tribological contacts under high loads at high temperatures of up to 800 °C, BALIFOR M from Oerlikon Balzers guarantees the best protection of both friction partners. The excellent compatibility with lubricants and additives is one of the main advantages of BALIFOR M. It is the alternative solution when carbon-based coatings

suffer from thermal degradation and/or are not compatible with lubricants.

BALIFOR T: The ta-C solution (tetra amorphous carbons) for high temperature environments

In some applications, BALINIT DLC (Diamond-like-Carbon) coatings may reach their limits with respect to their operating temperatures exceeding more than 350 °C, intermittently dry running and due to their incompatibility to aggressive additives (e. g. high concentration-MoDTC). Where BALINIT DLC cannot meet the requirements, the ta-C-coating from Oerlikon Balzers, BALIFOR T, is the solution.

Learn more about BALIFOR:

www.oerlikon.com/balzers/en/balifor

AUDIT MEANS TRAINING

To utilize coating systems as efficiently as possible, you need experience. And that is exactly what you can get in a technical training course from Oerlikon Balzers. Interestingly, the area of training at Oerlikon Balzers is complemented by the area of Operations Audit. **Garnat Christophers, Head of Operations Audit and Training, and trainer Walter Stähli** explain what they can provide and the rationale for this combined service offering.

At Oerlikon Balzers, the term 'audit' has a positive connotation: It reflects the aim of providing the same levels of service and quality to customers in all of the customer centers worldwide. This is why training is always the supporting aspect of the annual audit at more than 100 centers around the world. Each audit is carried out jointly by a trainer from the

"Training and Audit" department and one of ten auditors whose everyday position is that of production manager in one of the other global Oerlikon Balzers customer centers.

Safeguarding standards

For nearly 20 years before Garnat Christophers assumed leadership of the department, he managed the

customer center of Oerlikon Balzers Coating UK Ltd. in Milton Keynes, England. He and trainer Walter Stähli have conducted many audits in collaboration: "We don't want our audits to be seen as a means of control, but rather as an aid. That's why this is part of the location's ongoing qualification in terms of a training opportunity."

Of course, finding deficits is also part of the audit. "The centers are then requested to implement the required improvements within a defined time period," explains the team leader. "In connection with the individual training on the respective system that is 'delivered' at the same time in the context of the audit, this typically happens very quickly. A key reason for this is the very direct transfer of know-how from the other locations that takes place, enabling those involved to learn from each other," adds Garnat Christophers.

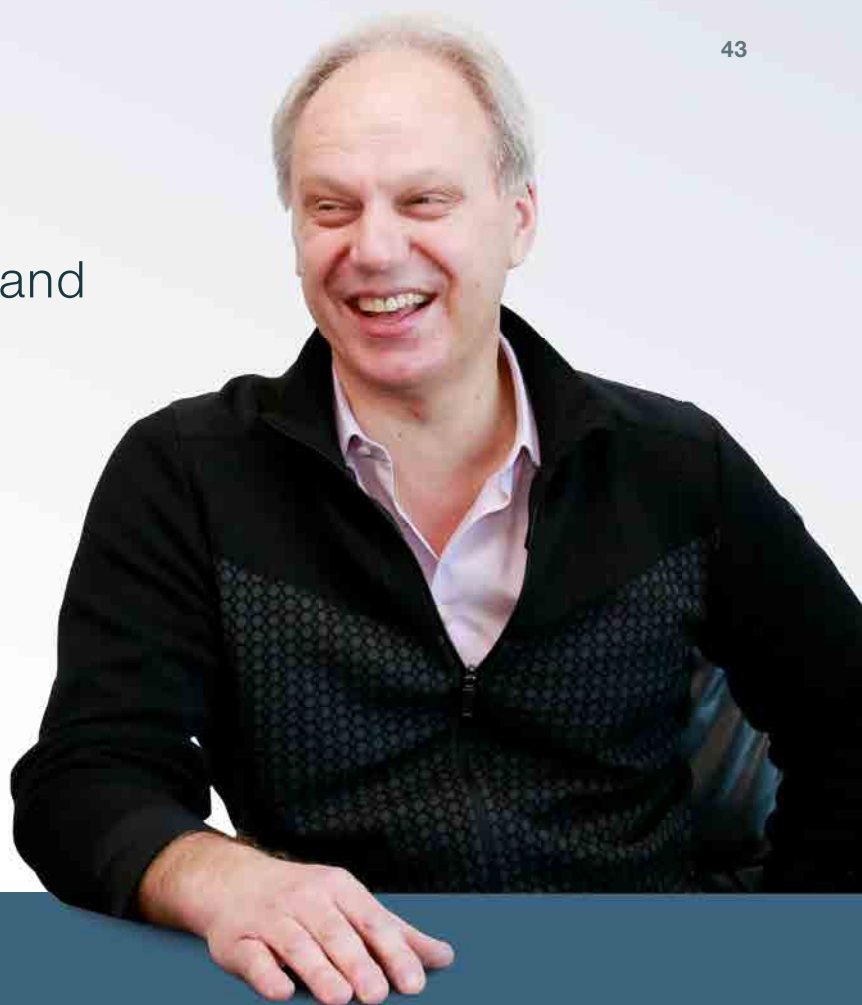
«For us, audit is first and foremost about *transferring know-how.*»

Garnat Christophers
Head of Operations Audit and Training,
Oerlikon Balzers



«Training, as we understand it, **is very personal** – and that makes it truly fascinating.»

Walter Stähli
Technical Trainer,
Oerlikon Balzers



A great deal of experience

Walter Stähli is a man with a great deal of experience: After completing his apprenticeship as an electrician at Oerlikon Balzers, he traveled the world as a service technician for many years. There is hardly a single Oerlikon Balzers coating system that he has not either set up or visited at least once as a technician or later as a technical trainer. And he thoroughly enjoys passing on his experience. That is why he moved to this department eight years ago: “Because the job meant new challenges for me and is simply more varied than the work in technical service.”

About one week after a new system has been delivered and put into service, Walter Stähli or one of his team colleagues arrives at the site to provide a basic training program that runs for about ten days. “That is standard procedure for us,” he

reports. “Primarily, our customers are able to learn how to operate the system correctly and how to take care of the system and carry out maintenance properly.”


However, the on-site training schedule also offers plenty of space for dealing with individual questions and applications. “Training, as we understand it, is very personal – and that makes it truly fascinating. It also keeps me on my toes,” he explains with a grin, “because at least one or two new system models are added to our product range every year.”

Added value

Whether as auditor or trainer, Garnat Christophers and Walter Stähli always have the overall process in view. That perspective encompasses the coating itself, but also the upstream and downstream production steps. They see this as a genuine added value for their cus-

tomers: “The epitome of quality, of course, is the caliber of the coating itself, no question,” comments the team leader, leaving no doubts as to the key task of the trainer. “But quality also means achieving the goal efficiently, avoiding scrap, maximizing productivity. And these, in turn, help in getting everything right in terms of ecology and economy.” And that is why training is a good investment.

Oerlikon Balzers helps you keep your know-how up to date by optimizing availability and added value. These are key components of the company's comprehensive and customized training programs. Learn more here:

 www.oerlikon.com/en/balzers/after-sales

Stronger TOGETHER

Oerlikon expanded its portfolio with the addition of promising **surface technologies** and expertise in the areas of **additive manufacturing**.



CONSISTENT EXPANSION OERLIKON ACQUIRES FINNISH SURFACE ENGINEERING SPECIALIST

Front: Jukka Kolehmainen, DIARC Technology Oy, and Jochen Weyandt, Oerlikon, after contract signing.

DIARC Technology Oy is a Finnish supplier of surface technologies and services. With the acquisition contract signing in January 2018, the company became part of the Oerlikon Balzers brand. The integration of the two companies expands the range of technologies and the portfolio of surface treatments available to the automotive and precision components industries.

Like Oerlikon Balzers, DIARC develops thin-film coatings that improve the performance and durability of tools and precision components. The company supplies its customers with ta-C structured

amorphous diamond coatings, functional carbon and metal nanocomposite thin-film coatings as well as ultra-dense metal nitride and metal oxide coatings, all at a very low deposition temperature of less than 100 °C.

“As a highly specialized service provider, DIARC complements our range of ta-C solutions for the automotive market. Moreover, we are confident that this merger of our teams will strengthen our position in Scandinavia,” said Jochen Weyandt, Head of Business Unit Automotive Solutions at Oerlikon.

A STRONG TEAM

BOEING AND OERLIKON TO JOINTLY ADVANCE 3D PRINTING



Oerlikon and Boeing are entering into a five-year research collaboration. The objective is the development of both standardized products and a standardized process for additive manufacturing using titanium powder. The resulting components must also comply with regulatory requirements, meet reliability standards and be approved for air traffic use. “This move will drive the use of

additive manufacturing processes forward, especially in aerospace applications,” says Dr. Roland Fischer, CEO of the Oerlikon Group. Boeing has been a pioneer in the use of components manufactured by 3D printing since 1997. Their aerospace program today already includes more than 50,000 components that have been fabricated with additive manufacturing processes.

ADDITIVE MANUFACTURING: EXPANSION INTO CHINA

COLLABORATION WITH FARSOON TECHNOLOGIES

Together with Farsoon Technologies, Oerlikon has laid the cornerstone for a partnership to last many years. Farsoon, a manufacturer of systems for additive manufacturing in China, selected Oerlikon as a supplier of metal powders. The purpose of the collaboration is to increase the adoption of AM in China by providing customers with a combined solution of system hardware and fully certified metal powders, thereby driving their use forward in the aerospace and automotive industries, energy production and tool-making. The companies also plan to implement joint research and development projects for applications in the Chinese market. “We are looking forward to this collaboration with a company that is known for its excellence and high quality metal powders,” said Dr. Xiaoshu Xu, founder of Farsoon. “Our customers will benefit from the outstanding material quality.”

Dr. Xiaoshu Xu,
founder of
Farsoon
Technologies





Hidden CHAMPIONS

Fine screws in the millimeter range for dental technology, camshafts for Formula 1 engines, roller bearings for wind turbines, pistons for pumps or reeds for the textile industry – all of these are **precision components**. They need to be coated so that they can fulfill their functions properly. This in turn requires **a great deal of experience, a profound understanding of processes and excellent sector knowledge**.

«With coated jet engines, **one million liters of fuel can be saved per hour worldwide.**»

Precision components are parts that must fulfill special tasks, typically in challenging mechanical or thermal circumstances. In medical technology, for instance, special surfaces reduce the growth of bacteria to a minimum. In aircraft engines, the compressor blades operate under extreme conditions throughout their service life. And valves in the petroleum production industry must operate perfectly at the decisive moment even if they have not been used for years. "Coatings allow the service life of components to be extended and both maintenance expenditures and raw materials consumption to be reduced. In fact, some functions become possible only as a result of the coating," remarks Dr. Andreas Ehrbar-Reiter, Global Head of Marketing and Sales Precision Components at Oerlikon Balzers.

The "right" surface

The results that a coating can attain are impressive, as a few examples will demonstrate: The right surface on a turbine blade increases its wear resistance by up to 25 times. With corrosion protection coatings on pipelines, maintenance and repair costs can be dramatically reduced. And with coated jet engines, one million liters of fuel can be saved per hour worldwide.

But how do you find the "right" surface? Selecting the respective optimal coating for different applications requires expertise. "This is why we see our place in the process as being very close to the customer; we both want to and are able to comprehend their application and understand their processes down to the last detail," explains Dr. Ehrbar-Reiter. For this reason, at Oerlikon Balzers, recognized industry experts with years of experience in the respective markets support customers from the key sectors of aerospace, medical technology, high-end deco, motorsport, oil & gas, semiconductors and energy production. Customers who are not directly associated with one of these sectors will also find an experienced contact person at Oerlikon.

Coating with experience – and more!

Early involvement helps ensure that precision components are able to fulfill their tasks optimally: "We don't see our job as being merely a 'coater'; instead, we already offer customers our know-how during the conception of their components. After all, what matters ultimately is the overall function of the component," says Dr. Ehrbar-Reiter. →

In addition, one of the most important questions to be answered in a series or mass-production situation is how to apply the coating as efficiently as possible. The maximum possible throughput in the coating system is not the only factor to be considered here. There is also the means of fastening the components for the coating process in the holders, which are typically custom made. "Of course, our teams of specialists in the service centers are able to contribute their experience from other tasks as well. This benefits our customers. We also don't hesitate to explore previously unknown approaches," says Dr. Ehrbar-Reiter.

"Hidden champions"

Precision components typically fulfill their functions at locations where they are not even visible. And they are characterized by a variety so vast, it is hard to imagine. Which poses a logical question: With all the different sectors, requirements and components, isn't it hard for even an expert to maintain an overview? Dr. Ehrbar-Reiter laughs: "The variety and the complexity are exactly the factors that make the area of 'Precision Components' so fascinating for me."



«We don't see our job as being merely a 'coater'; instead, we already **offer customers our know-how during the conception of their components.**»

Dr. Andreas Ehrbar-Reiter

Global Head of Marketing and Sales Precision Components,
Oerlikon Balzers

More than just coatings

At Oerlikon Balzers, more than 62 million components are coated annually. Groundbreaking coating solutions are developed that are tailored to the current market needs and individual customers' requirements. Oerlikon Balzers is the only supplier that is present locally in all significant industrial regions throughout Europe, the USA and Asia through an extensive network of customer centers.

Read more about our services dealing
with all aspects of coatings here:

 www.oerlikon.com/balzars/coating-services



2018 Trade show dates

Oerlikon will again be represented at the important surface solutions and additive manufacturing trade shows. We look forward to your visit!

Europe

- June 5–6** **VDI Conference**
"Zylinderlaufbahn, Kolben, Pleuel"
Baden-Baden, Germany
- June 5–7** **Rapid Tech**
Erfurt, Germany
- June 5–7** **Engine Expo**
Stuttgart, Germany
- June 5–7** **Automotive Interior Expo 2018**
Stuttgart, Germany
- June 11–15** **Eurosatory**
Paris, France
- June 12–15** **EPJH Trade Fair**
Geneva, Switzerland
- June 19–20** **5th Győr Tribology and Efficiency Conference**
Győr, Hungary
- June 27–28** **VDI Conference**
Hamburg, Germany
- July 16–22** **Farnborough Airshow**
Farnborough, UK
- Aug 27–30** **Offshore Northern Seas Exhibition & Conference**
Stavanger, Norway
- Sept 9–13** **Eurocorr 2018**
Krakow, Poland
- Oct 8–10** **Aachen Colloquium, Automobile and Engine Technology**
Aachen, Germany
- Oct 14–18** **EURO PM**
Bilbao, Spain
- Oct 16–18** **IZB**
Wolfsburg, Germany
- Oct 25–26** **HVOF Colloquium 2018**
Erding, Germany

- Nov 5–7** **8th Aviation Forum**
Hamburg, Germany
- Nov 13–16** **FormNext**
Frankfurt, Germany
- Dec 5–6** **A3TS Conference**
Thermal Spraying and
Other Dry Coatings in Industry
Pau, France

America

- June 12–14** **OMTEC**
Chicago, IL, USA
- Oct 23–25** **Automotive Interior EXPO 2018**
Detroit, MI, USA
- Oct 23–25** **Engine Expo US**
Novi, MI, USA
- Nov 6–8** **FABTECH**
Atlanta, GA, USA
- Dec 4–6** **POWER-GEN International**
Orlando, FL, USA
- Dec 12–14** **PRI**
Indianapolis, IN, USA

Asia

- June 13–16** **INTERMOLD Nagoya 2018**
Nagoya, Japan
- June 20–22** **M-Tech**
Mechanical components &
materials technology expo 2018
Tokyo, Japan
- Sept 16–20** **WORLD PM**
Beijing, China
- Sept 18–20** **CTI**
Shanghai, China
- Dec 1–4** **Automechanika**
Shanghai, China



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