

BEYOND SURFACES

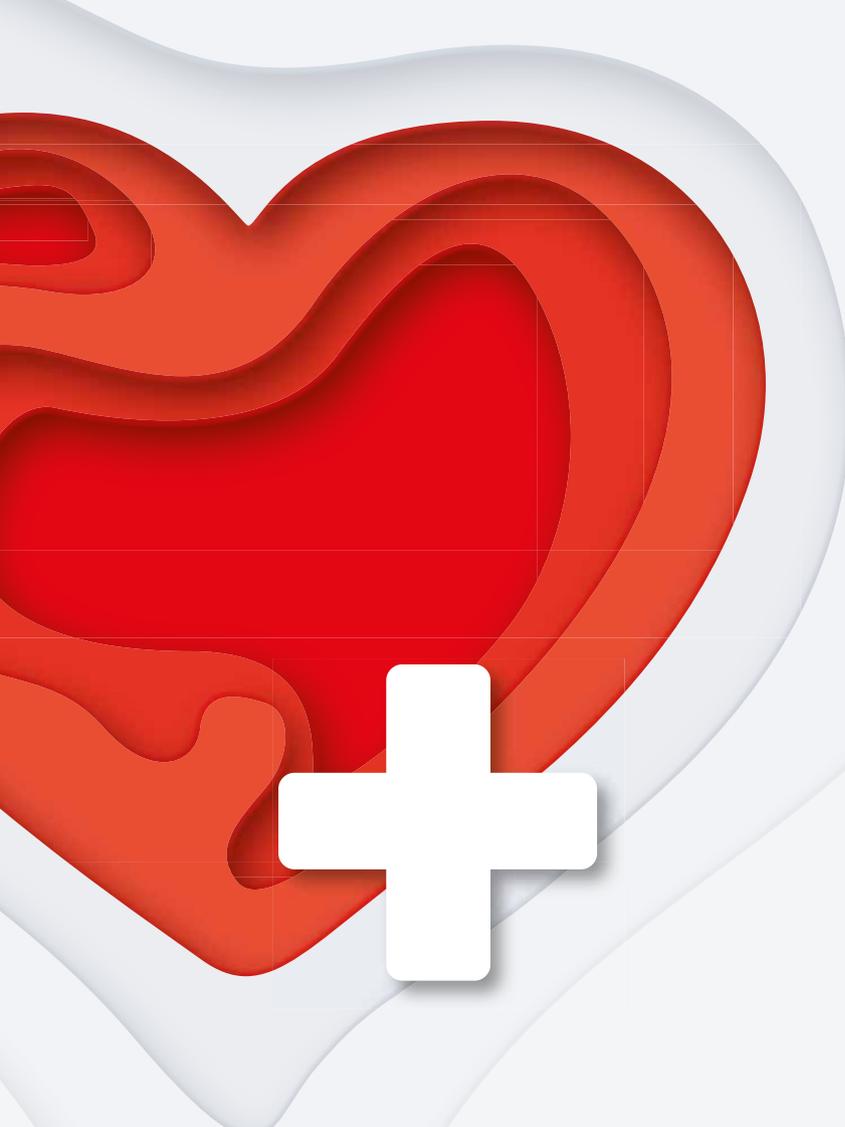


MEDICAL TECHNOLOGY

Biocompatible: What links scalpels, dental crowns and hip joints

The test quest: Tim Horn on testing and quality control in AM

Montia Nestler and Nancy Shepard: Passion for challenges



“At the age of 66, life begins...” This is the opening line of a 1977 German pop song. The interpreter, Udo Jürgens, could not know at the time that he was anticipating a global megatrend. People are reaching older ages today than ever before in history thanks to improved access to food and drinking water, fewer epidemics and infectious diseases, and better medical care.

This is, of course, gratifying for each and every one of us – especially when we grow older in good health. But when that is not the case, aging places extreme burdens on the health system. As a result, health care costs are constantly rising, a problem complicated by a growing shortage of medical doctors and qualified nursing staff. Efforts to address these challenges include innovations in a wide variety of areas – among them, new devices and therapies and effective use of tools such as telemedicine, big data and artificial intelligence. The aim is to make better diagnoses more quickly, optimize treatment and thus treat patients more efficiently and sustainably.

Innovations from Oerlikon play a role in these advances by covering the entire process chain for medical products – a highly regulated market with long and complex supply chains.

Drawing on our know-how, we advise manufacturers in the medical device industry during the development of their products. We offer both materials and equipment for thermal spraying and PVD coating. And these materials and technologies are also used to finish the surfaces of medical instruments. Coatings such as BALIMED ARGENTA are a key factor in infection prevention – for example, in minimally invasive surgery. This approach shortens (and sometimes even eliminates the need for) hospital stays, even after relatively complicated operations, which reduces costs and minimizes the burden on patients.

HEALTH

INNOVATION FOR OUR MOST PRECIOUS GOOD

Sustainable medicine often depends on implementation of individual solutions. Here, too, Oerlikon is a pioneer. Today, additive manufacturing produces implants (even those with new, more complex structures) that function better, last longer and can be tailored precisely to the patient.

For example, a critical factor in implant surgery's success is how well the implant connects with the bone. We offer solutions that support this concern in both the production and post-production phases: Thanks to 3D printing, it is possible to produce implants that correspond to the pore geometry and density of natural bone so that as it heals, it can integrate with the implant. Today, coatings are helping to modify the surface of implants, and our engineers are working on the next step: layers that promote bone growth.

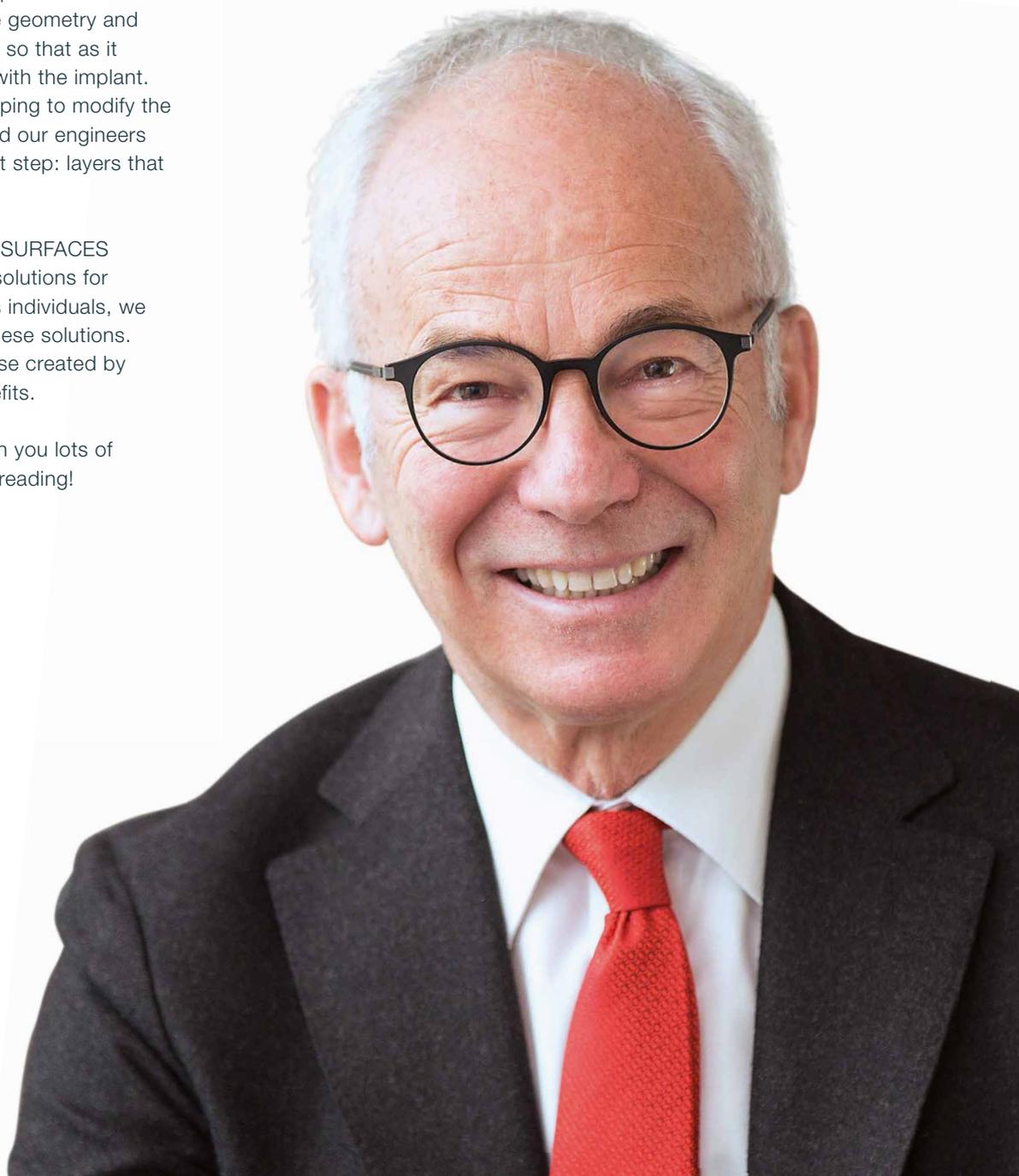
This issue of BEYOND SURFACES focuses on Oerlikon's solutions for medical technology. As individuals, we hope we won't need these solutions. But in case we do, those created by Oerlikon offer key benefits.

With this in mind, I wish you lots of health and informative reading!



Dr. Helmut Rudigier
CTO Oerlikon Group

“Sustainable medicine often depends on **implementation of individual solutions**. Here, too, Oerlikon is a pioneer.”



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ENGINEER AND MANAGER: THE APPEAL OF A CHALLENGE

She worked in a steel foundry, studied in Germany and Moscow, and now commutes between the U.S.A. and Europe – and leads a worldwide team of experts. **Montia Nestler works locally, globally and digitally with the same agility as she uses to integrate product management, research and practical application.** As a member of the management team, she plays a key role in shaping Oerlikon Metco's strategy and business processes.

by Agnes Zeiner

It's not exactly easy to get together with Dr. Montia Nestler for a talk. As a member of the senior management team at Oerlikon Metco, she often travels, meets customers and partners, engages in product and business strategizing as well as acquisition activities and, as Global Head Applications/Product Management, leads an area with activities that span the globe and encompass over 70 employees.

Nevertheless, she spontaneously agrees when the editorial team of BEYOND SURFACES knocks on her door and asks for an interview: "Maybe this will encourage other women to enter the engineering sciences and take on leadership responsibility in technically oriented companies!"

It runs in the family

There was no need for such external encouragement

during her childhood in the former East Germany. She was the youngest of four sisters in a household where the natural and engineering sciences were omnipresent: "For many years, my father was the director of the Engineering School for Materials Technology, which later became part of the Chemnitz University of Technology, where he then taught as a professor."

Montia Nestler was drawn to the Freiberg University of Mining and Technology, the oldest university for mining in the world. There, she studied materials application. "I love mathematics and technology, and I am both analytical and practical at the same time. In my studies, I was able to include all of this, because the field combines the very theoretical area of metallurgy with applied materials engineering. I was already particularly interested in surface treatment and surface engineering during my studies."

This combination of theory and application is a common thread throughout her curriculum vitae: Before beginning university, she worked for a year as a casting grinder in a steel foundry, and as a student she already gave award-winning lectures, took part in exchange programs in the former Eastern bloc and spent a semester abroad in Moscow. She wrote her doctoral thesis on "Electron Beam and Laser Surface Alloying", and even before receiving her doctorate, entered the arena of industry as an R&D engineer in the field of plasma nitriding. A special topic she investigated was the combination of thermal spraying and nitriding. This was virtually an anticipation of her joining Oerlikon, where both processes – separately or together – are also used, for example in coating solutions for brake discs.

Climbing through turbines

At that time, materials engineering was an absolutely male-dominated →



“Two key questions motivate us every day: **What do customers need today? And what will they need tomorrow?**”

field – And that was also true at Oerlikon Metco, where Montia Nestler started in 1993 and took on her first leading role: “I was not even 30 years old back then, had done my doctorate in engineering, and was probably a provocation for many colleagues. Sometimes it was pretty tough to assert myself!” Her task was to establish the European center for application development, complete with an application laboratory (the “Coating Solution Center”), and corresponding customer support.

“That was very application-oriented. In order to promote the sale of our products – coating systems and materials, powders and wires – we wanted to develop coating solutions by means of thermal spraying that were ideally suited to the stresses encountered with the components involved. I have literally climbed through water turbines, boiler plants and airplanes to understand what surface problems our customers face. But I also wanted to find out what challenges they would face tomorrow so that we could have the right solutions ready when needed.”

Despite all the internal skeptics, the young woman not only successfully completed the task assigned to her – she also followed the European example to further expand the Coating Solutions Center in Westbury, U.S.A.

At the time, there were three regional application centers, which she brought together utilizing global processes.

During that period of work in the USA, Montia Nestler also met her husband, and today they live near New York. And even though she currently spends about a quarter of her time in Europe once again, she still has her office in Westbury, the headquarters of Oerlikon Metco in the US.

Start-up manager

Challenges appeal to Montia Nestler. So she (for the time being) turned her back on application development and laid the foundation for Oerlikon Metco’s service business in North America with the first coating shop in West Virginia. “Today you would say that we founded a ‘start-up’. I suddenly had to dedicate myself entirely to the entrepreneurial perspective, covering all areas from investment management and planning, operational processes, quality management and customer development right on to hiring the first employees. What I learned about management and leadership has been with me ever since.”

Research, application; local, global or digital? Preferably everything!

Time and again, Nestler has embarked on new paths: for example, as head of the global R&D department “Materials”.

While at the same time building local powder development laboratories, her department operated both globally and digitally. Isn’t that a contradiction in terms? She smiles: “No, quite the opposite! Local R&D sites enable an efficient exchange of knowledge between research and development, production and quality control, and optimal use of analysis technology and the local logistical infrastructure. And that means: developments can quickly make the transition to mass production. Globally, however, we make optimal use of our resources in terms of project management and experts and readily share knowledge and expertise. This enables us to offer customers the best possible solution.”

Experts as a link

Even as a manager, the engineer in Montia Nestler is always interested in the technical, operational aspect. For example, in order to bring developments to market more efficiently, she introduced application-oriented product management and headed the materials production site in Westbury for several years. From there, it was a logical step to unite both, application and product management, under her leadership in 2018.

As Global Head Applications/Product Management, she leads a global

team of coating experts and product, project and application portfolio managers who represent a wide range of sectors, from aerospace to power generation and from mining to e-mobility. At the same time, Montia Nestler is responsible for the five regional application and coating development laboratories worldwide, where new coating solutions are developed.

“My team of experts is the link between sales, internal development, production and marketing, and beyond that between the individual business lines. Two key questions

motivate us every day: What do customers need today? And what will they need tomorrow? Together with our customers, we develop the solutions that provide the answers. The key for doing so lies in the Application Solutions Centers, where materials know-how is combined with expertise in system engineering and the industrialization of coatings. That’s unique in the market.”

Coming full circle

Despite her many management and leadership roles, Montia Nestler continues to be involved in numerous

projects and programs. She remains enthusiastic about materials and surface engineering. “The variety of possibilities makes our work very demanding, but also incredibly fascinating. I still learn something new every day. For me, it’s like coming full circle: Just as at the beginning of my career, I can optimize workflows and processes in an advisory capacity. Today, however, this means that I can pass on my experience to my employees as a coach and be actively involved in shaping Oerlikon Metco’s strategy, products and services. Both are extremely fulfilling.”

Montia Nestler and her team in front of the newly developed Surface One.



ADDITIVE ACCELERATOR



Andy Christensen likes to stay ahead of the crowd when it comes to innovation. His earliest work with **3D printing technology** focused on plastics and surgical planning. But he turned his attention to additive metals in 2005 and founded Medical Modeling. Within five years, the company's support of Exactech resulted in the manufacture of an acetabular product that became the first additive metal implant in the U.S. to earn FDA clearance. The following year, Medical Modeling provided manufacturing support to 4Web Medical in creation of the first 3D-printed spinal implant in the U.S. to get the green light from the FDA.

by Randy B. Hecht

The son of a surgeon, he was drawn to a career in business. He sees part of his role as working with surgeons so they aren't overwhelmed by AM and understand how to tap its potential. And he's learned to help medical practitioners and engineers find a common vocabulary for seeking solutions. "When you can get them talking the same language, you find there's common ground, and then they start solving problems together."

One example of such a success in his own experience came while working with a surgeon who "had ideas for doing some things that we didn't have great knowledge of" in the treatment of benign and malignant tumors of the upper and lower jaws.

"He wanted to think about more precision in this particular surgery, more pre-surgical planning, more guidance of the bone cuts," Christensen says. "As we talked, I thought of separate 'tools' in our armamentarium, workflows that happened to be related to cutting out a piece of bone, replacing that piece of bone with another piece that's been cut to size and re-shaped. These surgeries also take skin, bone, muscle and vessels from the leg and put

them into the neck and create this living construct. Products that eventually emerged from that conversation are now the standard of care and have raised the level of precision of these surgeries. At the end of the day, we're helping a very specific patient with a big problem. The hope is that AM gives them a better result than they might otherwise have."

In the search for new opportunities to exploit AM's capacity to solve problems, he sees listening as an invaluable tool. "The way you would even figure out that there is a problem is by listening – interacting with the people who are doing the work," he says. "So I've spent a lot of time with surgeons and a lot of time in surgery, trying to figure out where clinical problems exist. If I have a 3D printing mindset, I can focus on problems that could be solved by better three-dimensional visualization and/or guidance in the personalization of surgery."

Christensen sold Medical Modeling in 2014 and left it the following year. Today, he is pursuing new business ventures and also serves as an Adjunct Professor in the University of Ottawa's Department of Radiology. And he's keeping a close eye on emerging new →

opportunities for AM to play a role in the evolution of medical devices. His biggest interests are in the areas of personalized products – patient-matched devices made for a particular person – and implant production that meets the needs of a specific patient population rather than one individual.

He foresees increased personalization of surgical devices that are not yet designed for individuality, such as hips and knees. “Today, most of that work is done using off-the-shelf sizes,” he says. “I think in the future, there will be more ability to personalize that as software workflows make it easier and hardware on the output side becomes more streamlined.”

In addition, Christensen anticipates advances in the use of additive metals to make “implants that share the load with the underlying bone structure. I think additive will play a role in providing, instead of big, bulky implants for the knee and hip, devices that are actually more about load-sharing. They’re strong enough to do their job but also share a bit of that load to keep the underlying bone healthy and vibrant.”

The future of regenerative medicine – “replacing body parts with body parts” – also has his attention. “This is about your own cells and fixing a problem with a particular body part by putting these cells back into your own body and creating parts that are indistinguishable in the long term from the parts they’re replacing,” he says. “I think this will be 3D printing’s largest impact in the healthcare space. It’s fairly early, but there’s a lot of research going on and a probability that it will happen. It’s just a question of whether it’s 10 or 30 years from now.”

Companies and organizations that are driving research in that direction should keep Christensen on their radar. To keep track of where he is, look ahead of the curve. He’s rarely behind it.

To read more of Andy Christensen’s insights into AM’s current and emerging medical capabilities, see our Q&A with him on the Oerlikon blog:

www.oerlikon.com/stories



“A lot of AM has to do with solving problems. And the way you would even figure out that there is a problem is by **listening – interacting with the people who are doing the work.**”

BIOCOMPATIBLE COATINGS FOR THE BENEFITS OF PATIENTS

People in blue surgical gowns hurry around, their faces half covered by masks. There are hoses and cables in a variety of colors everywhere. Sterilized stainless steel scalpels, tweezers, bone drills, clamps and other **surgical instruments** are neatly lined up on a cloth at the ready. **Nothing is left to chance.** →

by Carlo Portmann



“Surgeons can rely on instruments **over the course of a longer lifetime.**”

Canet Acikgoz, Segment-Manager Medical, Oerlikon Balzers

A good deal is expected of these medical instruments during an operation. As Canet Acikgoz, Segment Manager Medical at Oerlikon Balzers, explains, surface technology plays a decisive role here. With this in mind, greater emphasis is being placed on the functional coatings that are applied to scalpels, needle drivers, bone saws and reamers. “With physical vapor deposition (PVD), materials such as stainless steel and titanium can be coated with extremely hard and thin layers. The vacuum-based coating process can further improve the key properties of medical instruments,” she explains.

Friction-reducing coatings

An important factor, for example, is friction, which can influence the performance of a bone drill: the less friction a drill like this generates, the lower the negative effect on surrounding bone will be. In the industrial sector, lubricants would be used in a case of this nature, but that is not possible in surgery. Consequently, Canet Acikgoz and her colleagues asked themselves: “What other possibilities for preventing friction are there besides the use of grease?” They

came up with the idea of applying a friction-reducing coating to medical instruments. The technology is now being used successfully.

DLC coatings (Diamond-like-Carbon, which signifies very hard carbon coatings) with low coefficients of friction will provide lubricity, corrosion resistance, anti-sticking and antifouling. They even improve sharp edge retention of surgical instruments, which extends the service life of the instrument considerably. As an added benefit, cleaner cuts help surgical incisions heal more quickly and so reduce patient recovery time.

Corrosion resistance for extended lifetime

Coatings can also extend the life of these instruments, which are often expensive. For example, bone rongeurs must be able to withstand quite a bit. Blood and other bodily fluids contain numerous salts and proteins. After the operation, the bone rongeurs are subjected to sterilization to prepare them for their next use. Devices known as autoclaves are frequently employed for this purpose. In these chambers the instruments are sterilized by means of increased temperature, pressure and steam. However, salts, proteins and steam can corrode knives and make their blades dull. Special coatings help to better protect the base materials, such as stainless steel or titanium, from corrosion: “The aggressive substances are then unable to penetrate as easily, and they cause less damage as a result. Surgeons can rely on instruments over the course of a longer lifetime,” says Canet Acikgoz.

But physicians must also be assured that they will be able to see at all times – in the brightly lit surroundings of the operating room – the exact depth that the scalpel or drill has already penetrated. Light reflected from the instruments can cause an unpleasant glare or distraction. Stainless steel, for example, which is often used in medical environments, is highly reflective. Surface coatings can be used to darken medical instruments so that they reflect less light.

Color coding enhances precision

As the coatings are available in different colors, instruments can also be colored differently. These color codes make it easier for the

surgical staff to find the right instruments at any time and within seconds. The coating can also be applied as a marking on drills so that the surgeon is able to see how far into the bone the drill has already penetrated. All this helps these professionals to work quickly and with precision in the operating room.

Next step: antimicrobial coatings

Canet Acikgoz and her colleagues are currently working on another exciting topic: How can surface technology help with the dreaded threat of infections? In hospitals and other medical facilities, there is always a latent danger that germs may be introduced from outside and endanger patients. “We are working on antimicrobial coatings to help prevent infections in the operating room,” explains Acikgoz. Copper and silver, in particular, have the property of stemming the spread of bacteria. For example, surgical instruments made of titanium and other metals can be coated with silver to achieve this effect. But the coating alone is not enough, because in order to have an antimicrobial effect, the silver must first dissolve somewhat. Only then can the silver ions attack and eliminate the bacteria. “To start this process, we need a humid environment,” explains Canet Acikgoz. Bodily fluids can take over this function. Medical instruments coated with silver will not replace antibiotics in the fight against bacteria. However, the technology could allow doctors and hospitals to use fewer antibiotics during surgery.

Increased precision, improved durability, and entirely new features: Coating solutions from Oerlikon Balzers marketed under the brand name of BALIMED make a significant contribution to further improving medical instruments. These enable surgeons to work more efficiently and treat patients better and more safely at the same time. If things go as planned by Canet Acikgoz, her colleagues and Oerlikon Balzers, more precise scalpels and bone drills that can be used for longer periods of time are just the beginning.

Video on BALIMED
PVD coatings:

youtu.be/pbxzGyWiPKU



SOLUTIONS FOR MEDICAL TECHNOLOGY

The demands made on **surface solutions in medical technology are many.** Among these are consistently sharp cutting edges on surgical tools and, for implants, both body compatibility and surface conditions that facilitate bone ingrowth.



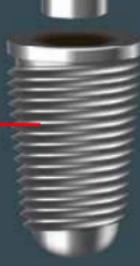
Crown



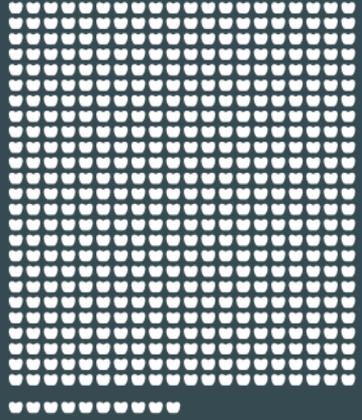
Abutment



Dental screw



A laser sintering system produces more than **500 dental crowns** per day. Using traditional casting techniques, a dental technician can make about ten.



25%

By 2021, it is estimated that 25% of all surgeons will train on models of the patient produced by a 3D printer before the actual operation.

In 2018 more than 433,000 artificial hip and knee joints were implanted in Germany.



252,000

Hip joints



181,000

Knee joints

58%

It is estimated that 58% of all hip implants achieve a retention time of 25 years.

SOLUTIONS FOR MEDICAL TECHNOLOGY

Dental abutments and screws



In addition:

- › Low torque during insertion
- › No breaking or blocking

Instruments for Minimally Invasive Surgery (MIS)



In addition:

- › Insulating properties
- › Autoclavable (disinfection with steam under high pressure)

Medical instruments and devices



In addition:

- › Autoclavable (disinfection with steam under high pressure)
- › Color coding
- › Reduced friction: High-speed drills can be used without lubricants

Implants





WEAR AND CORROSION PROTECTION

Special coatings on medical instruments and tools preserve their sharp cutting edges, remain scratch-resistant and prevent wear. This also makes them impervious to cleaning agents, and protects them against corrosion caused e. g. by sterilization treatments.

In the manufacture of medical instruments and implants, cutting tools with special wear protection coatings enable efficient and precise machining.



ANTI-REFLECTIVE COATINGS

Glare-free black coatings on medical instruments and tools, and especially surgical instruments, enable surgeons to work faster and more efficiently.

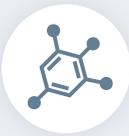


BALIMED ALTINA coatings maintain sharp cutting edges and allow glare-free surgery.



ANTIMICROBIAL COATINGS

The addition of silver to Oerlikon Balzers coatings inhibits the growth of bacteria and helps prevent postoperative wound infection.



BIOCOMPATIBILITY

Implants (which remain in the body for a long time) and surgical instruments must contain no substances that are harmful to surrounding tissues.



HIGH OSSEOINTEGRATION

A stable connection between the implant and the surrounding bone tissue is an important factor for the healing process as well as a prerequisite for enabling a long retention time.

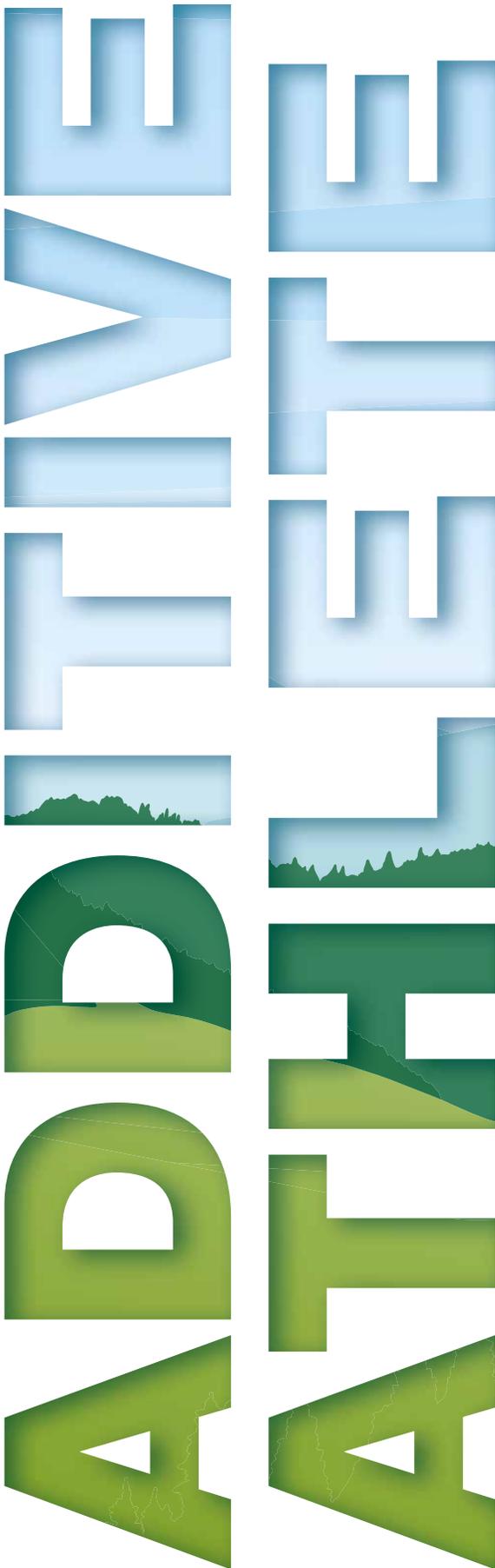
Additively manufactured implants can be imprinted with a porous titanium surface that promotes a direct connection with the bone.



Additively manufactured spinal implant with visibly porous surface for enhanced osseointegration



The rough titanium surface enables a success rate of over 95% with a five-year retention time.



Oerlikon's Nancy A. Shepard markets AM implants – and now wears one, too.

by Randy B. Hecht

Nancy Shepard had been looking for trouble all her life. You can't be as athletic as she is for as long as she has without experiencing joint problems eventually. So when her orthopedist first asked what could have caused the persistent pain in her hip, she was stumped. She didn't recall anything that could have caused the injury during her ascent of Kilimanjaro. Nor during her five-day hike on the Inca Trail during an uncharacteristically wet – therefore slippery – dry season.

"It could've been when you went skydiving, too," her mother suggested. (Shepard, who is Director of Business Development, Oerlikon AM Medical, agrees that the experience probably didn't help.) Her orthopedist dug for more precise detail: "Can you think of a time when you were in a position of pain that you couldn't get out of?" With that question, the memory of a skiing incident during her 20s came back to her.

"I went, Oh, my God. That was it," Shepard says. "I wouldn't call it an accident. I was not properly trained – didn't do lessons, because they said, 'Oh, you'll figure this out.' So, I was in a difficult position for many minutes, I couldn't be moved, and my right hip suffered from it."

Farm life prepared her for physical challenges and mechanical engineering

At the time, she shrugged it off and kept going, because that's how she had been raised as the sixth of seven children on a dairy farm in Vermont. When her older siblings had left home, a lot of milking and farm work became her responsibility. That hard work prepared her for physical challenges as well as her university studies.

"I became an engineer. In part that's because my mom was a math teacher. But the bigger part was that I understood processes, the need for manufacturing flow, scheduling," she says. "I could fix equipment, because I had to. I'm only five feet tall, but I was always hands-on and a really good worker. I knew how to run equipment. Mechanical engineering just naturally came to me."

10 years of therapy and care

Then, in her 40s, the hip injury – a slow degradation of the cartilage around her acetabular cup – became noticeably painful. An MRI led to a diagnosis: she had a macerated labrum. "That sounds awful, doesn't it? And essentially,



Always on tour: Nancy and her husband hiking the mountains of Mexico to the Monarch Butterfly's annual migration.

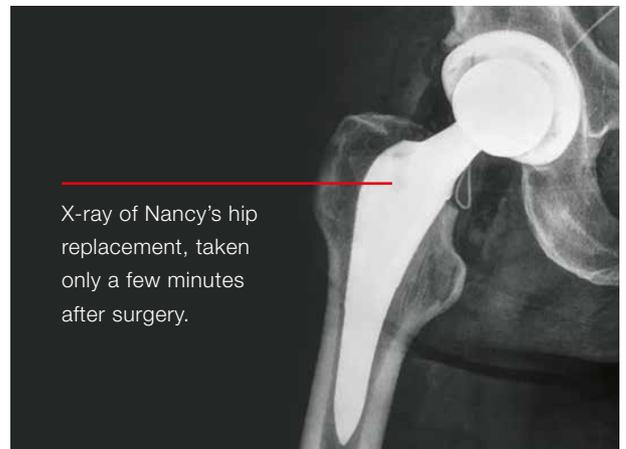
it's shredded cartilage," she explains. "But the pain wasn't always prevalent, and the surgeon said, 'You're still not a surgical candidate.' For 10 years, I did physical therapy, massage therapy, chiropractic care – whatever I could do."

The combined therapies worked until a year ago, when she was in constant pain. A new MRI revealed that her condition merited surgery. Steroid injections bought her a bit more time, and then she finally scheduled the operation. But not before Shepard weighed in on the choice of implant she'd be fitted with.

"I intend to get an additively manufactured cup"

The patient and professional spoke as one. "I travel with a sales kit that contains several acetabular 3D printed parts," she says. "We produce other parts at our Oerlikon AM facility in the U.S., but don't currently do acetabular cups like the one I wanted. So I went in there with my samples, and I said, 'This may be a little unusual, but this is my business. I fully believe that osseointegration benefits from a 3D printed part, and I intend to get an additively manufactured cup.'" In her work, Shepard promotes the benefits of 3D printed cups, which have the ability to offer quicker, more complete osseointegration when the implant mimics the bone structure. →

"I fully believe that osseointegration benefits from a 3D printed part, and I intend to get an additively manufactured cup."



X-ray of Nancy's hip replacement, taken only a few minutes after surgery.

“The structure that your bone naturally has is printed randomly on the outside of an acetabular cup,” she explains. “Its level of depth provides the bone that’s growing with a way to attach to the implant. Prior to additive manufacturing, they recognized that the smoother the surface, the harder for the bone to connect to it. In conventional manufacturing, the industry adds a Titanium Plasma Spray. But with additive manufacturing, the random structure is printed during the process and is integral to the implant.”

Her surgeon was excited to have a patient who was interested in and knowledgeable about the device. And her colleagues were excited by the model she chose, just as conversation in another office might turn to enthusiasm over a coworker’s new car or mobile device.

“You’ve got to keep working at it”

She advises anyone facing the surgery that a strong support system is essential to a positive outcome. “My husband washed and

dried my foot, put on my socks and made sure I didn’t bend at my waist for six weeks,” she says. “You can’t bend past 90 degrees for six weeks, and that’s a restriction that you really don’t appreciate until you can’t do it.”

Beyond that, she stresses the importance of diligence in physical therapy. “Do what you’re supposed to and your outcome is going to be positive. A lot of people want it to be over after the surgery, and you can’t do that. You’ve got to keep working at it.”

By three weeks after the surgery, Shepard felt as though she was “getting toward pain-free,” and at the 10-week mark, she was able to walk a mile in 20 minutes. “I used to do three miles in about 50 minutes, so it’s getting there,” she says. She’s now looking forward to embarking on a physical therapy program for athletes. Because the whole point of getting an additively manufactured hip implant was that it would let her resume the active life she loves.

THE PREFERRED OPTION FOR ACTIVE PEOPLE

Optimal outcomes following hip replacement surgery depend on the quality of the implant, the medical team, and the patient’s engagement. Nancy Shepard’s surgery represents “a perfect case,” says her orthopedic surgeon.

An expert in total hip replacement, Dr. Hernan Prieto points to two key advances in hip replacement over the past decade: the materials used to make implants, and the surgical techniques in use. “We aim for minimally invasive techniques allowing patients to have faster recovery and lower complication rates,” he says.

Materials development has supported that surgical objective by changing the way the implant is fixed to the patient’s native bone. “Twenty years ago, we used a lot of cement to fix the implant to the patient’s bones,” he explains. “Nowadays, we use metal devices that have a surface that allows the patient’s bone to heal around the implant and enhance the fixation.”

That makes additively manufactured implants the preferred option for active people, Dr. Prieto says. Because it takes a high-performance implant to keep up with a patient like Nancy.



Dr. Hernan Prieto,
Nancy’s orthopedic
surgeon

ADVENTURE AWAITS

FOR A STRONG BITE

An **abutment** is the connection between a dental implant – the artificial tooth root – and the visible part of the prosthesis, called the crown. **For Bächler Feintech, however, it is much more: an “overall trust package for patients.”** This is why the traditional Swiss company works together with Oerlikon Balzers.

by Agnes Zeiner

Lucas van der Merwe, CEO of Bächler Feintech, demonstrates on a model enlarged by a factor of five how the crown with the abutment is simply “clicked” into place on the implant. “Nothing wobbles here, there is no need for adhesive cream, the patient has no restrictions, and of course nothing is visible. Do you still remember that television commercial from the 80s: ‘So that your bite will remain strong in the future?’ I guarantee you’ll be able to bite a lot harder with this. And you can do it at least two million times.” →



“We have some very promising projects in the pipeline. **We will definitely implement these with our partner Oerlikon Balzers as well.**”

Lucas van der Merwe
CEO, Bächler Feintech

Behind this promise and the confidence with which it is expressed are a great deal of high technology, experience and passion – and an unconditional demand for quality. In fact, that word comes up often in this conversation. Before Lucas van der Merwe joined the precision mechanics company with its rich tradition, he managed projects for large corporations and, fascinated by the subject of quality management (QM), engaged in further training to become a leading QM auditor.

“We are a Center of Excellence and strategic supplier for our largest customers, most of whom are in the medical and dental industries. This means that we need to pay attention to extremely good process quality and documentation. Quality, transparency and trust form the basis for long-term customer relationships like this. And I am proud that these things also characterize our relationship with our employees,” he says.

Standard-issue products? No thanks!

The bar is thus set high for the partners and suppliers of Bächler Feintech: “In recent years we have systematically checked all our suppliers. We work exclusively with those who can meet both regulatory standards and our own quality process requirements. Sometimes that meant that we had to find new partners. And in a few cases, we even decided to bring processes directly into our own company. It’s the only way to make sure standards are met.”

Oerlikon Balzers has frequently been engaged by Bächler Feintech for the application of coatings in the past, but mostly in smaller series. “When we started developing products for the dental sector, we were looking for a coating that could meet our expectations – not a standard-issue product. I have to admit, we

bet on the wrong horse first. Then we approached Oerlikon Balzers, not least because we were very impressed with their level of commitment.” The new cooperation bore fruit and the response from Bächler Feintech’s customers was enthusiastic. Van der Merwe notes: “We have planned the next product line with Oerlikon Balzers coatings right from the start!”

Delicate handling

The turning of the titanium abutments, which are only a few millimeters in size, is precision mechanics “par excellence.” Only a few specially trained employees at Bächler are proficient in this. The tolerances are extremely tight, as are the inspection intervals: Inspections are made every few pieces. With the help of a special treatment, the surface of the abutments is then made even smoother so that the BALIMED A coating adheres even better. “Unevenness would lead to increased abrasion so that we could no longer provide a lifetime guarantee,” explains van der Merwe. And the handling, as well, is anything but easy: The extremely fine threads must be protected from every form of mechanical stress. This is why the parts are prepared for coating immediately after being cleaned.

On arrival at Oerlikon Balzers, a handling machine takes over the loading (or after the coating process, the unloading as well): “Our risk analysis has shown that the usual manual handling otherwise employed could damage the threads. The machine ensures process reliability and stability because it nearly always grasps the part at the same location with the same force. And last but not least, it works without fatiguing,” explains Florian Schmitt, Business Development Manager Medical Europe. The fixture used was also developed in cooperation with the specialists from Bächler Feintech to ensure

Rendering of an
abutment fitted on
a dental screw.



optimal coating of the abutments. Defined cleaning cycles and ongoing tests guarantee consistently high quality throughout the entire coating process.

S3p technology for market entry in the USA and Japan

The two partners faced a particular challenge when Bächler's customer planned to enter the US and Japanese markets, where the requirements were somewhat different. After special load testing, the team selected BALIQ TINOS, a coating based on Oerlikon Balzers' S3p technology. It combines the advantages of the electric-arc and sputtering technologies and provides a revolutionary smooth and hard surface.

"We have a very positive outlook concerning the development of the medical and dental sector in the coming years and expect strong growth for Bächler Feintech. We have some very promising projects in the pipeline. We will definitely implement these with our partner Oerlikon Balzers as well – and not just because the quality is right, but so are the trust and transparency," says Lucas van der Merwe, looking to the future.

Bächler Feintech

- › Founded in 1964
- › 150 employees
- › Quality certificates ISO 9001 and ISO 13485
- › Location: Hölstein, Switzerland
- › Part of the Klingel Medical Metal Group, Pforzheim (Germany)

www.baechlerfeintech.ch



NEW BALIMED PORTFOLIO OF COATINGS FOR MEDICAL APPLICATIONS

The quality requirements for medical instruments are increasing every year, and enhancing surfaces by applying highly wear-resistant antimicrobial coatings has become an integral part of modern medical technology. In addition to these ultra-high quality standards, instruments used in the medical industry must also meet stringent biocompatibility regulations.

The seven innovative new BALIMED coatings from Oerlikon Balzers, each of which has been developed for specific medical applications, meet the demanding requirements of today's medical instruments and components industry. These low-friction and wear-resistant ThinFilm coatings offer higher cost efficiency and contribute to improved patient outcomes thanks to their biocompatible, antimicrobial and chemically inert properties.

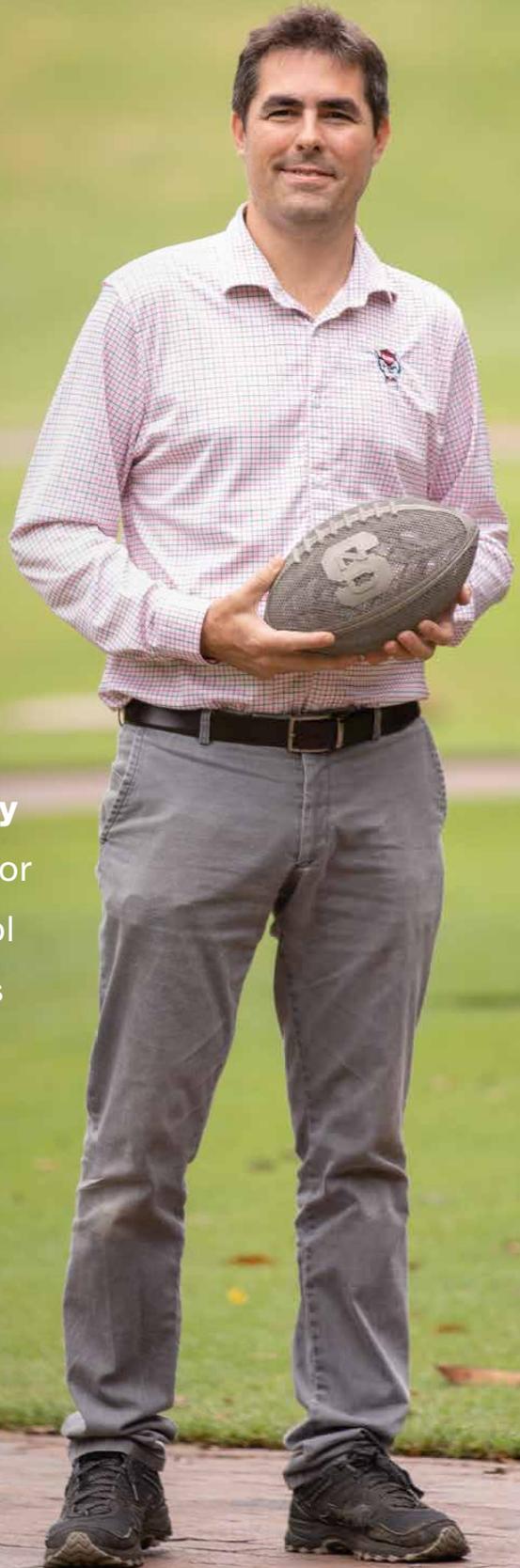
www.oerlikon.com/balzers/balimed

THE TEST QUEST

Additive manufacturing is an answer that raises many new questions. When we build components outside the traditional mass-production model, how do we **control and standardize their quality?** How do we ensure **compliance with the regulatory requirements** in sectors such as medicine or aviation? What do testing and quality control look like for Industry 4.0? **Tim Horn's job** is to answer these and related questions.

by Randy B. Hecht

With his varied background, **Tim Horn** has no trouble managing a trio of titles. In addition to being Assistant Professor of Mechanical and Aerospace Engineering at North Carolina State University, he is Director of Research at the Center for Additive Manufacturing and Logistics and Director of the Consortium on the Properties of Additively Manufactured Copper.



“We have to bring in the expertise of many different disciplines ... **It’s about learning to speak one another’s languages and learning about the different processes.**”

Tim Horn isn’t just developing quality control and testing protocols outside the parameters of traditional manufacturing. He’s also drawing on knowledge and experience gained while following an unconventional path to an additive manufacturing career.

After training as a cabinetmaker, he earned a degree in wood and paper science and engineering. As a researcher in wood machining and tooling, he worked within a program focused on cutting tool design and tool instabilities for the sawmill industry. A master’s degree in manufacturing engineering and a Ph.D. in Industrial Engineering set the stage for contributing to advances in testing and quality control for additive manufacturing. We spoke with him about what testing looks like today and where it’s headed.

When you began working in additive manufacturing, much of the focus was still on prototyping, and the cost-benefit ratio was not yet clear. What inspired your interest at that stage?

I was ready to go out and get a job at about the same time that NC State acquired the Arcam metal additive technology. This was nearly 18 years ago. I’m not sure how many people really took it seriously back then. But I was amazed at the tremendous potential in the idea that you could make a metal object directly from the CAD file without a mold or tool. From that point, I started working in materials and processes for metal additive machines.

One of the challenges in testing and quality control is repeatability in results. What are the biggest changes you’ve seen in results using electron beams and laser-based metal processes with metal powders?

Fundamentally, the powder bed additive manufacturing processes haven’t changed appreciably over the years. What has changed is our ability to predict process outcomes given a rather complex set of inputs. The processes

have become more robust and more repeatable for a small subset of alloys – titanium aluminide, nickel superalloys, alpha beta titanium – maybe five or six proven commercial alloys. And there’s this enormous space out there with new materials that exist but aren’t used for this process and materials that don’t exist and are yet to be utilized. There’s a tremendous amount of work that can be done.

What is it about the nature of AM that makes it necessary to find a new approach to testing?

Additive in general lends itself to small-batch quantities of geometries that are highly complex and otherwise difficult to produce. As amazing as it is, AM can be incredibly slow. Build times can range from a few hours to several days or more. The real power and promise of additive manufacturing is in the elimination of part-specific tooling and the idea of producing just one of something – a custom patient-specific implant or a replacement part for an aircraft – but to do so in a digital, predictable and traceable way.

The main challenge then becomes one of quality control and assurance. These are almost all critical applications where the risk of failure may be low but the cost of failure may be exceedingly high.

How do you, as a process engineer, guarantee when you make a new custom geometry that it meets all of the quality requirements for a given application?

That becomes quite challenging with additive because there’s a geometric dependency on the localized heat inputs. For instance, thick and thin wall parts within a layer may exhibit different thermal inputs and therefore different solidification microstructures – and, of course, the properties.

On top of that, we have this difficult-to-predict set of stochastic boundary conditions around →

this weld pool that we're creating. The powder bed itself is made up of very small particles that range in size, so we see local variations on the order of a few hundred microns. That significantly alters the packing characteristics and the bulk thermophysical properties, which necessarily requires us to change our inputs – power, velocity, focus – to maintain a constant set of solidification conditions.

The question becomes what fidelity of model is required to predict these properties and performance across multiple length scales. Ultimately, I would like this done in real time and integrated within many machine controls so that defects can be identified and eliminated in a single process step.

You describe your research as application-agnostic. But in practice, there are sector-specific challenges and instances of skepticism. How do you deal with those?

Additive really lends itself to specialized high-value-added applications, often in regulated environments. Qualifying these components and processes for non-standard or widely varying geometries becomes quite challenging.

Within specific sectors, there is a great deal of skepticism, but I think it's generally been open-minded skepticism, and that is a good thing. The stakes are incredibly high in these environments. We have to show, as researchers and process engineers, what the processes are capable of and what the limitations are. It requires the combined expertise of many different disciplines.

If we imagine a day when we are making implants in the surgical suite for instance, we would need to compound all the expertise, information, material characteristics, simulation tools and process controls into a single operation. Today, at least in our lab, when we design



implants, we have the clinician, the surgeon, often the radiologist, the anesthesiologist, the engineers, the modelers, all together in the room, and we design this implant concurrently.

It's a step in the right direction, but also a long way from where we need to be in order to make the "vision" a reality. The situation is the same whether it's a particle accelerator, a reactor or a high-temperature aerospace application.

What does the testing process look like, and how do you test the testing?

The scientific question is, how do we affect quality control on a single component? If I make one implant for one patient, how do we predict its life-time? How do we guarantee that failure will occur within an acceptable window of confidence? Which tools do I need to improve my confidence?

In traditional processing, we do that by sampling among a population of many other parts. In additive manufacturing, we don't always have these flavors of data. I think that is where our research is today. It's developing the materials, moving through qualifications and utilizing process monitoring, process control and post-build inspections.

Recently, we developed a suite of sensors that utilize artifacts of the electron beam melting process itself to generate in-situ imaging and data, in real time, during the melting process. Essentially, we have turned our Arcam production EBM systems into high power electron microscopes that also manufacture componentry. With these tools we can identify porosity, cracking and variations in material density and composition.

What advances should we anticipate in the evolution of nondestructive testing?

It is computationally expensive right now, and we're not always entirely sure what to do with the massive quantities of data we generate. But all these things are advancing as I'm speaking. We're getting better and better at predicting. In two or three years, this will be a very different conversation.

A great deal of work is going into the science of additive manufacturing and measurement. The modeling of the processes and our understanding of the underlying physics is continually improving. And all the while, the processes

“We’re getting better and better at predicting. In two or three years, this will be a very different conversation.”

themselves are improving. The tolerances are getting tighter. Standards and best practices are developing. As these factors converge, we will be able to operate within a tighter set of manufacturing and design limitations.

What can you tell us about the Consortium on the Properties of Additively Manufactured Copper and its work?

We've observed a growing demand for sophisticated solutions in power electronics, radio frequency devices, accelerator components and thermal management using high purity, oxygen free electronic grade copper for years. But it's difficult to process copper using welding-based additive manufacturing processes and maintain the quality, density and purity required of these applications.

We've done quite a bit of research in this area and made some viable demonstrations. Moving these results into a set of qualified components and processes requires us to leverage the growing interest and the support of the machine manufacturers, powder material suppliers, parts producers and end users. So, this consortium was established as a prelude to the qualification of additively manufactured copper, to give us a deep understanding of the material itself and the influence of external factors like oxygen content, orientation within the build, effective geometry. We're trying to get the level of understanding for copper that we have for more mature materials like titanium today.

The group's founding members are GE Additive, Siemens, Radiabeam Technologies and Calabazas Creek Research, and we're actively recruiting others. The more members we have, the more resources we can commit to the robustness of the data set we produce.

AT YOUR SIDE

Even closer to our customers



1

PRODUCTION BEGINS AT OERLIKON BALZERS ST. LOUIS

With the launch of a new customer center in St. Louis, Missouri, Oerlikon Balzers expands its presence in the U.S. market. Production began in June at the center, which is equipped with the latest coating technology and pre- and post-treatment systems. This will allow Oerlikon Balzers to supply coating services for cutting and forming tools to its customers in St. Louis and across Missouri.

Sectors with strong activity in the state include automotive, aerospace and other industries. Steve

Crowley, Head of Sales and Operations, President of Oerlikon Balzers North America, said: “We have worked for a number of years with fantastic customers in the greater St. Louis and Missouri area, and the opening of this new center now allows us to take our relationships to the next level by having a full-time presence here. For us, it is all about providing the highest-quality service and being part of the local community. We are really pleased to be here.”



2

INNOVATION HUB IN HUNTERSVILLE

In May, Oerlikon opened its Innovation Hub & Advanced Component Production facility in Huntersville, North Carolina. The facility will serve as a cornerstone of the company's additive manufacturing business in the U.S. and support its growth strategy in this market.

"We are already working with customers in the aerospace, automotive, energy and medical industries in the U.S., and we anticipate continued growth in those sectors, as well as in others," said Dr. Sven Hicken, Head of Oerlikon's Additive Manufacturing business. "We believe that additive manufacturing can transform production in many industries, and we are excited that our presence here in North Carolina allows us to better demonstrate those possibilities to our customers."

The Hub's 60 employees form Oerlikon's second team in North Carolina. In total, Oerlikon employs more than 1,300 people in 18 U.S. states. Over the next three years, the company plans further investments in the U.S., which will result in the creation of additional jobs.



3

SUSTAINABLE INNOVATIONS ENTER MEXICAN MARKET



Mexico's automotive industry has gained access to environmentally friendly PPD and BALITHERM PRIMEFORM technologies with the opening of a new customer center in Querétaro. These innovations from Oerlikon Balzers bring sustainable production of automotive components to the Mexican market, and the new location is well positioned to serve customers in other Latin American countries.

The opening coincided with the 20th anniversary of Oerlikon Balzers Mexico. In Querétaro, Oerlikon Balzers will serve OEMs and Tier 1 suppliers in the automotive industry as well as mold makers in the metal forming and plastics processing industry. The new center enables Oerlikon to be more responsive to the automotive industry's increasing demand for sustainable high-quality coatings and heat treatments.

Environmentally friendly and more cost effective as wear protection, PPD is an alternative to harmful chrome plating and an improvement on conventional nitriding. BALITHERM PRIMEFORM treatment improves demolding, optimizes process reliability and enhances component quality.

4

OERLIKON BALZERS EXPANDS PRESENCE IN SWEDEN



The vehicle production sector is undergoing radical change, and increased proximity to customers strengthens Oerlikon's capacity for collaborating on R&D in such key areas as productivity, efficiency and sustainability. Oerlikon Balzers Sweden's invaluable expertise has made it an indispensable partner in the production of powertrains for commercial vehicles in recent years. Since May, two new customer centers in Eriksberg and Köping strengthen its presence in Sweden.

These new centers will enable Oerlikon to expand its range of coating solutions for cutting tools and offer high-quality pre- and post-treatment services. This, in turn, aligns with the company's strategy for being as close as possible to its customers to shorten delivery times and routes, improve customer service and help Oerlikon reduce its carbon footprint.

Eriksberg 4 | 4 Köping

5 | Bisingen

5

BISINGEN, GERMANY

Competence Centre for sustainable metalization of plastics with a chrome look

In May, Oerlikon Balzers laid the foundation stone for its new Competence Centre in Bisingen, Germany. Once open by mid 2020, components made from plastic, primarily for the automotive sector, will be metalized with a chrome look using sustainable ePD technology on a site covering several thousand square meters. More than 100 new jobs will be created at the Bisingen Competence Centre, which will enable Oerlikon Balzers to meet the high demand and ever increasing requirements of its customers from the automotive sector.

REACH standard-compliant ePD technology provides a sustainable alternative to galvanic methods, which involve chromium (VI) and can be hazardous to health. Fully integrated and automated INUBIA I6 and I15 production systems have been designed for large-scale manufacturing and produce metalized components without any harmful substances. The new Competence Center will meet all environmental production standards in their entirety.

Found in interior and exterior vehicle design as well as consumer electronics, high-gloss metallic or matte surfaces and a chrome look are increasingly popular in high-end components. In addition to being fashionable, they enhance product performance and value. Projects at the Bisingen site will include further development of the ePD process.

7

AM TECHNOLOGY CENTER OPENS IN SHANGHAI

June marked the official opening of the first Oerlikon AM technology center in China. With its location in the Jiading district, the center enjoys proximity to the Chinese automotive industry's main innovation base. The district is also home to the largest scale and highest level of R&D capabilities in the country along with the most complete industrial chain.

Resources at Oerlikon AM Shanghai include two professional printing machines and a variety of testing and analysis facilities to ensure product quality control. The center's launch positions Oerlikon to deliver printing solutions to the Chinese market rapidly and conveniently. Its capabilities encompass metal powder materials, printing design and production, post-processing, technical consultation and other services.



The Oerlikon AM Shanghai team was honored to welcome many key partners and dignitaries to the opening.

7 | Shanghai

Dongguan | 6

6

GROWTH IN DEMAND DRIVES EXPANSION IN CHINA

Oerlikon Balzers significantly expanded its production space in Dongguan, China with the opening of a new coating center. The new facility brings the capacity in line with order volume, which has grown rapidly in recent years. It triples the size of the former center to allow Oerlikon Balzers to scale production to the high demand for its solutions for cutting and forming tools as well as precision components.

The new center is the second largest in China and one of eleven established by Oerlikon Balzers since 2008. It will serve customers from a wide variety of sectors in this heavily industrial region.

Colorful opening ceremony in Dongguan, China



▶ THE FUTURE

For the nearly eight billion people worldwide, mobility is a necessity. About four billion people travel by plane every year; about one billion cars drive on our roads. Cities are growing, traffic is increasing. At the same time, digitization is radically changing entire industries and society and opening up new opportunities.

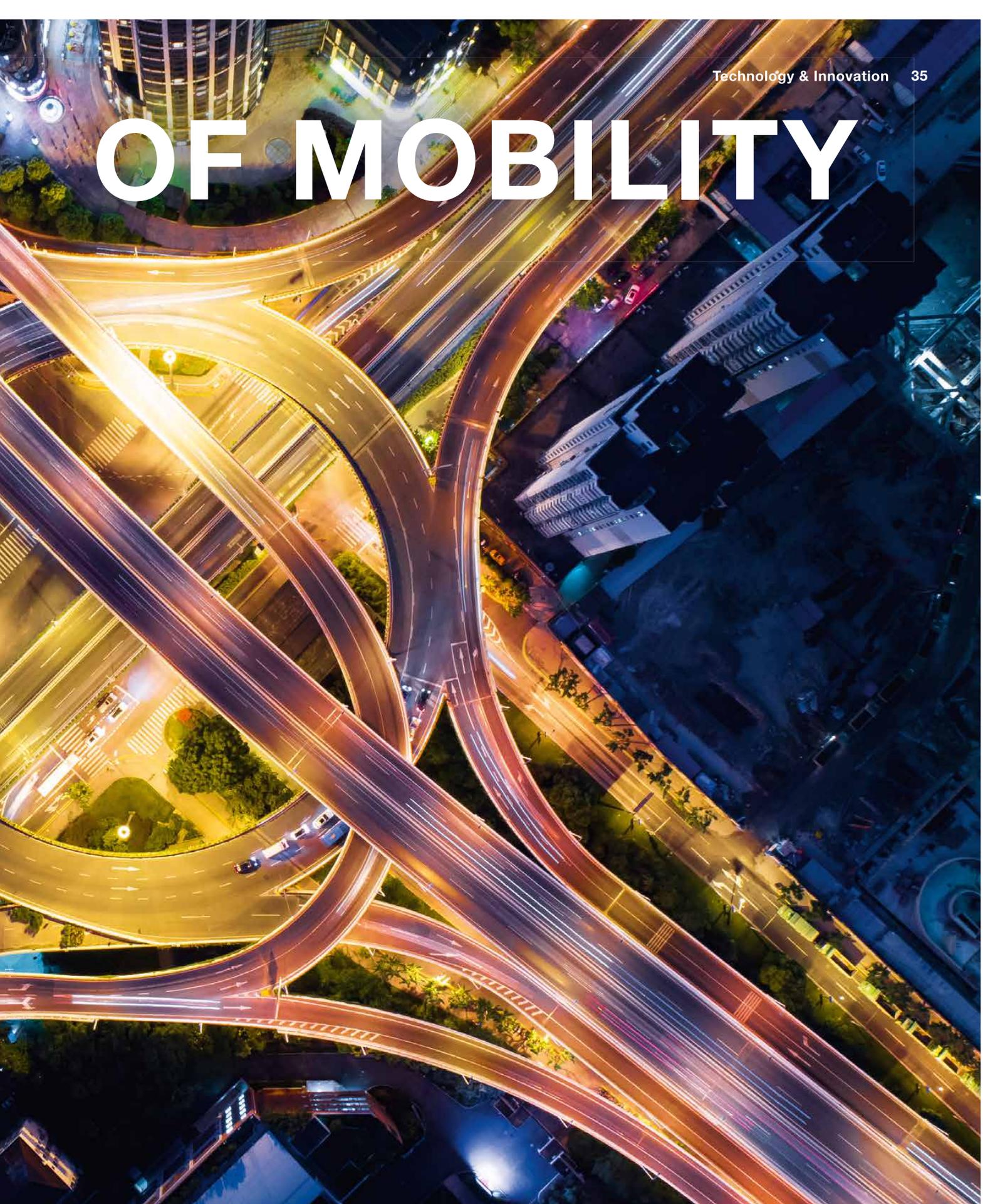
The international media group Sky picks up on these trends in its TV series “The Digitalization of Mobility,” which presents technological innovations that will shape the future of mobility. In the latest episode, “Hidden High-Tech — Super Technologies for the Mobility of Tomorrow,” Oerlikon’s innovations play the leading role. During the 25-minute documentary, the audience learns how Oerlikon technologies, materials and coatings are changing the future of mobility.

Over the past few months, the production team visited Oerlikon sites in

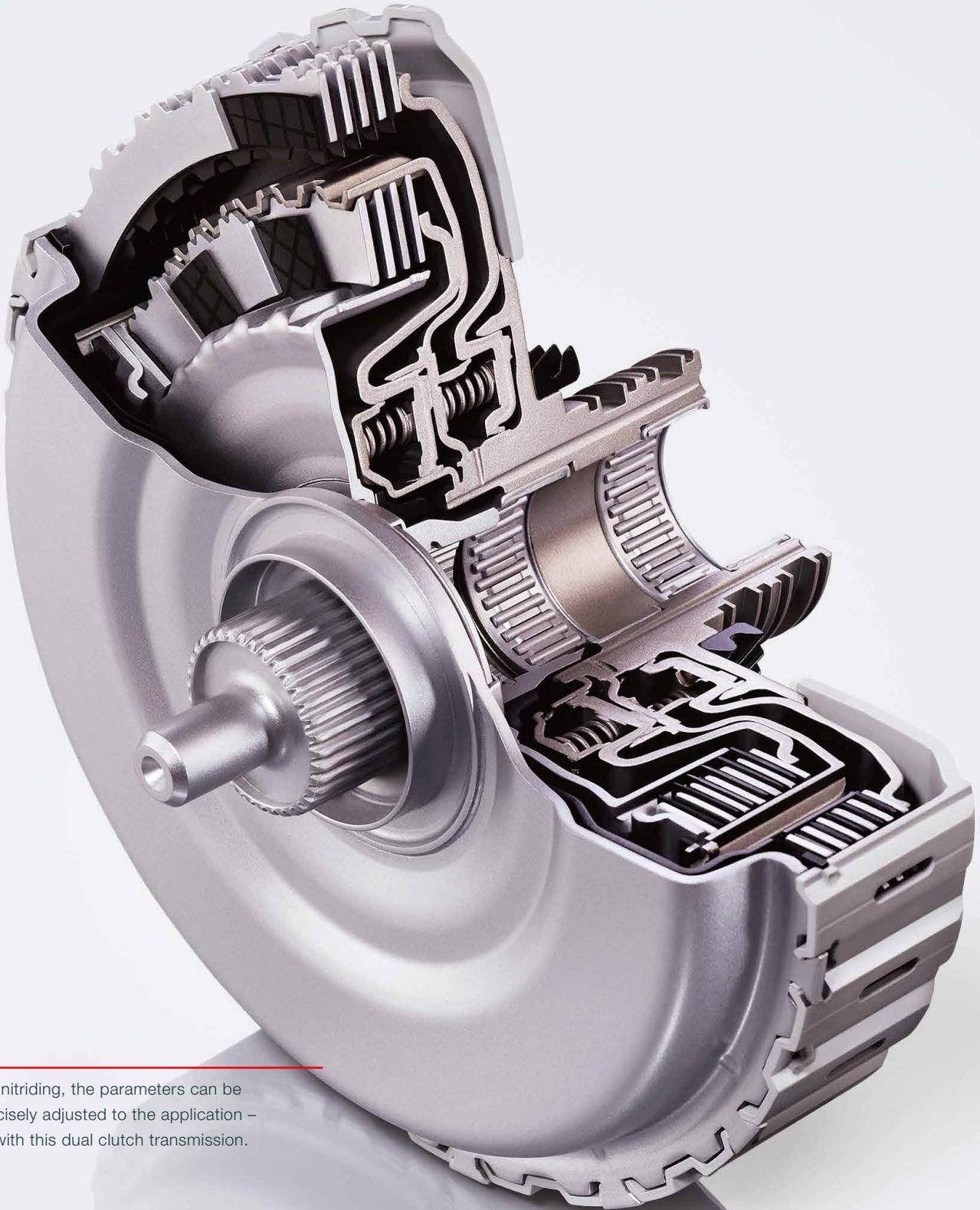
Huntersville (North Carolina, U.S.A.), Wohlen (Switzerland) and Suzhou (China) and interviewed internal experts, customers and scientific partners. The film covers additive manufacturing, Oerlikon Metco’s new “Surface One” system and thermal spray, as well as Oerlikon Balzers’ environmentally friendly ePD coating solution — and explains how these technologies and experts are helping to solve the challenges of the future of mobility in cars, planes and space technology.



OF MOBILITY



HOW NITROGEN MAKES STEEL ESPECIALLY HARD



For nitriding, the parameters can be precisely adjusted to the application – as with this dual clutch transmission.

Ever more cost-effective production, but without compromising quality; ever higher legal and social requirements; ever greater customer demands for environmentally friendly and sustainable products: the metalworking industry is facing many challenges. **With the BALITHERM product family, Oerlikon Balzers offers thermochemical heat treatment processes such as nitriding and nitrocarburizing** in gas and plasma. These are environmentally friendly alternatives to treatments such as hard chrome plating or salt bath nitriding and, depending on the process and material, allow hardnesses of up to 1,100 VHN*.

In these processes, the diffusion of nitrogen into a surface creates improved mechanical and chemical resistance properties for the functional surface. In other words: no coating is applied, but instead, the material itself is given a higher surface hardness.

Plasma nitriding and nitrocarburizing are carried out using an ionized gas mixture consisting of nitrogen and hydrogen or carbon. These processes take place in a vacuum by means of low-energy plasmas and at relatively low treatment temperatures of 380–560 °C. Gas nitriding, on the other hand, takes place under atmospheric pressure using ammonia, which is split and thus serves as a donor for nitrogen and hydrogen. If the process takes place in a carbon-donating atmosphere, this is referred to as gas nitrocarburizing. Typical treatment temperatures are 430–580 °C. Gas nitriding/nitrocarburizing can be combined with plasma nitriding/nitrocarburizing and subsequent oxidation to provide excellent corrosion protection, as well.

Depending on the process variant, this influences the performance and fatigue strength of the parts and components. At the same time, it increases resistance to corrosion and wear. Design measures can be used to achieve material savings and protect the components' stressed surface zones against abrasive, adhesive and corrosive wear.

The BALITHERM solutions make it possible to adapt many parameters to customer-specific requirements: "The decision as to which process is suitable for the respective component depends on its geometry, the stress profile, the required properties and the permitted tolerances. Thanks to the individuality of the processes, we can

adjust the nitriding depth and temperature as well as the resulting surface hardness to suit the component with precision and thus match customer requirements. This makes BALITHERM extremely flexible," explains Bernhard Reisert, Key Account Manager, Automotive Nitriding at Oerlikon Balzers.

"Thanks to the individuality of the processes, we can adjust the nitriding depth and temperature as well as the resulting surface hardness to suit the component with precision."

Bernhard Reisert,
Key Account Manager
Automotive Nitriding,
Oerlikon Balzers



* VHN = Vickers Hardness Number. For comparison: quartz has a similar hardness of 1,120 VHN and can scratch window glass. A diamond has 10,060 VHN.

MORE VALUABLE THAN JUST A NICKEL*

Atomic number: 28
Element symbol: Ni

Relative atomic mass: 58.693
Series: Transition metals

Special features

With a density of 8.9g/cm³, nickel is a very heavy metal that can be forged and is highly receptive to polishing. It is also resistant to corrosion and oxidation and is magnetic at room temperature. The melting point of the metal is 1,453 °C. As a component of steel, nickel improves toughness, strength and ductility. It can also be the starting material for alloys in a wide variety of applications. Nickel coatings can be applied particularly well by electroplating. A major advantage is that nickel can be recycled more easily than any other metal – several times and without any loss in quality.



*Nickel is the 5 cent coin in the USA containing 25% nickel.

What is nickel used for?

Most people deal with nickel on a daily basis, as it has been used in alloys for coin production since 1860. However, it is most commonly used in the production of stainless and heat-resistant steel, which is mainly used in special applications in the industrial, aerospace and military sectors. It is also used in coatings, batteries or as a catalyst in the hydrogenation of unsaturated fatty acids.

At Oerlikon, nickel and nickel alloys are components of a wide variety of products and solutions: for example, in powders for additive production or in many solutions from Oerlikon Balzers and Oerlikon Metco. The spectrum extends from nickel as a component of welding materials to nickel graphite materials that shield electromagnetic radiation as conductive fillers in EMI seals and thus replace expensive, silver-coated materials.

Where can you find it?

Nickel is a naturally occurring metallic element that has a silver-white sheen. It is the fifth most abundant element on Earth and is found in both the Earth's crust and core. Meteorites and certain plants, animals and seawater also contain nickel. It is mined in more than 25 countries throughout the world. The metal usually occurs as oxide, sulphide or silicate. Since different ore forms exist, diverse manufacturing processes are also used. Around 68 percent of the nickel used in consumer goods is recycled. And yet 17 percent still ends up in landfills, mostly in the form of metal products or electronic equipment.

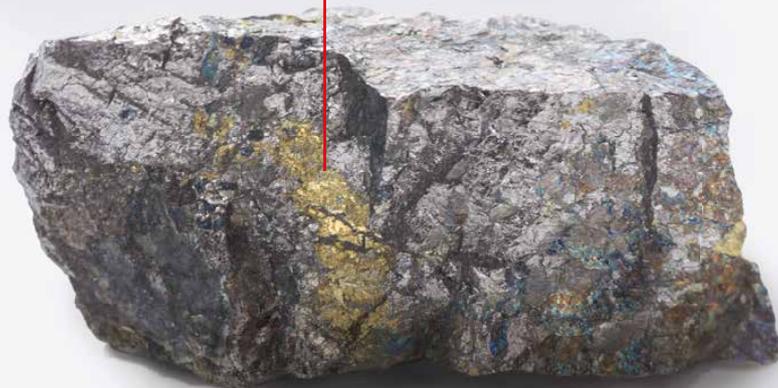
Small plates from pure nickel.



Garnierite is a collective term for a green nickel ore containing 24–34% nickel.



Besides Garnierite, **Pentlandite (gold-colored)** is one of the most important nickel ores with 34% nickel.



Is nickel expensive?

The price of nickel is subject to strong fluctuations due to speculation and currently is three times that of copper but just half that of cobalt. The quantities mined remain constant at around 2.3 million tonnes per year.



OERLIKON BALZERS' DIGITAL SERVICES

Follow the flow of smart coating services

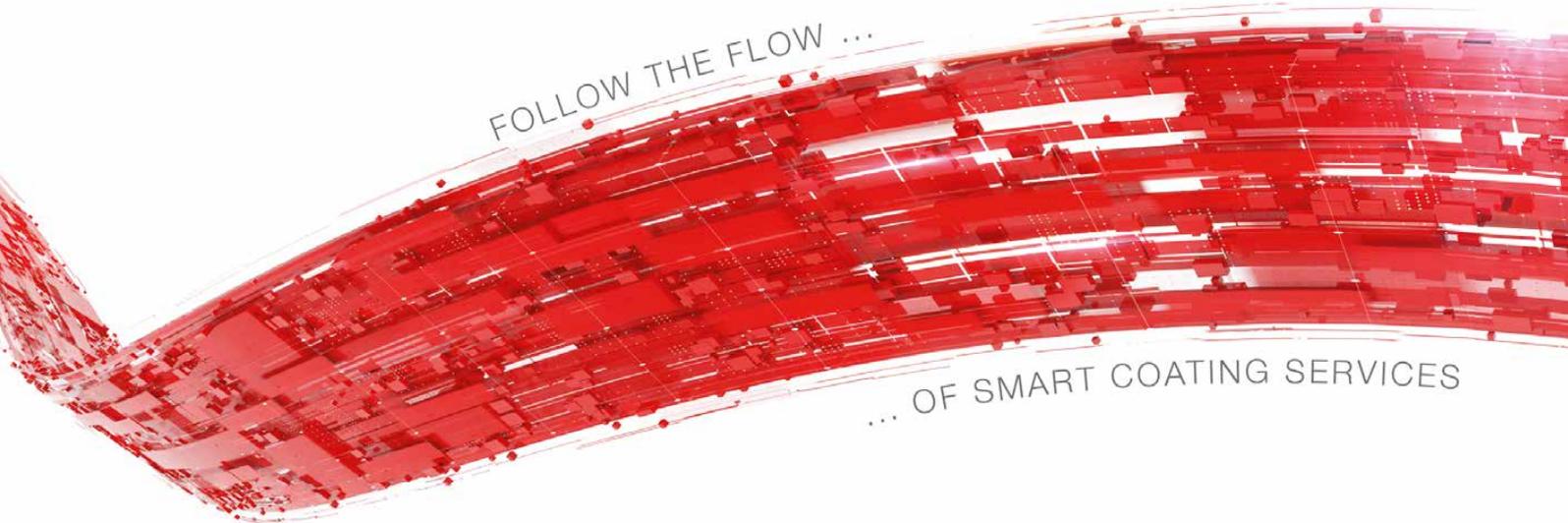
At EMO in Hanover (September 16 to 21), Oerlikon Balzers showcased its new digital services. These make production more predictable, even more efficient and resource-saving, as they simplify and accelerate the entire order processing, including the logistical processes with status query of the order – environmentally friendly without wasting paper. With an app, video enquiries about coating systems can be quickly and reliably resolved.

Easier, faster, more reliable

The new “myBalzers” customer portal offers digital services that significantly simplify and accelerate order processing, including logistics sequences such as door-to-door tracking and document management.

For cutting tools, Oerlikon Balzers introduced a digital solution for coating workflows: a “digital twin” of the tool allows relevant data such as the coating used, the number of reconditioning cycles, quality and measurement protocols to be stored. This full tool history transparency will in future enable connected and automated reconditioning workflows, giving customers a number of key advantages.

Another innovation is a specially developed app that helps Oerlikon Balzers experts respond in real time to questions about a coating system or coating services. The app helps queries to be resolved quickly and reliably, so that customers benefit from even faster response times and optimized coating system availability.





NEW HIGH-PERFORMANCE COATING FOR THREADING TOOLS

For high-quality threading tools, Oerlikon Balzers presents the new high-performance BALIQ AUROS coating. This extremely smooth and wear-resistant coating is combined with a top coating to prevent the tool surface from welding with the workpiece material, which improves performance and ensures high process reliability.

OERLIKON BALZERS BRAZIL RECEIVES BOSCH QUALITY EXCELLENCE AWARD



Oerlikon Balzers Brazil has received a “ZERO defects certificate” from Bosch in recognition of supplying components coatings of the highest quality in 2018. By delivering products with no defects, Oerlikon Balzers made a substan-

tial contribution to the continuous improvement in quality for the world-leading automotive supplier. The coatings, which are applied to pistons used in diesel injection pumps for HGV (heavy good vehicles) engines, reduce wear between the

piston and the pump body, thus extending the component’s service life and increasing product reliability. The production center in São José dos Pinhais is currently coating a number of components for various configurations of Bosch pumps.

SHAPING THE FUTURE OF AEROSPACE

by Agnes Zeiner

Oerlikon has long had a connection to the central French city of Limoges and its university. Now that relationship is at the start of a new era. In focus: the **Institute for Ceramic Research (IRCER, from the French Institut de recherche sur les céramiques)**. We met director Philippe Thomas and Head of Research for thermal spraying activities Alain Denoirjean.

It is no coincidence that IRCER – with its 200 employees, founded in 1975 – has its headquarters in Limoges, a city known throughout the world for its traditional enamel and porcelain manufacturers. Around 15,000 students are enrolled at the local university, which is one of IRCER's headquarters; the second is the National Center for Scientific Research (CNRS: Centre national de la recherche scientifique). An institution under the umbrella of the Ministry of Research, CNRS is dedicated to basic research and is the second largest research organization in Europe, with around 32,000 employees.

IRCER's modern main building is within a short walking distance of Oerlikon Balzers France, a specialist in high-end coating solutions for motor sports. IRCER itself has four research priorities, one of which is surface treatment. Philippe Thomas explains: "We work not only with the university and the CNRS, but also with various industry partners. They outsource parts of their basic research to us on a contractual basis. We even have joint, exclusive research institutes with two companies."

Cooperation with Oerlikon and Safran is the culmination of two long-standing partnerships
In June, a press release was sent to the media: "Safran, Oerlikon, CNRS and the University of Limoges create a joint research lab and technology

platform for surface treatment in southwest France,” was its headline (see next page). High-ranking representatives of the participating partners had signed a corresponding contract at the “Paris Air Show” trade fair. The two projects that are at the center of this: PROTHEIS, a joint research institute, and the technology platform SAFIR.

For Philippe Thomas and Alain Denoirjean, this is the culmination of two long-standing partnerships linking the IRCER with both Oerlikon and the French Safran Group operating in the aviation sector. “The fact that we are now realizing a joint institute with these two partners means that we can join forces and transfer our research directly to the aerospace industry!” PROTHEIS is reserved for basic research and innovation in the field of TLR 1–4 of the Technology Readiness Level* and exclusively for the project partners.

The SAFIR technology platform, on the other hand, will cover the areas up to TLR 6 (definition: prototype in the operational environment), depending on the research object, and is open to the entire industry. “This means that we can offer ‘saleable’ research while still improving coatings – which is essential for us,” says Alain Denoirjean. His enthusiasm is contagious, and he is looking forward to working in this new platform during the last quarter of 2020: “We will be able to work with the latest generation of equipment, including an INNOVENTA Kila from Oerlikon Balzers, and a Thermal Spray system from Oerlikon Metco, and with test tracks that we can work with under industrial conditions ... but unfortunately we still have to wait until the new building is finished, because we are talking about around 1,000 square meters of laboratories and offices!”

Focus: Functional limitations in the aerospace sector

And what exactly is being researched here? Alain Denoirjean explains: “We are working on functional limitations in the aerospace sector. For example, we want to explore how organic composites, which are used to reduce aircraft weight, can be protected against erosion and lightning strikes. Or how Thermal Barrier Coatings can be protected against CMAS infiltration. This is because calcium-magnesium-aluminum silicates (CMAS), i. e. sand or volcanic ash, penetrate into the coatings, →

* Technology readiness levels (TRLs) are a method for estimating the maturity of technologies. TLR 1–4 includes Basic Technology Research, Research to Prove Feasibility and may also include first steps in Technology Developments.

“The fact that we are now realizing a joint institute with these two partners means that **we can join forces and transfer our research directly to the aerospace industry!**”

Alain Denoirjean (left), Head of Research at IRCER, and **Philippe Thomas (right)**, Director of IRCER





IRCER's multidisciplinary approach brings together teams of researchers and teacher-researchers from various scientific backgrounds (chemistry, physics, mechanics) in complementary research areas.

which can lead to malfunctions in aircraft turbines that have to withstand temperatures of over 1,250 °C. But we also want to find out how very fine powders can be applied to surfaces with the help of liquids. And last but not least, how processes such as thermal spraying and PVD can be combined. And we want to do all this with the help of the new equipment, plus simulations, monitoring, tests and process diagnostics as well as data processing.”

Advancing the future of aviation

Oerlikon's aerospace solutions range from high-end coatings and equipment to advanced materials and metal additive manufacturing. This makes Oerlikon an important partner for the global aviation industry. Gilles Widawski, President of Oerlikon France, explains: “We add value to the manufacturers by adding value to the parts. With this research partnership, we can combine our expertise with the R&D roadmap of one of the largest aerospace equipment suppliers, our customer Safran, and jointly advance the future of airplanes and helicopters.”

www.ircer.fr

Partnership on joint research lab and technology platform

Safran, Oerlikon, CNRS and the University of Limoges have the intention to create a joint research laboratory, PROTHEIS, and a technology platform, SAFIR. These two entities will help Safran enhance its surface treatment capabilities, to make lighter and longer-lasting products capable of reducing noise and nitrogen oxide emissions, compliant with the European regulation REACH and capable of addressing the requirements of all types of aerospace applications, now and in the future. Oerlikon expects the collaboration to advance its already strong support of the aerospace industry along the entire value chain. It contributes to the partnership with deep and long-standing expertise in advanced materials, surface engineering and high-end, industrialized equipment to increase the competitiveness in the industry. The research to be carried out will be guided by Safran's requirements, as well as the R&D activities of Safran, Oerlikon and IRCER.

Acquisition of AMT AG

STRENGTHENING OF TECHNOLOGIES AND COMPETENCIES



Oerlikon acquired AMT AG, a Kleindöttingen, Switzerland-based company whose technology know-how and customized approach to customer solutions complements Oerlikon's thermal spray assets and solutions. AMT AG is now part of the Oerlikon Metco Aero & Energy business unit, although it will continue to operate under its existing name until the end of 2020.

The move supports Oerlikon's strategy of focusing on and expanding its surface solution technologies and increasing market applications and service available to customers.

OERLIKON AM AND MT AEROSPACE PARTNER ON AM SOLUTIONS

A new partnership between Oerlikon AM and MT Aerospace aims to accelerate the use of additive parts in aerospace and defense. The combined expertise and sophisticated technical capabilities of the two companies promise to help address the industry's most difficult and disruptive challenges – improved efficiency and safety at lower cost. Incorporating digitization in both air and space will enable new advances in the industry.

In addition to MT Aerospace's heritage in designing highly stressed and lightweight metal structures and Oerlikon's materials, design, 3D-printing and post-processing capabilities,

the partnership offers aerospace customers a notable advantage by realizing synergies between construction/design, manufacturing and part inspection and qualification.

By advancing the standards of optimal design for specific parts or components, the partnership provides customers with a path to unlocking AM's full design and manufacturing potential.



Bionically optimized bracket for possible space application

A HAIR'S BREADTH FOR GREATER EFFICIENCY

Gas turbines and turbochargers contain **systems that rotate at high speed**. Operating them as efficiently as possible requires that the distance between the rotating compressor blades and the stationary turbine housing is minimized. To accomplish this, thermal sprayed abrasion-resistant coatings from Oerlikon Metco are applied for clearance dimension control.

Dynamic systems that rotate at high speed are designed to rotate concentrically. Nevertheless, slight eccentricity may develop during operation. In addition, the rotating components can stretch due to creep caused by the inertial forces. Consequently, clearance must be provided between the rotating and stationary

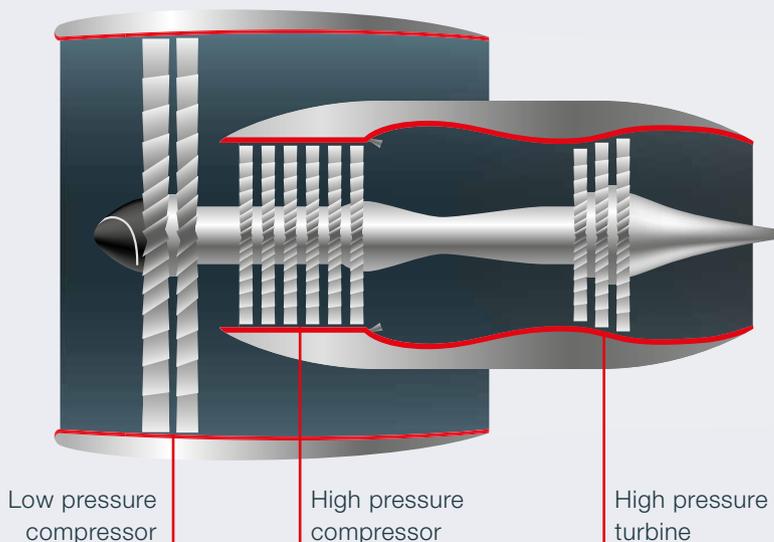
components of these systems. However, a clearance that is too large has a negative effect on the efficiency of the turbine. Even a clearance of 0.125 mm – roughly twice the thickness of a human hair – increases the fuel consumption of gas turbines by 0.5%. The following applies for other turbine types as well: The smaller the

clearance, the more efficient the turbine. Efficiency increases as high as 3 percent are possible here.

To ensure that the clearance is as small as possible, coatings known as abrasion-resistants are used for clearance control. These coatings are easily cut when touched by the opposing body. Thermal sprayed abrasion-resistant coatings have proven to be effective sacrificial elements in this context. They reduce fuel consumption and emissions in many different turbine types.

Learning from the past

Experience has shown that aircraft are exposed to a wide variety of environmental influences that lead to corrosion of aluminum-silicon-based abrasion-resistant coatings. Depending on the location, the time of year and the intensity of use, an increased level of corrosion can occur – often within just a few hours. Accordingly, aircraft that are used only occasionally or parked overnight are exposed to increased corrosion. The same



“Even a clearance of 0.125 mm **increases the fuel consumption of gas turbines by 0.5%.**”

The thickness of this line correlates to 0.125 mm:

applies for steam and gas turbines in other fields of application.

Corrosion can cause massive damage to the rotating components. Smaller turbines are more susceptible to this than larger machines, as they have a narrower gap through which the air flows. The formation of blisters or flaking due to corrosion has a lasting effect on their performance.

New abradable powder for corrosion protection

With the new powder Metco 1602A, Oerlikon has developed a new product that counteracts this problem. At the Oerlikon test stand in Wohlen, Switzerland, the coatings with the new material are thoroughly tested. Modifying different variables makes it possible to simulate various operating conditions. This enables the testing of new candidate materials for abradable applications.

Metco 1602A
(after 3 weeks of salt spray bath)

conventional coating
(after 3 weeks of salt spray bath)

To determine the corrosion properties of Metco 1602A (top) compared to conventional aluminum silicon coatings (bottom), a titanium ring was coated with both materials and subjected to a salt spray bath for three weeks.

The new Metco 1602A powder stands out due to its performance:

- › Good abrasion properties: comparable to conventional LPC coatings, better than traditional aluminum silicon polymers
- › Suitable for clearance control
- › Reliable protection against corrosion: less maintenance and rework
- › Can be applied with the same spray parameters as Metco 601NS – no need to change production parameters when the material is changed
- › Significantly reduced process times

www.oerlikon.com/metco/clearance-control

MTC³: REALITY CHECK ON AM INDUSTRIALIZATION

Additive manufacturing (AM) is driving a new industrial revolution – but in some industries, industrialization is progressing more rapidly than others. What can the success stories we've realized so far teach us about opportunities to accelerate innovation and adoption in other sectors?

That was among the key questions inspiring discussion and debate at the 3rd Munich Technology Conference on Additive Manufacturing (MTC³) in October at the Technical University of Munich, Germany. The conference, launched by Oerlikon in 2017 in partnership with the Technical University of Munich, attracted more than 1,500 par-

ticipants and 50 speakers from across the additive manufacturing ecosystem. The theme of this year's conference was putting AM to a reality check. Throughout MTC³, leading experts discussed the technical and regulatory challenges that the technology must address as proponents continue to pursue innovation. Proof points presented

at the conference addressed questions and concerns about scalability, cost, production efficiency and opportunities to customize solutions by sector. We spoke with the partners who realized the MTC³ together with Oerlikon.

Read more on www.munichtechconference.com



SAVE THE DATE!

Strong partnerships form the basis for the continued development of future technologies. As we look ahead, we invite you to join us in 2020 at AMTC⁴ in Aachen, together with RWTH Aachen University, the newest member of the MTC partner network.

October 20–22, 2020 at Eurogress Aachen, Germany

Why is now the time for the industry to take a reality check?

Now is the time to scale up the efforts and implementation of additive manufacturing because R&D has shown that the technology is ready; materials are ready; machines are ready. The entire process can be managed. We have shown the world over at various

lab environments that prototypes can be produced using additive manufacturing, but now is the time to really have the courage and put that into the production of products that are being sold to customers.

Holger Lindner, CEO, Product Service, TÜV SÜD



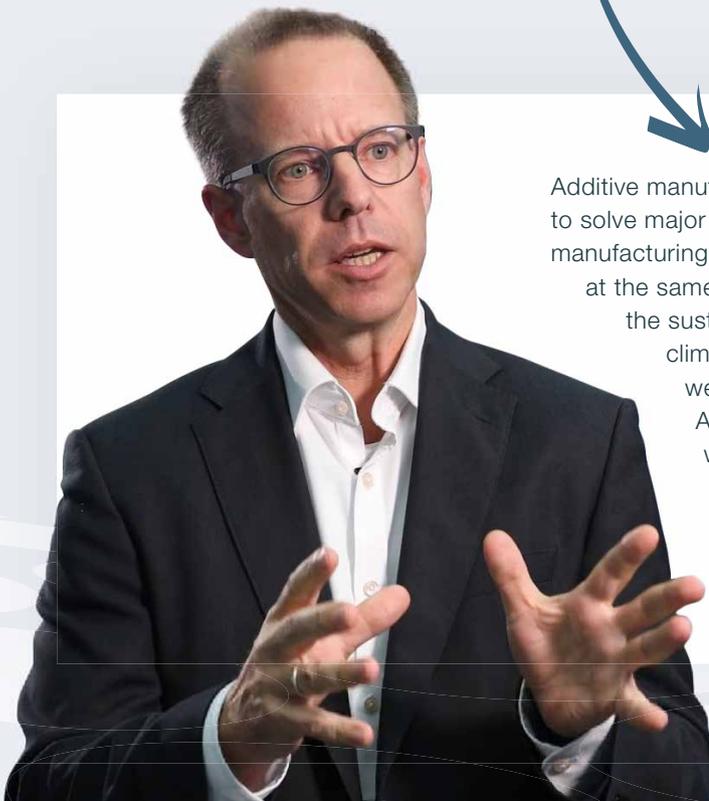


Additive manufacturing can shorten time to market significantly and it offers a wide variety of applications for lightweight design, for parts with better

corrosion or wear resistance. To take full advantage of the potentials of additive manufacturing, it requires a solid base of materials, engineering, and process knowledge.

Dr. Sven Hicken,
Head of Business Unit Additive Manufacturing, Oerlikon

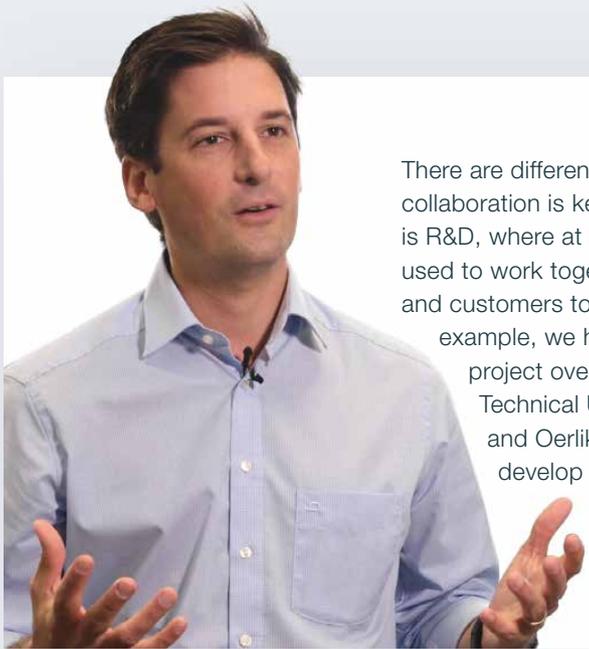
How important is additive manufacturing as a strategic future technology?



Additive manufacturing helps to solve major production manufacturing challenges, and at the same time, it supports the sustainability and climate discussion we have right now. AM is changing the way we design parts, the way

we produce parts, and how we do business. Just imagine how many spare parts we have in the world, and we store them for years and years without usage. What would it mean if you digitally can store your spare part, and you print it when you need it, where you need it, in the future?

Karsten Heuser, VP Additive Manufacturing,
Siemens Digital Industries



There are different areas where collaboration is key. One example is R&D, where at Linde we are very used to work together with partners and customers to develop faster. For example, we have a cooperative project over three years with Technical University of Munich and Oerlikon. We want to develop a completely new material where

Linde, as gas specialist, will bring its know-how to develop a process gas to make this powder printable. Or when we think of norms: We need new norms in additive manufacturing, and all the stakeholders need to work together to write those norms. And we need to educate, all together, all engineers to make them understand what they can do with additive manufacturing.

Pierre Forêt, Senior Expert Additive Manufacturing, Linde

Why is collaboration between the stakeholders so important?

Collaboration between stakeholders is important for two reasons. First, additive manufacturing is not a separate industry. It's part of every industry. Thus, the integration or interaction with the established sectors is key to identify and especially co-develop applications with different players to increase the entire mass adoption. And second, additive manufacturing is a cutting-edge technology which I believe will grow along with other disruptive technologies, such as AI, VR, advanced robotics or cloud computing. So an early collaboration and the integration of these technologies within AM will be another key driver for the entire market growth.

Tobias Kuhl, Head of Operations, XPRENEURS, UnternehmerTUM & 3D-Printing Cluster

Additive manufacturing is never an island. It's a very complex, integrative process. So we need to work together: machine hardware providers, material suppliers, factories, implementers, and all other solution providers within the ecosystem. If not, we will never establish a solid basis for industrial-grade implementation. That's why it's crucial to work together on norms and standards which every implementer as well as solution provider is able to reference.

Gregor Reischle, Head of Additive Manufacturing, TÜV SÜD Product Service GmbH

What is the current status of additive manufacturing from a market perspective?

Some people say the market is still a niche – but going forward we expect that this will change. The challenge, however, is that mass production facilities for additive manufacturing are not a reality yet today. To turn that situation around, OEMs need to make big investments to actively create and build those production facilities. And we need to see a significant mindset

shift in product management, examining how each and every product can provide enhanced customer value through additive technologies. This could be by producing those products more cheaply or by incorporating better features. Our engineering workforce has to learn how to design parts with additive technologies.

Dr. Andreas Behrendt, Partner, McKinsey & Company



How does TUM support and encourage students to launch a start-up?



TUM is one of the leading start-up hubs in Europe. In many degree programs students at TUM are repeatedly asked: “How can your idea become a product that you can bring to the market?” Together with UnternehmerTUM, the Center for Innovation and Business Creation at TUM,

we provide intensive support through all phases of the start-up process, from student ideas to founding the company and the subsequent growth phase. Every year more than 70 high innovative tech start-ups are founded at TUM, many of which make a significant contribution to the industrialization of additive manufacturing.

Thomas F. Hofmann,
President, Technical University Munich TUM

EXTENDING SERVICE LIFE OF SANITARY FITTINGS AND PUMPS

Ceramic seal discs in sanitary fittings, pneumatic valves, ceramic shafts and pump bearings as well as components in pumps and compressors are exposed to extreme friction over a long period of time. To keep these devices running reliably for longer, Oerlikon Balzers has developed BALINIT MILUBIA and BALINIT NALUBIA; hydrogen-free hard carbon coatings that protect components against wear from frequent use and at elevated temperatures.

BALINIT MILUBIA has been specially developed for sealing discs, pneumatic valves, ceramic shafts and pump bearings and is suitable for metals and electrically insulating materials such as ceramics and even plastics.

Mechanical seals in pumps and compressors use silicon carbide ceramics as seal ring materials. BALINIT NALUBIA minimizes wear in these components by eliminating poor lubricating conditions that cause increased temperatures.



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Learn more:
[www.oerlikon.com/
balzers/baliq-carbos](http://www.oerlikon.com/balzers/baliq-carbos)

The new BALIQ CARBOS and BALIQ CARBOS STAR coatings from Oerlikon Balzers are very versatile and best utilized in applications with high contact pressure combined with sliding velocities, such as in all high-performance motorsport vehicles specifically for applications such as the camshaft, piston pins, valves, lifters and finger followers. The coatings are also used within the general industries market for applications such as weaving reeds, valve plates and valve stems and in pneumatic valves.

Because maximum load bearing capacity also depends to a large extent on the substrate, an additional chromium nitride-based layer is added to BALIQ CARBOS STAR to resist extreme loadings when using softer substrates like stainless steel and titanium – or substrates that are subject to continuous knocks.

2020 Trade show dates

In the upcoming months, Oerlikon will again be represented at important trade fairs dealing with surface solutions and additive manufacturing. We look forward to your visit to our booth!

EUROPE

January 14–16	Euroguss Nuremberg, Germany	June 10–12	International Thermal Spray Conference ITSC Vienna, Austria
March 18–21	Grindtec Augsburg, Germany	June 16–18	Automotive Interiors Expo Stuttgart, Germany
March 17–20	ESEF 2020 Utrecht, Netherlands	June 16–18	Surface Technology Stuttgart, Germany
March 31 – April 3	Industrie Paris Paris, France	June 16–19	EPHJ Trade Show Geneva, Switzerland
April 28–30	Battery Show Europe Stuttgart, Germany	June 16–19	Salon France Innovation Plasturgie Lyon, France
May 12–15	Intertool Vienna, Austria	July 20–24	Farnborough Airshow Farnborough, United Kingdom
May 25–29	BIEMH 2020 Bilbao, Spain		

AMERICA

January 27–30	HAI Heli Expo Anaheim, U.S.A.	May 12–16	FIMAQH 2020 Buenos Aires, Argentina
March 24–28	AAOS Orlando, U.S.A.	May 19–22	Hospitalar 2020 São Paulo, SP, Brazil
May 5–9	FEIMEC 2020 São Paulo, SP, Brazil	June 8–11	ARGENPLAS 2020 Buenos Aires, Argentina

ASIA

January 23–28	IMTEX Bengaluru, India	April 22–26	BLECH INDIA Mumbai, India
February 19–21	TCT Asia Shanghai, China	May 20–22	Automotive Engineering Exposition Yokohama, Japan
March 12–14	PLASTINDIA Mumbai, India	June 10–14	Die & Mold China Shanghai, China
March 31 – April 4	SIMTOS 2020 Ilsan (Seoul), Korea		
April 22–25	TAGMA Bangalore, India		



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