

BEYOND SURFACES

INTELLIGENT MATERIAL PROCESSING

How can **communicative materials** shape the industry?

What do an **aircraft** and **additive manufacturing** have in common?

And how many individual parts does a **wind turbine** actually have?



«Our customers are constantly searching for solutions to make their products better – be it for cars, airplanes, gas turbines, tools or any other application. New and better-performing materials and surfaces, and new ways of shaping them – even giving them new characteristics – allow our customers to achieve more with less. That’s exactly what we do at Oerlikon: ***we help our customers outperform in their markets.***»

A personal insight

WHY WE DO WHAT WE DO

The constant demand for lighter and stronger materials, the need for higher productivity and energy efficiency, improving environmental sustainability and coping with scarce resources are just some of the key challenges that our customers face. Here at Oerlikon, we help our customers to overcome these obstacles, find sustainable solutions and achieve better results. How do we do this? By providing our customers with access to a leading portfolio of advanced materials and surface technologies, while supporting them with our in-depth understanding of materials and properties, together with our engineering expertise in surfaces and industrial components. In this edition of BEYOND SURFACES, you will find some inspiring examples of our solutions in practice, including how we help to get aviation innovation projects off the ground.

Addressing structural trends

At Oerlikon, we are convinced that advanced materials and surface technologies will continue to grow in importance – not just in industry, but also for society in general. Our materials and surface solutions know-how and engineering expertise enable us and our customers to address structural social and industrial trends such as increasing demand in energy, mobility, clothing and construction. Oerlikon Balzers is a pioneer in PVD coatings with more than 25 000 customers in the automotive and general industrial market, while Oerlikon Metco is a pioneer and the largest player in thermal spray coating equipment and materials. Both brands are firmly anchored in the leading industrial sectors. To ensure we remain a key link in

our customers' value chains, we operate more than 145 locations worldwide, in all important regions and industries.

Manufacturing of tomorrow

We believe that additive manufacturing (AM) is at a major inflection point in industrialization and will play a major role in the factories of the future. The technology allows industrial components to be developed in new ways, using new materials and fewer resources, while also offering shorter lead times – all of which ultimately leads to increased competitiveness. AM has the potential to take industrial manufacturing to the next level, and we want to give our customers the opportunity to be part of this technological shift. To this end, we are making significant investments and building up a strong network of academic and industrial partners, which now also includes the Technical University of Munich, Skoltech and GE Additive.

This latest edition of BEYOND SURFACES is not just about how we are making intelligent materials processing a reality – it also offers a glimpse of what the future could hold for this exciting technology.

I hope you enjoy reading our customer magazine.

Yours faithfully



Dr. Roland Fischer
CEO of the Oerlikon Group

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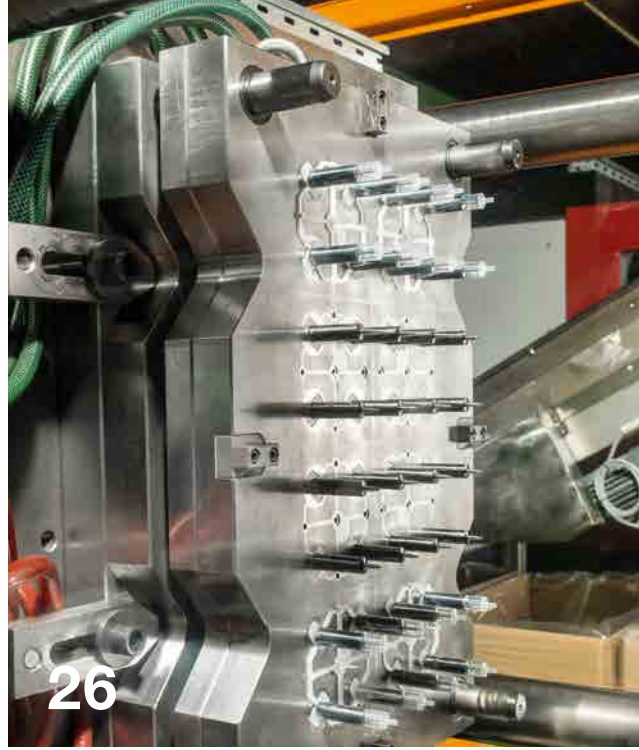
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Materials are becoming smarter all the time – and they will redefine the boundaries of technology. At the same time, they are already transforming industry, especially the field of materials science itself. **Professor Jochen Schneider** teaches and researches at the chair for materials chemistry of the RWTH Aachen University, one of the most renowned technical universities in Germany. For BEYOND SURFACES, he has taken a daring look at the future.

Professor Schneider, you are a specialist for smart materials. What does that term actually mean?

Smart, or “intelligent”, materials represent a very broad field which is closely linked to the truly great questions of our time – the environment, energy, mobility and health. In general, these are materials which react to changed conditions with no need for human intervention. I deal specifically with so-called self-reporting materials, or materials that communicate.

Communicative materials – could you elucidate on that a bit?

Here is a good example: When you go to the doctor, he or she measures various vital functions of your body – pulse, blood pressure and so on. Based on this data, the doctor can tell how your body is doing. Self-reporting materials work in a similar fashion. In the future, materials and even entire machines will be able to “report” how they are doing.

The foundation for our research is provided by so-called self-healing materials. One of the basic problems in technical structures is material fatigue. Take an aircraft engine as an example: The components in the turbine are attacked by sand and other particles in the air and over time, cracks form on their surfaces. If a so-called healing agent is introduced into the surface coating, it reacts as soon as a crack opens up because this causes the healing agent to come

Pretty intelligent:

SMART MATERIALS

Self-healing, communicative,

and soon, even more?

into contact with oxygen. Through the resulting chemical reaction, the crack is closed and thereby healed.

In the event that this “healing process” causes a change in a property that can be measured, then it is only a relatively small step to a communicative material.

How do these materials communicate then?

We achieved an initial breakthrough in 2003 when we were able to synthesize a material which becomes magnetic when chemically altered. The magnetization, or the strength of the magnetic signal, then delivers a report to us concerning its vital functions, if you will. The further the “healing process” has progressed, the less magnetic it is (provided that the healing products do not contribute to the magnetic

signal). The principle is similar to the now outdated cassette recorder which converts the magnetic information on the cassette tapes into music.

What does that mean for industry?

Self-healing and communicative materials represent a paradigm shift for the area of machine design. If materials can heal themselves and both the materials and entire machines can report their condition, engineers are able to go closer to the limits with their designs. Reserves which are necessary today would then hardly or no longer have to be factored in to the design calculations. Concretely, this means that components and machines will become lighter and consequently a car or an aircraft, for example, would need to move

less mass, which in turn will lead to significant savings, such as in fuel.

But I am also thinking about other possibilities which arise when machines or devices can communicate actively. A drill, for example, could issue a report before its service life expires – preferably directly to the coating company and not just to the user. Or a wind turbine would report to an engineer’s mobile phone when it needs to be serviced; technicians would then only need to take action when it is really needed, and, with the relatively exposed work site involved, the advantages here are self-evident.

Communicative materials also mean that today’s customary maintenance intervals would be omitted – humans would only intervene when it actually became necessary.

Will this future also affect the professional profile of material scientists?

And how! We are already talking today about "industry 4.0" in which everything is networked and the parts all communicate with each other. Huge amounts of data are being collected and in the future, industry will function with a great deal more precision than today, thanks to these data. Everything will operate according to plan and resource efficiency will be maximized. This holds enormous potential for the industry. But even today, we can already see that the data amounts being generated are not always used optimally. That means it is not enough to just collect the data, but the relevant data must also be examined critically so that processes and materials can be optimized. The interfacing of materials sciences and data,

including material, production and performance data, will give rise to a new profession, a new profile for materials scientists. It will no longer be sufficient to know the material – simulation and data analysis will become increasingly important. One great challenge is sure to be the data analysis and the filtering of those data which are definitive for performance.

Hmmm, that's sounding a bit dry...

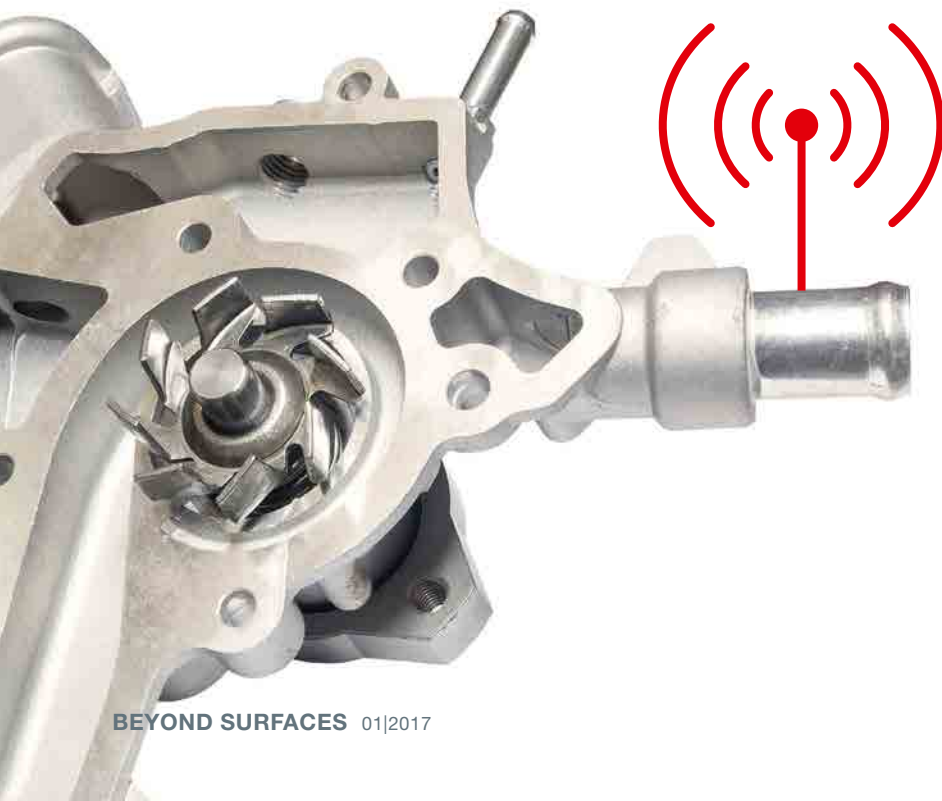
(Laughs) Yes, well, I have to admit: In the past few decades materials science has become more and more calculation oriented. This is demanding and often not easy to communicate effectively. Nonetheless, we are having no trouble recruiting a new generation. This year alone, almost 250 new students in Aachen have enrolled for a study programme in the area of

materials technology. Our doctoral candidates are sometimes taken under contract by companies even before they have graduated.

Universities in German-speaking regions practice the unity of research and teaching. This is an advantage of inestimable value when it comes to remaining on the cutting edge of new developments and the needs of industry. In Aachen, teaching staff are appointed who are working with new topics and therefore pass these on to the students, thereby completing the cycle. The same thing applies for the topic of smart materials.

And what do you see coming for the future of materials sciences, let's say in the year 2040?

Of course, I'm not able to see the future, but there is a topic which



«One great challenge is sure to be the **data analysis and the filtering of those data** which are definitive for performance.»

I find extremely exciting, however also very difficult to predict. Nonetheless, it is one we will all be dealing with: the broad theme of materials in connection with health and medicine.

A short time ago, I was present at a test in which the doctoral candidate made a case for the production of human organs using 3D printing. If you take this idea a bit further, you soon arrive at a point where humans would be able to print their own “spare parts” – a kidney here, an eye there – and could possibly become 150 years old as a result, or even more.

It would then no longer be very far from there to the cyborg.

Of course, this is still a long way in the future. However even now, materials scientists are already working on surface solutions for implants designed to be inserted into the human brain. There, they are to measure brain waves with which a robot can be controlled – or by means of which quadriplegics who are unable to move their arms and legs could operate their own wheelchair. Just how “cyber engineering” will impact the development of the human race cannot yet be predicted.

As I mentioned, these are future scenarios which we all will certainly not live to experience. But they touch on questions with which materials science must begin dealing already today – including their moral implications.

Professor Schneider, thank you for this interview!

Prof. Jochen Schneider

Jochen M. Schneider, born 1969, studied materials engineering in Germany, the United Kingdom, and the USA and received his Ph. D. in 1998. Until 2002, his activities included a position as a guest scientist at the Lawrence Berkeley National Laboratory in Berkeley, California (USA) and as an Assistant Professor and Docent at the Linköping University in Sweden. In 2002, he was appointed Professor and Chair of Materials Chemistry at the RWTH Aachen University. His research focus is quantum-mechanically guided materials design. He was awarded the Sofja Kovalevskaya-Prize for outstanding materials research by the President of the Alexander von Humboldt-Foundation in 2001. Schneider was appointed as Fellow of the American Vacuum Society (AVS) in 2013, and since 2015 has been a Max Planck Fellow of the Düsseldorf Max Planck Institute for Iron Research, where he heads a work group on the topic of self-reporting materials. Prof. Schneider is also the speaker of the special research area / Transregio 87: “Pulsed high-power plasmas for the synthesis of nano-structured functional layers.”

More information: Materials Chemistry at RWTH Aachen University and Max Planck Fellow Group: Self-Reporting Materials:

 www.mch.rwth-aachen.de



Behind the scenes

Lighter + more complex

ADDITIVE

Already as a student, Ludo Bautmans made a decision to be a lifelong learner. **That he would one day belong to the group of men and women who transform an entire industry sector** is a fact he would never have considered even in his wildest dreams. He spoke with BEYOND SURFACES about how suppliers and manufacturers in the turbine industry are facing challenges due to additive manufacturing and how Oerlikon is providing assistance.

“It couldn’t be more exciting anywhere else at the moment than it is right here.” Ludo Bautmans, Application Engineering Manager in Oerlikon’s Additive Manufacturing business unit, makes a hand gesture that includes not only his office in Holland’s Lomm, but encompasses the entire tri-border region between The Netherlands, Germany and Belgium: “We’re at the centre of what’s happening! The leading protagonists in the ongoing development of additive manufacturing are to be found here within a radius of only 100 kilometres. This includes the universities of Leuven and Aachen, the Fraunhofer Institute for Laser Technology (ILT) and ICTM Aachen, the Aachen Center for Additive Manufacturing and many researchers and companies working in the area of additive manufacturing that are concentrating their efforts on specific topics such as electronics, equipment assembly and software. And we work together with all of them because we are part of a ‘Consortium Study’ with a long-term focus that deals with processes, materials and applications for additive manufacturing as well as with questions concerning the topics of productivity, cost-effectiveness, design and process quality!”

For two and one half decades with Oerlikon Metco, Ludo Bautmans has researched the question of how to make turbines even more efficient. As the head of the Eldim research department and a member of the worldwide R&D team, he began dealing with the topic of metal-based additive manufacturing (AM) very early on in the game. He was also involved from the start when, after the acquisition of Metco by the Oerlikon Group, a separate “Additive Manufacturing” business unit was established. In the meantime, the number of staff in the AM team at Oerlikon is already in the three-digit range.

Light, complex components are suited perfectly for additive manufacturing

Metal-based additive manufacturing is today often used only in development. This saves manufacturers and suppliers time and expense in the testing and validation phase, because expensive tooling is only needed for series production. However, additive manufacturing is going to radically change entire sectors, and the trans-

formation has already begun. Bautmans cites an example: “Fuel nozzles used to be fabricated conventionally, but today this is often done additively. Especially light, complex components are perfectly suited for AM – and in turbines, there are plenty of light, complex parts.”

For him, the fuel nozzles are only just the beginning: “A number of large suppliers are developing their own internal departments for additive manufacturing, or they are buying out start-ups. But the technology is developing unbelievably fast and the demand for additively manufactured components will soon be so great, especially in the aircraft and energy turbine market, that it will no longer be possible to satisfy it in these in-house departments. Smaller suppliers as well will soon either want to or have to engage in additive manufacturing and these are frequently unable to afford their own AM departments. This means it is only a matter of time until the market opens wide for additive manufacturing and thus for third-party suppliers such as Oerlikon!” →

Layer by layer

Not only turbine manufacturers, but other industry sectors as well are constantly on the lookout for new ways to build more functionality into components and to increase their performance. In most cases, however, this also makes their geometries more complex, and that means that producing them conventionally becomes difficult or can become a bottleneck in the production chain.

In contrast to conventional fabrication of workpieces in which material is removed from a solid block by milling, drilling and grinding until the desired shape is achieved, in additive manufacturing, a workpiece is built up layer upon layer, which means that the complexity of a part is insignificant for the additive manufacturing (AM) process.

[www.oerlikon.com/stories/
additive-manufacturing-reshapes-industries](http://www.oerlikon.com/stories/additive-manufacturing-reshapes-industries)

www.oerlikon.com/am



Tuning materials to get the most out of them

In contrast to the 3D printing of plastic components, metal-based additive manufacturing is significantly more complex. "Here, it's not enough to just get the material and a printer and take off with them!" As an engineer in the Additive Manufacturing business unit, Bautmans is working on the question of how the materials portfolio needs to be modified for application in additive manufacturing and what materials are best suited for which applications.

"The material is already being offered by Oerlikon. In collaboration with my work colleagues, the independent research institutes here in Aachen and in the framework of projects by the 'Consortium Study', I am working on making it usable for additive manufacturing. This entails modifying the chemical composition of a material as well as its parameters – you could say we are 'tuning' it to get the most out of it for the respective application. And, of course, we are also looking at the most suitable surface treatments and heat treatment approaches."


But all of that is still not enough for an additively manufactured component to satisfy the requirements of turbine manufacturers. A whole series of production steps must be mastered, from application techniques and post-treatment, on to trial runs, inspections and quality control.

An entire process sequence for a new technology

"During my studies, a professor explained to me that my choice of a career would mean that I would have to remain a learner throughout my entire working life. And how right he was! Thanks to additive manufacturing, I have the chance as an engineer and researcher to be involved right from the start in the development of a new technology. That is unbelievably exciting and the speed at which this technology is developing is breathtaking, even for someone like me who is involved at such a fundamental level," says Bautmans.

Oerlikon Metco has decades of experience in metal-based powders, while Oerlikon Balzers is a pioneer in surface solutions. Together, they cover the entire process sequence which additive manufacturing requires. "Soon, we will be producing many other parts for turbines using additive manufacturing – including even significantly more complex parts and at a much higher speed than in the past – and then, the only question I will still have is when additive manufacturing will replace traditional production," says the engineer with a view towards the not-too-distant future.





«Especially light, complex components are perfectly suited for AM – and in turbines, there are plenty of light, complex parts.»

Ludo Bautmans

Solutions for turbines

Oerlikon Metco's Eldim technology specializes in components and the machine processing of turbines. For the Aero Turbines, mainly light weight seal carrier rings and sheet metal seal segments are created from nickel, cobalt and stainless metal sheets. For Industrial Gas Turbines, raw castings are received and finished using non-conventional technologies such as **ELectro DIsgarge M**achining, Electrochemical Machining (ECM), Electrochemical Drilling as well as high-temperature vacuum brazing and diffusion treatments. As such, grooves, pockets, tip cavities and cooling holes are added to housings made using superalloy castings, thus maximizing the turbine's efficiency.

 www.oerlikon.com/metco/turbine-components

Intelligent material processing

A coating can be

1-4 μm

thin and up to

6 times

harder than steel.



In comparison, the soma (or cell body) of a neuron can vary from

4 to 100 μm

in diameter.

Coating technologies for hydropower turbine components are essential and allow them to reduce material erosion by a factor up to

50 times

from that of uncoated components.

Abradable materials applied as clearance control

coatings in gas turbines increase efficiency by up to

5%.

thermal stability control con
erosion protection chemical
tection against surface fatigue
clearance control anti-reflec
environmental anti-sti
embossing & capacity
scratch resist 21 eability
control insulation control magn
decorative enhancement color
thermal protection biocompa
radar transparency easy cleani

From thermal and environmental protection, clearance control and scratch resistance to chemical stability and erosion protection – Oerlikon offers **21** different coating functionalities for industrial components.

The human brain
makes up

2%

of our body mass.



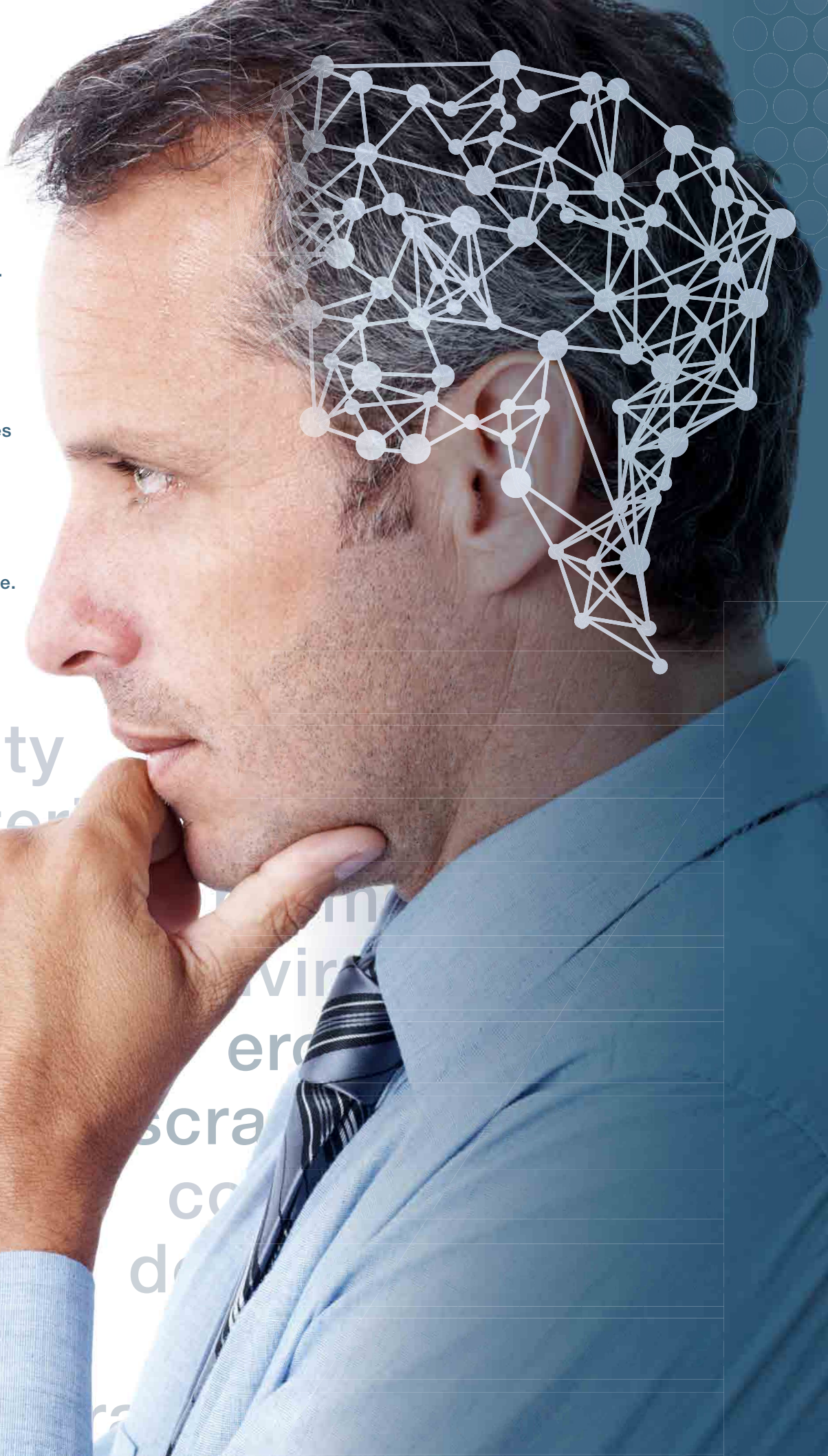
Yet with 20 W of
energy, it consumes
around

20%

of an individual's
basal metabolic rate.

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In the aerospace and automotive industries, the value of PVD (Physical Vapour Deposition) coatings per plane or car increased by

600%

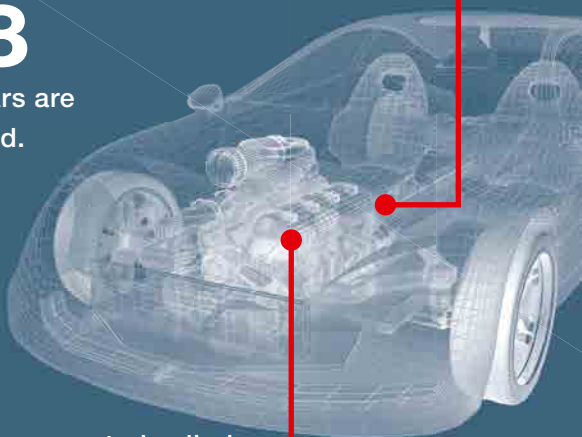
each compared to 2005.

Tools coated with **BALINIT ALTENSA** allow for a **30%**

faster cutting speed in the production of gears for gearboxes resulting in shorter machining time.

108

parts in cars are PVD coated.



Thermal spray coated cylinder bores in car engines result in a

30% reduction in oil consumption

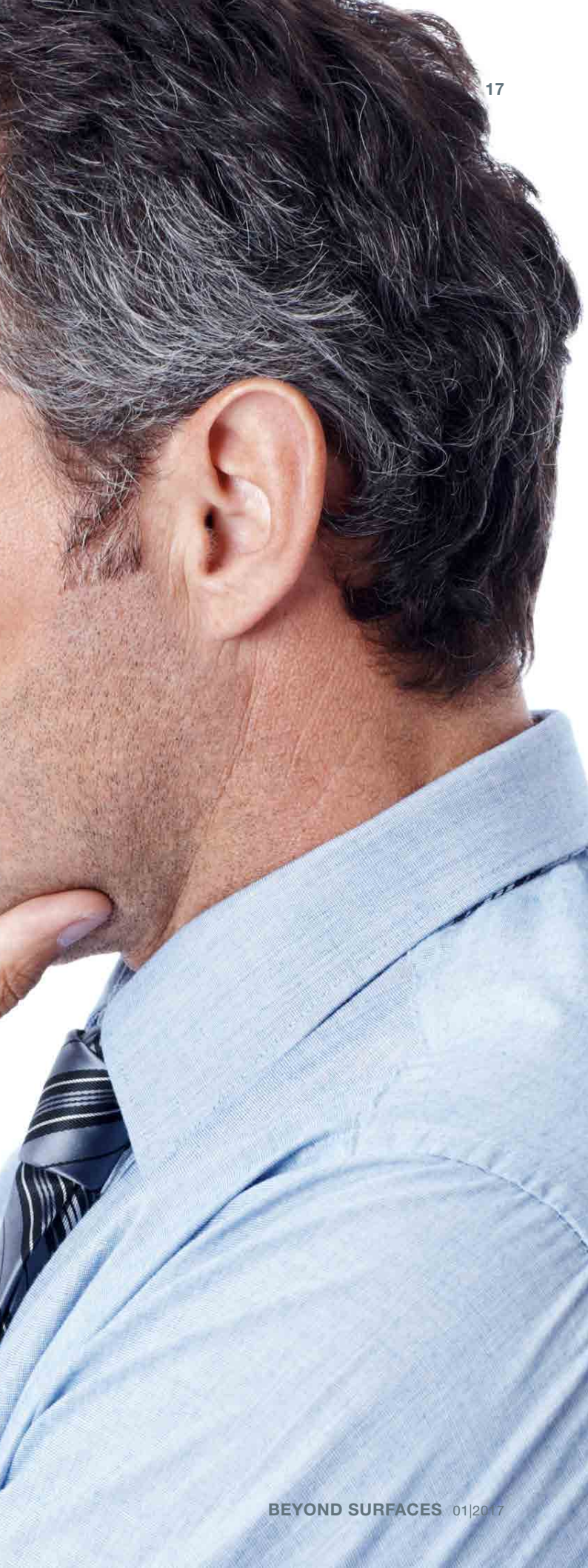
and fuel savings of around

2%.

Coated die casting tools can achieve a cost saving of

70%

as five times less maintenance and five times fewer tool changes are required.



341 320 *wind turbines spun around the world by the end of 2016.*

3.7 *The percentage of global electricity supplied by wind power in 2015.*

5 500 *The number of average EU households that one 6 MW offshore turbine can power.*

Wind power installed more than any other form of power generation in Europe in 2016, accounting for **51%** *of total 2016 power capacity installations.*

It takes a wind turbine **3-6** *months to recoup the energy that goes into producing, operating and recycling the wind turbine after its 20 to 25 year lifetime.*

In 2016, wind power avoided over **637** million tonnes of CO₂ emissions globally.

Wind turbines

A windy affair

Renewable energies have not only begun to boom as a result of the Paris Agreement. But the steadily increasing demand continues to shift the limits of technology on an ongoing basis. Wind turbines are growing in size and the associated forces are becoming more extreme – nonetheless, they must operate with absolute reliability and a minimum of maintenance effort. Coatings and surface treatments significantly extend the service life of their components and thus the lifetime of the entire system.

With the Paris Agreement, the interest in renewable energies has increased worldwide, as has the associated global level of investment. The agreement that was adopted on 12 December 2015 at the UN Climate Change Conference in Paris provides for a limitation of global warming caused by human influences to significantly less than 2 °C as compared to preindustrial values. It took effect on 4 November 2016. As of May of 2017, a total of 145 nations had signed it and these countries together account for 82.95% of global emissions.

Two-digit growth in wind energy

However, the climate goals of this agreement can only be reached if renewable energy sources are increasingly employed, in other words, primarily water, sun and wind energy. “Record low prices ... will be the primary drivers for the development of wind power in the short to medium term, and the evolution of the Paris Agreement ... will only add to the industry’s momentum,” writes the Global Wind Energy Council GWEC in its 2016 annual report.

All of the power plants in the world – fossil, atomic and regenerative – together produce about 24 000 terawatt hours of electricity (2015). Globally, wind energy power plants contribute 487 GW of overall power output to this and generate about 3.7 percent of the energy consumed worldwide. In total, about 80 countries have installed onshore or offshore wind energy systems. The “world champions” of wind energy are China, the USA, Germany and India. “Wind energy continues to grow at a two-digit rate,” explains Steve Sawyer, General Secretary of the GWEC. →

A 10 MW wind farm can easily be built in **2** months.

A larger 50 MW wind farm can be built in **6** months.

Ring gears: Plasma nitriding instead of gas nitriding

While the market offers a good deal of potential for the manufacturers of wind turbines and their components, the technological challenges are becoming greater – including literally in terms of size. The increased requirements concerning the power of wind turbines means that the equipment itself is growing larger. Accordingly, enormous forces are at work on the individual components.

For example, the ring gear in the gear box of a modern wind turbine can have a diameter measuring two or even three metres. In cooperation with a well-known manufacturer, Oerlikon Balzers engineers have conducted test series in which the surfaces of these gears have been treated with the modern plasma nitriding process BALITHERM IONIT. In contrast to gas nitriding in common use today, this treatment causes significantly less warpage and at the same time achieves a higher load-bearing capacity.

“In plain English, that means: The dimensions the design engineer has called for are maintained. Compared to gas nitriding, the tolerances for roundness, planarity and parallelism can be adhered to much better, even with

such large parts as the ring gears, and that is of great importance for the service life of a system in which enormous forces are at work simply because of its size,” explains Sascha Hessel, Director of Sales and Operations at Oerlikon Balzers Germany.

The results of the test series were confirmed by a study of the FZG Institute at the Technical University of Munich and in the meantime, Oerlikon Balzers has received a concomitant order from this development partner for the treatment of ring gears.

Less maintenance required for systems that are difficult to access

Every single part in a wind turbine is essential for trouble-free energy production. Some ensure that the system operates as efficiently as possible: Yaw rings position the upper part of the system, the nacelle, so that it faces straight into the wind. Pitch gears, on the other hand, position the rotor blades in such a way that energy exploitation is maximized. Oerlikon Metco coats these gears with zinc or zinc-aluminum by means of electric arc wire spraying to protect them against corrosion.



Oerlikon Balzers offers thin-film solutions to protect sun gears and planets as well as roller bearings from wear. This is important because in most wind turbines, the running lubrication is inadequate or often very difficult to realize – just consider offshore systems. Coating the gears and roller bearings with BALINIT C improves the abrasion resistance, thereby increasing the service life of the components.

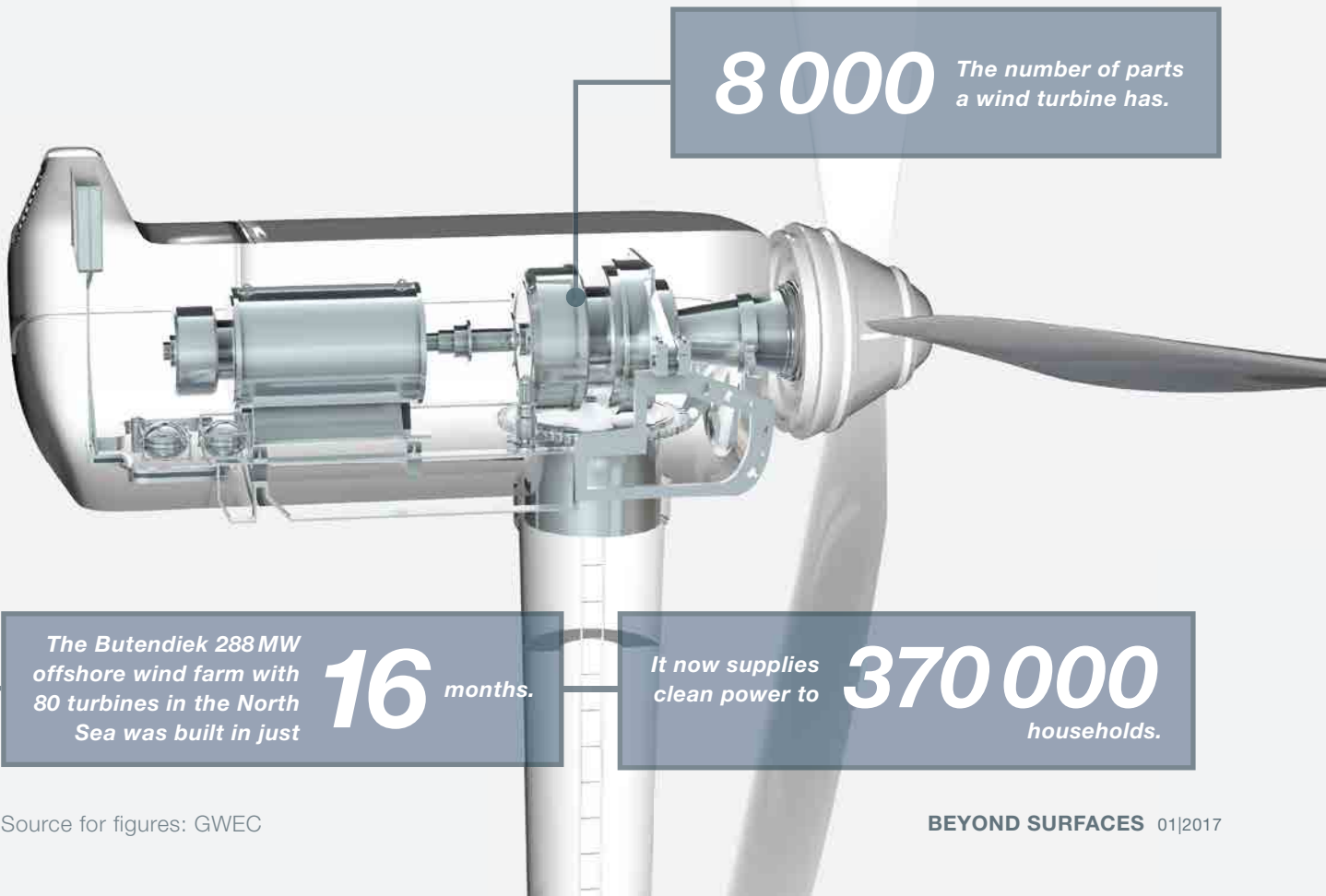
Specialized applications

However, Oerlikon has solutions not only for the internal parts of wind turbines, but also for external parts. For example, the German Oerlikon Metco location in Weissenborn specializes in the repair of rotor shafts. “The rotor shaft, which measures up to six metres, has a so-called bearing shell. If extreme forces operate on the system, for example due to a sudden, unexpected standstill of the gigantic rotor blades, this shell can slip and damage the shaft. This damage can be repaired, and in Weissenborn, we use thermal spraying as a process step for the regeneration,” explains Franz Jansen, managing director of Oerlikon Metco Coatings, Germany.

GWEC: Pioneering role in wind energy

The journey’s destination is clear after the Paris Agreement. Whether it will actually be achieved depends on the will of the nations that have signed. “Wind power is a mature technology. The cost-stability of wind power makes it a very attractive option for utilities, independent power producers and companies who are looking for a hedge against the wildly fluctuating prices of fossil fuels while at the same time reducing their carbon footprint. There is still an acute need around the world for new power generation which is clean, affordable, indigenous, reliable and quick to install. Wind power is leading the charge in the transition away from fossil fuels, and continues to blow away the competition on price, performance and reliability” sums up the GWEC perspective.

www.oerlikon.com/balzers/balitherm-ionit



8 000 *The number of parts a wind turbine has.*

The Butendiek 288 MW offshore wind farm with 80 turbines in the North Sea was built in just

16 *months.*

It now supplies clean power to

370 000 *households.*

MAKING AIRCRAFT INNOVATIONS FLY

Technologies' profound impact on the aviation industry

They're the giants of passenger aviation – literally. From Airbus A380 to medium and short haul aircrafts, their increased passenger capacity grabs all the headlines. But the more interesting and important news is what it takes to keep hundreds of people airborne safely, profitably, and in accord with environmental standards.

With the growth in demand for mobility and access to air travel, an increase in passenger load is inevitable. The challenge is meeting that demand while reducing overall weight and improving fuel efficiency. Meeting that challenge requires ingenuity. And while people in general aren't aware of the innovations behind those bigger yet lighter aircraft, the industry couldn't reach new heights without them.

Advances in technology – be it coatings, new materials or technical textiles – are having an impact on every aspect of aviation, from the wings and landing gear to the seatbelts and air quality in the cabin. Coatings, for example, improve the characteristics and functionality of a wide variety of materials in airplanes. Whether they need to be able to withstand extreme temperatures, resist surface wear and corrosion, minimize friction, or simply contribute to a more comfortable flying experience, these materials perform at their best thanks to coating innovations. That enhanced performance extends to improvements in fuel efficiency that help contain costs and ensure compliance with environmental standards.

As industry leaders and upstarts race to bring new aircraft to market, they're under pressure to shorten development and manufacturing cycles without sacrificing the quality of the end product. Coatings, new materials and textiles have become essential to ensuring passenger's safety, enhancing performance in the air, and promoting greater air quality. Without them, it would be impossible for aviation advances to get off the ground.

By Randy B. Hecht

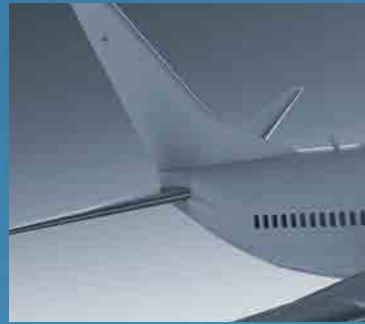


Airframe

› Durable wear and corrosion protection for actuators, flap tracks and other airframe components with BALINIT C of Oerlikon Balzers.

More Oerlikon technologies in the aviation industry:

www.oerlikon.com/stories/making-aircraft-innovations-fly



Machining of lightweight materials

- › Oerlikon Balzers' BALINIT coatings – as Diamond or Hard Carbon – improve the machining of a wide spectrum of difficult to cut materials like aluminium and composites used in wings, tails and bodies.



Air conditioning systems

- › Coated valves adjust the intake air to breathable pressure with BALINIT C of Oerlikon Balzers, additionally replacing noxious hard chromium.



Jet engines

- › Clearance control and thermal barrier coatings from Oerlikon Metco increase jet engine fuel efficiency and reduce emissions.



Landing gears

- › Oerlikon Metco thermal spray coatings apply faster and provide longer lasting protection than hard chromium plating.
- › Oerlikon Balzers BALINIT C and BALINIT CNI coatings deliver durable resistance against fretting, sliding, general surface wear and corrosion.

OERLIKON METCO AND THE CRADLE OF AVIATION

SUPPORTING
THE **AEROSPACE**
INDUSTRY
AND ITS CULTURE





Oerlikon Metco is a proud member of the Cradle of Aviation, an aviation and spaceflight museum located on Long Island, New York, which commemorates Long Island's part in the history of aviation. Among the exhibits that celebrate the companies that have contributed to Long Island's aviation heritage, proudly stands a display of Oerlikon Metco plasma spray guns and coatings.

"As an innovator in advanced surface solutions, with strong partnerships with global manufacturers in aerospace, Oerlikon Metco aims to cultivate prosperity in the local communities through the support for the industry and its culture. Our hopes are that our contributions to aerospace, science and technology will inspire future generations for the development of a creative and resourceful workforce for the region, and one which will expand to industries beyond aerospace," says the President of Oerlikon Metco (US) Inc., Michael Tobin. "Our experience shows us that surface solutions originally developed for aero applications launched growth opportunities in many areas and benefit diverse industries, demonstrating how the growth possibilities for surface technologies are boundless."



The Cradle of Aviation is an important landmark to the Long Island community where the Oerlikon Metco US headquarters is located. It is the site from where Charles Lindbergh took his solo flight to Paris in 1927 on the single-engine the Spirit of Saint Louis. The emergence of flight in the region and the community's rich aviation history has undoubtedly influenced the history of the United States. At the Cradle of Aviation, visitors can appreciate how Long Island played a vital role in the development and growth of aviation and aerospace from the early days of kites and ballooning to the race to the moon.

If in your travels you find yourself in New York, we encourage you to visit this historic museum appropriately located on Charles Lindbergh Boulevard in Garden City, Long Island. It could very well inspire you to look to the sky and reach for the stars.

Visit the Cradle of Aviation Museum online:

www.cradleofaviation.org

elm-plastic

A CLEAN SOLUTION



Every year, elm-plastic in Dudeldorf (Germany) produces millions of **dosing aids, pipettes, syringes as well as measuring cups and spoons for human and veterinary medicinal preparations.**

Pharmaceutical primary packaging products such as these typically come into direct contact with medicines. Consequently, production materials and manufacturing processes are subject to the highest quality, safety and purity requirements so that any possible interactions can be ruled out to the greatest extent possible.

An important factor guaranteeing success is the in-house toolmaking shop at elm-plastic. The reason is that the quality of every tool is decisive for the required dimensional accuracy in the range of 100^{ths} of millimetres, for 100 percent leak tightness in the injection moulding process, for burr-free results and thus for flawless products.

For more efficient production of a three-part dosing aid consisting of a pipette body, plunger and adapter for attaching a bottle for filling, the ram and mould cores have been coated with BALINIT DYLYN PRO STAR upon the recommendation of Oerlikon Balzers, a partner of many years.

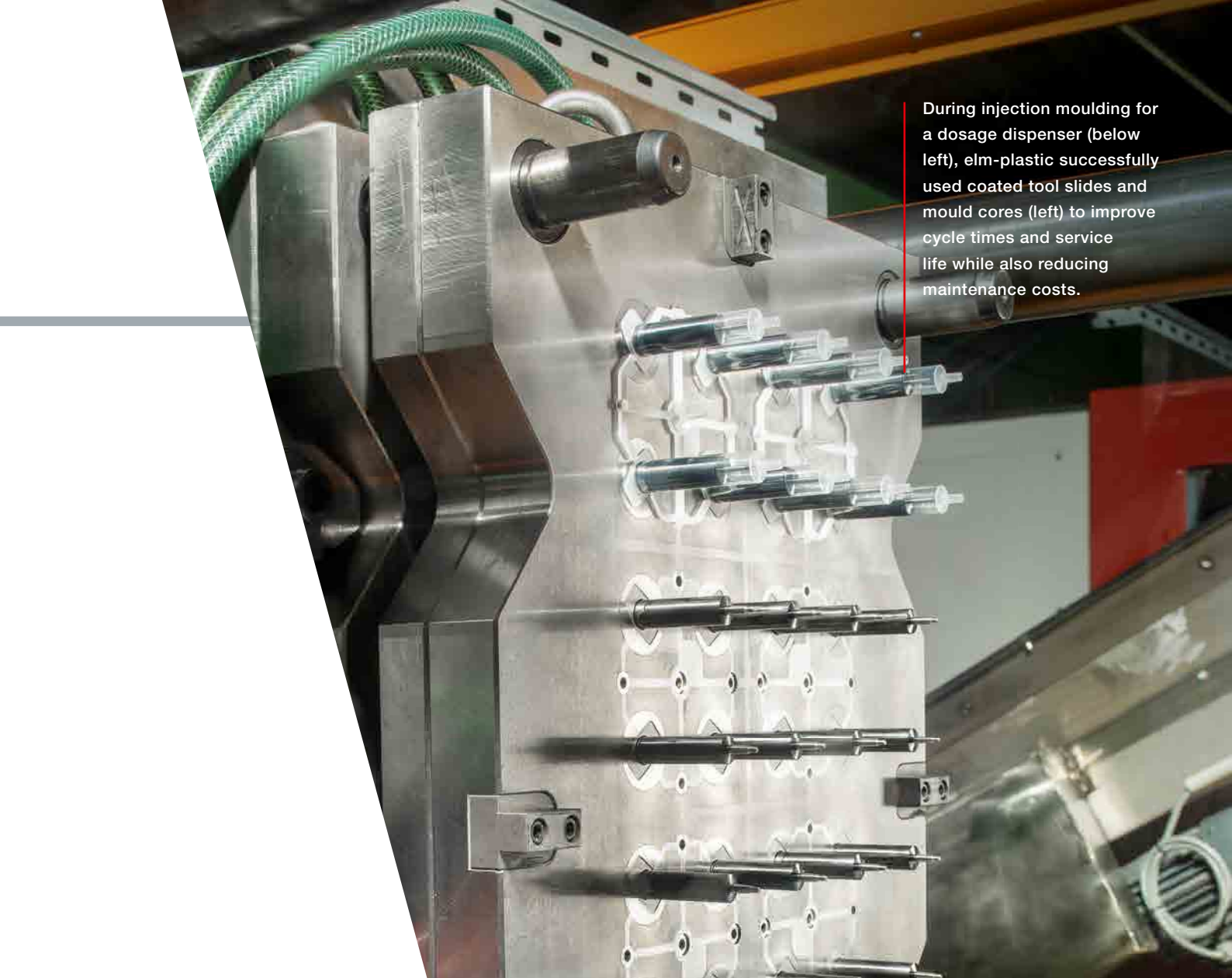
Richard Quintus, head of toolmaking at elm-plastic: "The bottom line is that we were able to shorten the cycle times by around 20 percent,

which amounts to quite a bit in mass production. The service life went up and the maintenance required went down. But most importantly, production reliability and quality were increased. In the future, we want to have all of our tools coated!"

BALINIT DYLYN PRO STAR offers ideal wear and corrosion protection for plastics processing as well as outstanding friction and anti-stick properties thanks to its exceptionally smooth surface. It enables injection moulding without lubricants and promotes better plastics flow at the same time. Moreover, with its low coating temperature, it is one of the few products suitable for coating copper-beryllium mould cores.

 www.oerlikon.com/balzers/balinit-dylyn





During injection moulding for a dosage dispenser (below left), elm-plastic successfully used coated tool slides and mould cores (left) to improve cycle times and service life while also reducing maintenance costs.



Founded in 1969, elm-plastic GmbH with headquarters in Dudeldorf/Eifel, Germany, produces high-quality pharmaceutical primary packaging and dosing aids for human and veterinary medicinal preparations for international pharmaceutical companies and contract bottlers.

 www.elm-plastic.de

Expanding our expertise

Over the past few months Oerlikon has entered into a number of new partnerships and completed strategic takeovers of businesses in the surface and advanced materials sectors. This gives our customers

access to new markets and solutions.

Expansion in the Medical Precision Components market

Oerlikon Balzers acquired Depots Metalliques Sous Vide (DMX), headquartered in Cluses, France. The company is active in PVD coatings, offering PVD Arc technology and pre- and post-treatment for tool optimization. "DMX has a very good reputation in the market and is well known among key customers in France. This acquisition allows us to expand into the Rhône-Alpes region, a key cluster of French mechanical industry. As a leading player in the Medical Precision Components market and the fast-growing Forming Tools market, DMX's expertise will further strengthen our position in these two key segments," says Marc Desrayaud, Head of Oerlikon Balzers Industrial Solutions.



Smart and superfast design of coating and additive materials

With the acquisition of Scoperta Inc., an innovative solution provider in advanced materials development, based in California, USA, Oerlikon gained for its Surface Solutions Segment unique and proprietary process technology and expertise in rapidly designing and developing materials using computational software, which enables a fast identification of disruptive material solutions.

Scoperta is an expert in translating material science into commercial products and has a highly skilled engineering and application development team, consisting of metallurgists and scientists who have developed an advanced computational materials development approach.

Novel technologies for the coating materials market

With the acquisition of assets, technologies and key people from Recentis Advanced Materials Inc., Canada, Oerlikon Metco strengthens its position in the coating materials market. The company is an innovative startup, which developed novel technologies to master materials manufacturing at high temperatures. This technology enables Oerlikon Metco to produce powder materials requiring melting or alloying temperatures above 3200 °C and/or require high purity properties. Oerlikon Metco also acquired the know-how and IP rights for the production of fully alloyed carbides that can be tailored in density to pair with a metal matrix, featuring excellent impact wear properties in combination with high abrasion resistance. The acquisition expands Oerlikon Metco's manufacturing capabilities and will open new applications fields in key markets such as oil & gas, mining, steel, power and aviation.



Additive Manufacturing: Research partnerships

Oerlikon has signed letters of intent to establish three research partnerships in the field of additive manufacturing – one with the Technical University of Munich (TU Munich, Germany), one with the Skolkovo Institute of Science and Technology (Skoltech, Russia) and a third with GE Additive. In anticipation of the expected growth in demand for advanced component manufacturing by additive manufacturing, the collaborations will address some of the most pressing research and development challenges in this field.

www.oerlikon.com/am

The **Skolkovo Institute of Science and Technology** has strong competence in advanced manufacturing and simulation expertise, including dedicated materials for additive manufacturing. Prof. Dr. Michael Süß, Chairman of the Board of Directors of Oerlikon: “These collaborations are important parts of our commitment to leading industrial research. We look forward to fruitful partnerships, and I will personally support our efforts in strengthening our global network and cooperation with leading researchers and research institutes.”

AM Agreement with GE Additive

Oerlikon, GE Additive and its affiliated companies Concept Laser and Arcam AB signed an agreement to collaborate on accelerating the industrialization of additive manufacturing (AM). The agreement specifies the provision of additive machines and services by GE to Oerlikon, and Oerlikon becoming a preferred AM component manufacturer and materials supplier to GE Additive and its affiliated companies. Further, GE and Oerlikon will collaborate on research and development in additive machines and materials over the period of the agreement.

Vice President and General Manager of GE Additive, Mohammad Ehteshami, said: “GE Additive and Oerlikon both understand the transformative power of additive manufacturing. As the adoption rate of AM grows rapidly, it is through strategic partnerships that we can push forward the uptake of AM in industries, and we’re proud to partner with Oerlikon.”



TU Munich has strong existing research capabilities across the additive manufacturing value chain and is a key academic institute working on driving the industrialization of the entire process. Prof. Dr. h. c. mult. Wolfgang Herrmann, President of the TU Munich, said, “In conducting research, it is integral for us to work hand-in-hand with technology companies to develop solutions for practical industrial challenges and applications. Partnering with Oerlikon exactly adds that perspective for us to drive forward our additive manufacturing research projects and opens up opportunities for exciting future research together.”

PERFECT SURFACES FOR MOBILE PHONES

“High-polish machining on stainless steel surfaces for mobile phones is an extremely difficult task for our customers, as the eye detects even the smallest stain or matt spot in the surface. If its surface is not absolutely perfect, a mobile phone shell becomes worthless,” says King Wang, General Manager of Guangdong DAOFU Precision Technology Co., Ltd. The Chinese business specializes in high-precision tools, and in particular it focuses on machining mobile phone parts, amongst other applications.

With the experts from Oerlikon Balzers China, Daofu successfully solved one of the main processing challenges that their customers faced with high-polish cutting tools. In combination with other methods, coating the tools with BALINIT ALNOVA now makes processing much more reliable and provides better surface quality. “Thanks to our continued cooperation with Oerlikon Balzers over the past six years, we have succeeded in earning the recognition of the world’s top mobile phone manufacturers,” says King Wang.

www.dao-fu.com/en

OERLIKON BALZERS TWO SUPPLIER AWARDS FROM CUSTOMERS

Oerlikon Balzers received a 2016 Award for Supplier Excellence from THK Rhythm in Changzhou. The Chinese company belongs to the Japanese THK Group and is a component supplier for the automobile industry. Since 2011, Oerlikon Balzers has developed customized plasma heat treatment solutions for and in close cooperation with THK Rhythm. The advanced heat treatment process BALITHERM IONIT OX has been adapted to meet THK’s needs focused on optimal wear and corrosion protection for ball pins.

Furthermore, Oerlikon Balzers received a 2016 Pinnacle Award for Supplier Excellence from Delphi, recognizing Oerlikon Balzers’ contributions to Delphi’s Excellence culture and commitment to quality, value and cost performance. Over the last years, Oerlikon Balzers has developed customized tribological coating solutions for and in close cooperation with Delphi in order to significantly improve the performance of Delphi’s products over their lifetime. Coatings such as BALINIT DLC STAR have been adapted to Delphi’s needs over several years of development to reduce friction and wear.

“Suppliers like Oerlikon Balzers play a significant role in Delphi’s success,” said Sidney Johnson, senior vice president, Delphi supply chain management. “At Delphi, it isn’t just about what we make, but what we make possible – a future where vehicles are safer, greener and more connected. Thank you for playing an important role in creating that future.”



From left to right:
Miguel Caulliez, Vice President Strategic Sourcing, Delphi; Bernd Moll, Global Key Account Manager, Oerlikon Balzers; Sidney Johnson, Senior Vice President / Chief Procurement Officer, Delphi.

Innovative solutions for metal forming

How can bodywork be made more stable and lighter at the same time? Which tools and surface treatments help form high-strength metals that are getting harder and harder to treat? How can pressing plants and processes become more efficient and cost-effective despite these challenges? These are the questions facing forming technology in automotive production. The **6th European Press-shop Meeting (EPM)**, held at the Oerlikon Balzers Centre in Schopfheim, Germany, with over 150 attendees from the automotive, supplier and research industries, produced an abundance of answers.

Watch the EPM 2017 video:

youtu.be/gMdG-xXN93s

Honda Engineering Europe

Honda reported on an innovative process improvement, whereby they have considerably reduced costs by developing an integrated deep-drawing tooling solution. Whereas until 2013 three separate steps were required for deep drawing, the new one-shot stamping die enables the drawing and blanking to be carried out in a single step. It is being used for the first time to produce the floor pan for the Honda S660 two-seater roadster. "We have been using it since 2014 in series production and it works flawlessly," said Mr Jun Yokoyama of Honda Engineering Europe (left).



Jaguar Land Rover

Richard Aylmore reported on experiences using aluminium. High-strength aluminium alloys are used in around half of vehicle product lines in the vehicle structure and for the body shell, such as side sections, bonnets and roofs. “New aluminium structures are helping us build light-weight vehicles with optimum performance and handling,” said Aylmore. Punching creates certain challenges, including an increase in the deformability of the sheet metal, which can be overcome with the help of specially adapted oil or wax-based lubricants. Electric cars will become even more important in future, and new vehicle structures will have to be developed for their batteries.



Zapp Materials Engineering

Zapp, the materials experts, focused on cold forming with new matrix materials. Amongst other things, the internationally renowned supplier produces powder-metallurgical high-performance steels, which combine ultra-high toughness with high wear resistance. “The trend nowadays is back towards materials with high basic strength to prevent premature broken components and improve service life. To do this, a lower hardness of 62 to 64 HRC is tolerated, sometimes with an extra coating,” explained Dr Wolfgang Püttgen.



Competence Centre in punching and forming technology

Schopfheim is Oerlikon Balzers' competence centre in punching and forming technology. It has facilities for surface treatment of forming tools such as those used in car body manufacturing, which can be up to ten metres long and weigh 40 tonnes. As Marc Desrayaud, Head of Business Unit Balzers Industrial Solutions, explained: “This is the nucleus for the global expansion of our forming technology in another 30 Skills Centres. We hope to see significant growth in our forming business in future.”

Porsche Panamera

THE SEDAN THAT
BURNED THE NOTORIOUS

NORDSCHLEIFE RACE TRACK

By Erik Sherman



The Nordschleife, the old **North Loop of the Nürburg-Ring** auto racing complex in Germany, has enjoyed a brutal reputation from its opening: The 73 turns and 300 meters (1 000 feet) of elevation change over a length of 20.8 km (12.9 miles) test the endurance, skill, and nerve of drivers ... and the mettle of the metal they drive. →

7 minutes and **38** seconds





One journalist, after watching the first race in 1927, described the winding steep grades and tight corners through the Eifel forests as something that could have been designed by a “reeling, drunken giant.” In its 33rd year, three-time world champion driver Jackie Stewart bestowed the track’s enduring nickname: Green Hell.

Even with modifications over the years to improve safety — in 1970, Formula 1 drivers boycotted the course because it was so dangerous — the Nordschleife remains a challenge.

World record

Unlike many race courses, the Nordschleife is actually open to the public, so you could take your car out for a spin. “But if you’re in the typical consumer auto, you probably won’t match the course record for a sedan of 7 minutes and 38 seconds that the new Porsche Panamera Turbo recently set,” commented Dr.-Ing. Thomas Günther, Director Development V-Engines, Porsche AG. The time is even more impressive when you realize that the track record set by the Porsche 918 Spyder, technically the most sophisticated sports car of all time, was 6 minutes and 57 seconds.

The Panamera combines extraordinary performance with incredible efficiency. Its modular 4-litre V8 engine drives between 5 750 and 6 000 rpm and top power of 550 hp. The acceleration propels you from 0 to 100 km/h, or roughly 62 mph, in 3.8 seconds. That approaches the kick of a fast street-legal production motorcycle.

And yet, for all the power, fuel efficiency is important as well. The new adaptive cylinder control system effectively, and unperceptively to the driver, switches between 8-cylinder and 4-cylinder modes, depending on power demand. The latter mode improves fuel

WITHOUT LIMITS: THE OERLIKON BLOG

10 million people around the globe have read the Oerlikon Blog since its launch at the beginning of 2016 at www.oerlikon.com/stories.

It features Oerlikon’s pioneering technology and engineering expertise through engaging customer and technology stories.



The reach and interest in the Oerlikon Blog has increased tremendously in the last few months, and Oerlikon is proud that even independent online and print media have used articles from it in their publications. This “Porsche Panamera” story, originally published on the Oerlikon Blog in February, travelled around the globe and reached 2.7 million users.

efficiency by up to 30 percent. The aluminum engine takes up to 9.5 kilograms (20.9 pounds) off the previous engine weights.

Inner values

A less obvious but vital part of gaining efficiency, and increased power, is the use of a steel coating on the interior of the cylinders. The weight improvement of aluminum crankcases is achieved without sacrificing the valued robustness of iron-based cylinder bores. Aluminum is soft compared to steel. The unrelenting movement and stress of the pistons can wear down the cylinders and shorten their life. The right coating is a thin layer

of metal that bonds to the cylinder surface, providing characteristics that aluminum alone doesn't possess.

Porsche has already been using thermal spray coatings (APS), in which hot, ionized gases are used to melt metal-based powders and propel them onto the surface of the inside wall of a cylinder to create a coating. The current material composition of the steel coating, about the thickness of a sheet of copy paper, cuts wear by upward of 10 percent compared to the materials of the raceway surfaces used in previous generations of engines. Oil consumption is also down by up to half compared to

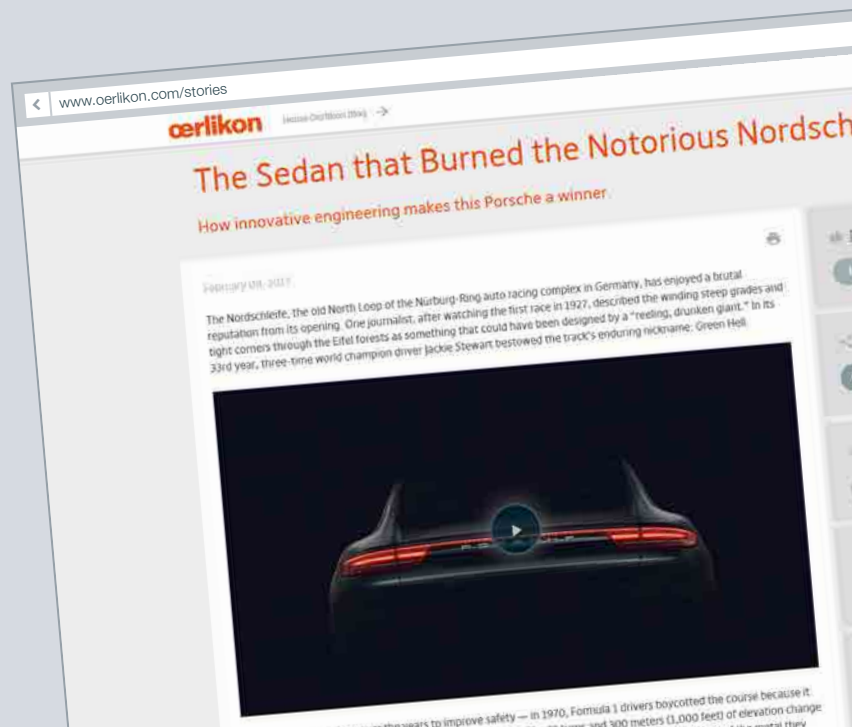
previous versions of the engine. So, not only is the car powerful, but it has respect for the environment as well. The coating that helps the Panamera attain its outstanding characteristics uses SUMEBore technology from the Oerlikon Metco brand. For over 20 years, Oerlikon Metco has helped automobile and truck manufacturers improve performance of their engines while cutting weight, improving fuel efficiency, reducing wear, corrosion and CO₂ emissions. And, of course, create a driving experience just this side of being in a Formula 1 race car.

Watch the video:

blog.oerlikon.com/panamera/en

Check out more stories on customer solutions, striking technologies, powerful innovations and visionary engineers, and subscribe to the Blog to stay informed whenever we publish a new story!

Would you like to share your story with us too? Tell us at beyond.surfaces@oerlikon.com





Simply intelligent

FREE YOUR IMAGINATION

Since their international premiere in 2012, the **ingeniously simplistic “Plus-Plus”** has taken children around the globe by storm. Within only four years, the machine pool of the Danish toy manufacturer by the same name grew from 2 to 24 injection moulding lines. Oerlikon Balzers delivers additional efficiency.

“One shape. Endless possibilities!” is what the Plus-Plus promise. The name says it all: 21 colours and two sizes, but only one single basic shape – two pluses joined together. You can build anything imaginable with them: Cars, dinosaurs, jewellery as well as entire farms and circus tents, including a vehicle fleet and all the relevant animals.

Stimulates the imagination and fine motor skills

“The only thing you need for Plus-Plus is your imagination,” explains CEO Martin Pihl. That there has been no lack in this department is

underscored by the thousands of pictures of Plus-Plus objects on Pinterest and other forms of social media. Not only the young builders over the world are enthused about Plus-Plus: “Especially teachers and caregivers recognize the fun factor in our colourful parts, but also see the educational value: Plus-Plus has no predefined purpose. That means there are no limitations as to what you can build with them – regardless of whether in two or three dimensions. This stimulates children’s imaginations, for one thing, and it also promotes the development of fine motor skills,” says Martin Pihl. →



The sector quickly recognized the potential of the Plus-Plus offer. The brand has raked in a whole series of distinctions and awards over recent years. “During the exhibit ‘Century of the Child,’ we even made it into the MoMA, Museum of Modern Art in New York,” Martin Pihl explains.

Intelligent solution: easier tool maintenance and prolonged service intervals

Along with success came higher demand, and between 2012 and 2016, the machine pool grew from 2 to 24 injection moulding lines. Plus-Plus chose to rely on BALITHERM PRIMEFORM early on in order to improve the surface density and hardness of the tools. Previously the tools had more downtime due to continuous maintenance, now with the Oerlikon Balzers coating, the operation

can run for longer intervals with much easier cleaning and general service: a simple cloth and a drop of alcohol will now suffice. This also makes it easier to use the same tool to produce parts in a different colour.

“An additional problem was the degassing of the plastic inside the tools insert,” comments Frederick Halbout, sales engineer at Oerlikon Balzers. “This meant that the inserts could only be used for three months at the most. Then they had to be cleaned in an elaborate process and often needed repairs and some were even completely unusable.” The solution was BALINIT CROMA which significantly increased the stability and resilience of the inserts: “After eight months in non-stop operation, we inspected the coated inserts. All we had to do was clean them and they were as good as new!”



Compliant to the strictest material regulations

Children's toys especially are subject to very strict material regulations, not only within the European Union, but also in other markets. This includes for example, regulations by the American Food and Drug Administration (FDA). "Thanks to BALINIT C coated ejector pins, we are able to completely refrain from the use of lubricants. Previously, we had to dispose of parts that had come into contact with lubricants. That never happens anymore! And it is reassuring to know that even the BALINIT coatings used in our production environment are themselves compliant with these regulations," says Martin Pihl.



- › Head office and factory located in Holbæk, 60 km from Copenhagen.
- › Danish Design, made in Denmark.
- › Established: 2009
- › Export since: 2012
- › 21 distributors covering more than 30 countries

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facebook.com/pages/plus-plus-as

AT YOUR SIDE

Even closer to our customers



1 Plymouth, Michigan, USA

Two new production sites in the USA will soon provide industrial customers better access to additive manufacturing. In the greater area of Detroit, Michigan, Oerlikon is building a new plant for the production of high-quality, modern materials for additive manufacturing and surface coatings in Plymouth Township. Here, cutting edge materials such as titanium for additive manufacturing and high-grade powders for thermal spraying will be produced in the future.

2 Charlotte, North Carolina, USA

At the same time, a competence and manufacturing centre for additive manufacturing expected to employ about 100 is being established in Charlotte, North Carolina.



3 Bielefeld, Germany

After relocating from the previous site in Spenge, Oerlikon Balzers opened its new production centre for the North Germany region in Bielefeld. The new site will allow Oerlikon Balzers to combine the services offered at their existing sites in Spenge, Herford and Hildesheim. The full production capacity of the site at Bielefeld will be reached in early 2018.



4 Barleben and Munich, Germany

A year ago, reconstruction of the citim GmbH production and office facilities in Barleben, near Magdeburg, was completed. citim has been part of the Oerlikon Group since early 2017, and with its 17 new-generation machines is the leading provider of additive manufacturing for metal components. Later this year, Oerlikon is to open a research and innovation centre for additive manufacturing in Munich, Germany.



Opening ceremony with Marc Desrayaud

5 Pune, India

Oerlikon Balzers is continuing to invest in its business in India, with substantial renovations and installation of the latest generation of tool coating equipment at its site in Pune. Particular emphasis was placed on sustainability and energy efficiency during the expansion of the site.



6 Chengdu, China

With the opening of the 4th production site in China, Oerlikon Metco extends its operation in Western China. Important customers and local government officials from Chengdu joined the impressive inauguration. As automotive markets and the production sites are moving to the west of China, the region now plays a more and more important role in the development of the automotive industry. The new Chengdu production location follows this west moving trend in order to get closer to our customers and provide optimized supply chain logistics in the automotive synchronizer ring area.



Ceremony for laying the foundation stone

7 Nagoya, Japan

In Nagoya, Japan, Oerlikon is building a new surface solutions centre in order to supply technologies and services to the Japanese automotive industry. The centre will allow us to fulfil a contract we have recently won from one of the largest Japanese automotive manufacturers. The site is scheduled to open in early 2018. Nagoya is one of the four major industrial centres in Japan, where the production sites of a number of major corporations, including the Toyota Motor Corporation and Mitsubishi Motors, are based. The new site will allow us to supply both Oerlikon Balzers surface solutions and Oerlikon Metco Friction Systems technologies.

**1st munich
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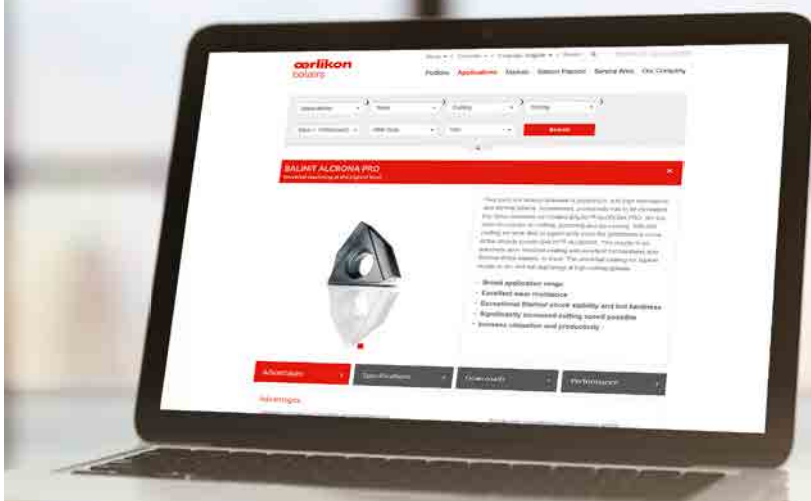
Additively manufactured
distributor housing

Oerlikon Balzers Coating Guide The best coating for your application

Selecting the best coating is becoming an increasingly decisive competitive factor. With the Oerlikon Balzers Coating Guide, you can find the optimal solution within seconds by selecting some key factors of production.

But that is not all: The Coating Guide also leads you to material libraries, thousands of practical examples and detailed information on the various coatings.

Check out the Oerlikon Balzers Coating Guide on www.oerlikon.com/balzers/coatingguide, or find it on your local website. The Coating Guide is now available in ten languages – more coming soon!



Find your
solution here:



2017 Trade show dates

Oerlikon will again be represented at the important Surface Solutions and Additive Manufacturing trade shows. We look forward to your visit.

5–8 Sept	SPE Offshore Europe 2017 Aberdeen, UK	17–21 Oct	FAKUMA International trade fair for plastics processing Friedrichshafen, Germany
18–23 Sept	EMO Hannover, Germany	6–9 Nov	FABTECH Metal Forming, Fabricating, Welding and Finishing Event. Chicago, IL, USA
19–20 Sept	Swiss Medtech Expo Luzern, Switzerland	14–17 Nov	FORMNEXT Frankfurt, Germany
25–29 Sept	Schweissen & Schneiden International trade fair Joining Cutting Surfacing. Düsseldorf, Germany	15–16 Nov	Overflate Conference on corrosion protection, surface treatment and insulation. Bergen, Norway
26–28 Sept	TCT SHOW 3D technologies for product development, manufacturing and engineering. Birmingham, UK	7–9 Dec	PRI Trade Show Indianapolis, USA
28–29 Sept	Supercharging Conference Dresden, Germany	13–15 Dec	Semicon Japan Tokyo, Japan



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