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RESEARCH NEWS – SPECIAL ISSUE

05 | 2017 ||

Research awards in brief

At this year's Fraunhofer-Gesellschaft annual conference in Dresden, the Fraunhofer Prize for Human-Centered Technology (topic 1) and four Joseph von Fraunhofer Prizes (topics 2 through 5) were awarded.

1 Live safely even in old age – within your own four walls

What to do if you fall in your home? Many elderly people ask themselves these and similar questions; they want security without having to give up their own four walls. A new technology concept, developed by the Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern, Germany, now makes this possible – while also ensuring privacy. A communication tool integrates nursing care consultation and ensures social integration.

2 Telephone calls clear as a bell

Smartphones can do almost everything you want, but their poor voice quality is still a vexing issue. Fraunhofer researchers have helped develop a new codec to banish this problem. Their solution raises voice quality to an unprecedented level – making it sound as natural as if the person you're calling is standing right next to you. That's because, for the first time, the entire audible frequency spectrum is transmitted.

3 Cleaning waste water effectively

Water is vital – therefore, waste water has to be cleaned as efficiently as possible. Ceramic membranes make this possible. Researchers from the Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Hermsdorf, Germany, were able to significantly reduce the separation limits of these membranes and to reliably filter off dissolved organic molecules with a molar mass of only 200 Dalton. Even industrial sewage water can thus be cleaned efficiently.

4 A way out of the chromium ban

To prevent components from becoming corroded or worn, they are often coated using hexavalent chromium. Starting in September of 2017, though, this will only be permitted with exceptions. The extreme high-speed laser application welding (EHLA) developed by Fraunhofer and RWTH researchers offers an economic alternative for the first time ever.

Janis Eitner | Fraunhofer-Gesellschaft, München | Kommunikation | Telefon +49 89 1205-1333 | presse@zv.fraunhofer.de

5 Holographic measurement technology at production speed

Fault tolerance in automobile production is increasingly diminishing. Until recently, this presented suppliers with a problem: There were no sufficient methods for detecting micro defects during production. Visual inspection was the solution of choice, but this is not suitable for in-line measurements in the production process. By developing digital holography to become suitable for production, researchers at the Fraunhofer Institute for Physical Measurement Techniques IPM in Freiburg, Germany, have resolved this dilemma. Digital holography makes it possible to fully inspect all parts – in a matter of seconds.

More information on the research awards under www.fraunhofer.de/press

The Fraunhofer-Gesellschaft is the leading organization for applied research in Europe. Its research activities are conducted by 69 institutes and research units at locations throughout Germany. The Fraunhofer-Gesellschaft employs a staff of 24,500, who work with an annual research budget totaling 2.1 billion euros. Of this sum, 1.9 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

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Research awards in brief

Fraunhofer Prize for Human-Centered Technology
The prize for Human-Centered Technology is funded by former Executive Board members and institute directors and the the Excellence Foundation of the Fraunhofer-Gesellschaft. This prize is awarded every two years to employees whose research and development work makes a significant contribution to improving people's quality of life and helps them actively participate in daily life into old age. The prizewinner receives a sum of 50,000 euros (Topic 1).

Joseph von Fraunhofer Prize
Since 1978, the Fraunhofer-Gesellschaft has awarded prizes every year in recognition of outstanding scientific work by members of its staff that solve application-oriented problems. To date, over 300 researchers have seen their work honored in this way. This year, four of these prizes will be awarded, each worth 50,000 euros. The prizewinners also receive a silver lapel pin bearing the face of the man for whom the award was named, as illustrated in the logo of topics 1 through 5.

Juries for the Prize for Human-Centered Technology and the Joseph von Fraunhofer Prize in 2017

Prof. Dr.-Ing. Reimund Neugebauer, President of the Fraunhofer-Gesellschaft (chair)
Dr. Reinhold E. Achatz, ThyssenKrupp AG
Prof. Dr. Karsten Buse, Fraunhofer Institute for Physical Measurement Techniques IPM
Dr. Gerd Deuster, former Director of the Fraunhofer-Management-Gesellschaft
Prof. Dr. Michael Dröscher, Gesellschaft Deutscher Naturforscher und Ärzte e.V.
Prof. Dr.-Ing. Jörg Eberspächer, Technical University of Munich
Dr. Alexandra Goll, TVM Capital GmbH
Prof. Dr.-Ing. Horst Hahn, Fraunhofer Institute for Medical Image Computing MEVIS
Prof. Dr. Hartmut Hoffmann, Technical University of Munich
Dr. Monika Kursawe, Merck KGaA
Dr. Gyula Meleghy, Meleghy Automotive GmbH & Co. KG
Prof. Dr. Gerd Müller, former Director of the Fraunhofer Institute for Silicate Research ISC
Prof. Dr. Thorsten Posselt, Fraunhofer Center for International Management and Knowledge Economy IMW
Prof. Dr.-Ing. Erich R. Reinhardt, Medical Valley Europäische Metropolregion Nürnberg e.V.
Prof. Dr. Paul Schönsleben, ETH Zürich

The jury evaluated submissions in the following categories:

Fraunhofer Prize for Human-Centered Technology
- Importance of the work for humanity and society
- Novelty of the approach / knowledge process
- Market situation
- Implementation of the results in applications

Joseph von Fraunhofer Prize
- Originality of the scientific methodology
- Scientific advancement
- Implementation / ease of application / economic success
- Setting of international standards

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Live safely even in old age – within your own four walls

RESEARCH NEWS
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Security? Absolutely – this is especially true for older people who live alone in their home. But monitoring is a very different issue. Hardly anyone would like to be watched day after day by cameras, even if it is only by trusted relatives who use cameras to make sure that the person living alone is safe and sound. So what if you do not want to move out of your own home, but still want to make sure that help will arrive quickly in the event of an emergency?

Security plus privacy

Researchers from the Fraunhofer Institute for Experimental Software Engineering IESE, the Deutsches Institut für angewandte Pflegeforschung e.V. [German Institute for Applied Care Research] and CIBEK technology + trading GmbH have now developed the system SUSI TD, which combines security and privacy. There are no cameras or other such devices to be seen in the home environment. "Our system is based on non-invasive sensors, especially on motion detectors (such as those used in lamps and alarms) as well as touch sensors placed on often-used drawers or refrigerators," explains Rolf van Lengen, Head of Department at the IESE. On the basis of the sensory data, the system learns to identify the recurring actions of the person and to recognize when assistance is needed.

There is another plus in terms of privacy: the collected data remain in the residence and are also evaluated there. Only when the person's behavior deviates from the usual does the system send an encrypted message to the nursing care center or the nursing care support point.

Direct link to the offerings of the nursing care support points

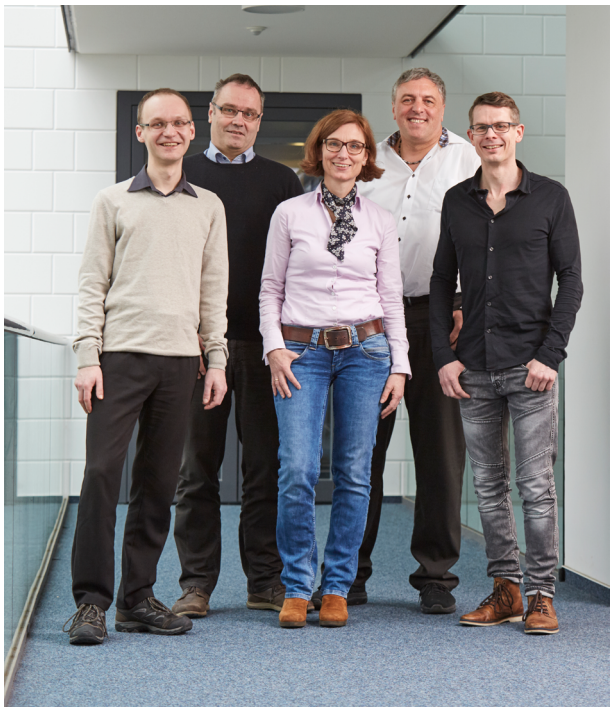
Just as important as providing security is promoting independent living as well as social integration – that is, counseling the elderly. What can they do to maintain their health and master their everyday life? Who is available as a contact person if there are problems in this area? This issue is of particular concern to Anne Gebert of the Deutsches Institut für angewandte Pflegeforschung e.V.: "Using a video communication tool, the people can talk directly with the counselors of the nursing care support points via touchscreen. As a result, the consultants are able to support people even more effectively than they could if they only paid occasional house visits." And more than that: via the communication tool, the residents can also contact friends and family members, play games or share pictures.

A central guiding principle in the development of the concept was to not create any new or duplicate structures. The concept has therefore been developed and tested with those individuals who are already active on the ground – that is, the nursing care support points and outpatient service providers.

Close feedback with test subjects

For the development of such a system, it is essential to keep the needs of the users in view. Therefore, the researchers initially equipped 18 apartments in the area of Trier, Germany, with the sensors, went repeatedly to the households and had direct contact with the people, experiencing firsthand their stories, desires and needs. In the followup project StuDI, the researchers want to integrate an adapted system into 100 apartments as a test run.

For the development of SUSI TD, Cornelius Moucha, Mario Schmitt and Rolf van Lengen from the Fraunhofer Institute for Experimental Software Engineering IESE, Anne Gebert from the Deutsches Institut für angewandte Pflegeforschung e.V. and Bernd Klein from CIBEK technology + trading GmbH received this year's Joseph von Fraunhofer award, entitled "Technik für den Menschen" [Human-Centered Technology]. The jury justifies the award by mentioning, among other things, "the special value which, in addition to the technical implementation, was placed on the ethical aspects."



The new technology concept enables elderly people to live in their own four walls with a maximum of security and privacy. The System was developed by Cornelius Moucha, Rolf van Lengen, Anne Gebert, Bernd Klein, Mario Schmitt (from the left). © Piotr Banczerowski / Fraunhofer | Image in color and print quality: www.fraunhofer.de/press/research-news

Fraunhofer Institute for Experimental Software Engineering IESE | Fraunhofer-Platz 1 | 67663 Kaiserslautern | www.iese.fraunhofer.de
Press: Nina Hahnel | Phone +49 631 6800-2149 | nina.hahnel@iese.fraunhofer.de

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Telephone calls clear as a bell

RESEARCH NEWS
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The music on hold sounds tinny through the smartphone's built-in speakers. And even when you finally get through to a real human being, the voice at the other end of line could barely be described as compelling. For although immense progress has been made in the development of all kinds of smartphone apps, the quality of voice transmission hasn't improved for years.

Clear and natural as opposed to muffled and distorted

The new Enhanced Voice Services (EVS) standard promises a step change comparable with the transition from analog CRT to digital flat-screen TVs. Instead of sounding muffled and distorted, the caller's voice is as clear and natural as in a face-to-face conversation. The impetus for developing the new codec was given by the 3rd Generation Partnership Project (3GPP), the international body that develops standards for mobile communication. A large team of researchers at the Fraunhofer Institute for Integrated Circuits IIS in Erlangen took part in this project.

The specifications for standards of this type are extremely demanding. "First of all, the codec must be capable of transmitting high-quality speech signals at relatively low data rates – so as not to compromise cost-efficiency," says Markus Multrus, who coordinated the software development part of the project at Fraunhofer IIS. Another requirement is that the codec should be sufficiently robust to recover from transmission errors, thereby ensuring that calls are not dropped due to poor reception. Moreover, the codec must also be able to deliver similarly high quality when processing other types of signal, such as music on hold. This challenge is anything but simple, given that speech coding and audio coding are two separate worlds. The new codec therefore analyses the flow of signals every 20 milliseconds to distinguish between voice and music transmission, enabling the appropriate algorithms to be applied.

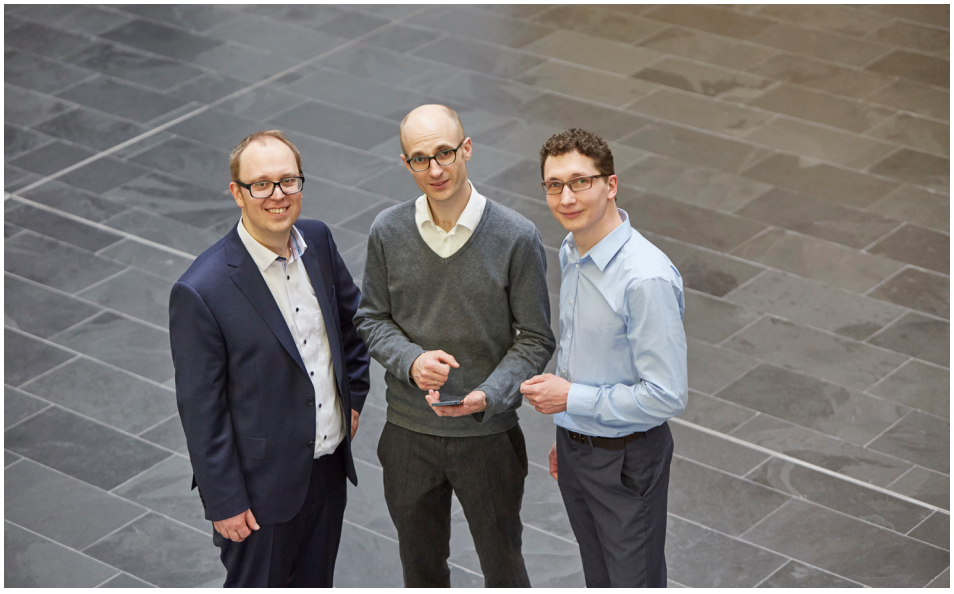
Transmission of the entire audible frequency spectrum

From a technical point of view, what is the difference between conventional and EVS codecs? "The human ear can hear frequencies of up to 20 kilohertz," explains Dr. Guillaume Fuchs, the research scientist who led the development of EVS at Fraunhofer. "But the frequency range of the audio signals transmitted by currently available codecs only extends to 3.4 kilohertz – any frequencies above that limit are simply cut off, which is why phone calls sound so muffled. The new codec allows frequencies of up to 16 or even 20 kilohertz to be transmitted, depending on the bit rate of the connection." In short, it is capable of transmitting the entire audible frequency spectrum – at similar rates to today's wireless data codecs.

Voice quality indistinguishable from normal speech

Before a new coding standard can be accepted, proof has to be provided that the codec fits the defined specifications. In numerous listening tests, the EVS codec was evaluated by several thousand test subjects throughout the world. They rated the new standard as significantly better than existing solutions. The new codec has meanwhile been approved as a 3GPP standard. "Enhanced Voice Services are already commercially available in Japan, Korea, the United States, and Germany," reports Stefan Döhla, who represents Fraunhofer IIS at 3GPP meetings. "It is estimated that between 50 and 100 million devices have been equipped so far with the EVS codec."

One of this year's Joseph von Fraunhofer Prizes went to Markus Multrus, Dr. Guillaume Fuchs and Stefan Döhla for the development of the EVS codec. They accepted the prize on behalf of the 50-strong team of researchers and engineers who worked on this project. The jury's decision was based among other things on "the codec's worldwide user base and its potential to generate substantial license-fee revenues."



EVS developers Markus Multrus, Guillaume Fuchs and Stefan Döhla (from the left). © Piotr Banczerowski / Fraunhofer | Image in color and print quality: www.fraunhofer.de/press/research-news

Fraunhofer Institute for Integrated Circuits IIS | Am Wolfsmantel 33 | 91058 Erlangen | www.iis.fraunhofer.de
Press: Mandy Garcia | Phone +49 9131 776 6178 | mandy.garcia@iis.fraunhofer.de

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Cleaning waste water effectively

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Anyone who has dragged himself along a sunny coastal path at the height of summer with too little water in his bag knows all too well: without water, we cannot make it too long. Water is one of the foundations of life. In industry, water is a must, as well: in many production processes, it serves as a solvent, detergent, to cool or to transfer heat. As more and more water is consumed, waste water has to be treated and reused. Ceramic membranes offer a good way to do this: since they are separated mechanically – similar to a coffee filter – they are particularly energy-efficient. However, this method previously came to an end when a molecular size of 450 Daltons was reached: smaller molecules could not be separated with ceramic membranes. According to experts, it was even considered impossible to go below this limit.

For the first time, molecules as small as 200 Daltons can be separated

Dr. Ingolf Voigt, Dr.-Ing. Hannes Richter and Petra Puhlfuerss from the Fraunhofer Institute for Ceramic Technologies and Systems IKTS have achieved the impossible. "With our ceramic membranes, we have achieved, for the first time, a molecular separation limit of 200 Daltons – and, thereby, a whole new quality," says Voigt, Deputy Institute Director of the IKTS and Site Manager in Hermsdorf.

But how did the researchers manage to do this? On the way to making the impossible possible, it was first necessary to overcome various obstacles. The first was in the production of the membrane itself: if such small molecules were to be separated reliably, a membrane was needed that had pores smaller than the molecules which were to be separated. In addition, all of the pores had to be as similar in size as possible, since a single larger opening is sufficient to allow molecules to slip through. The challenge was therefore to produce pores which were as small as possible, with all of them having more or less the same size. "We achieved these results by refining sol-gel technology," says Richter, Head of Department at the IKTS. The second hurdle was to make such membrane layers defect-free over larger surfaces. The Fraunhofer researchers have succeeded in doing this, as well. "Whereas only a few square centimeters of surface are usually coated, we equipped a pilot system with a membrane area of 234 square meters, which means that our membrane is several magnitudes larger," explains Puhlfuerss, scientist at the IKTS.

Transfer from the laboratory into practice

Commissioned by Shell, the pilot system was built by the company Andreas Junghans – Anlagenbau und Edelstahlbearbeitung GmbH & Co. KG in Frankenberg, Germany and is located in Alberta, Canada. There the system has been successfully purifying waste water since 2016, which is used for the extraction of oil from oil sand. The researchers are currently planning an initial production facility with a membrane area of more than 5,000 square meters.

The innovative ceramic membranes also offer advantages in industrial production processes: they can be used to purify partial currents directly in the process as well as to guide the cleaned water in the cycle, which saves water and energy.

For the development of the ceramic nanofiltration membrane, Dr. Ingolf Voigt, Dr.-Ing. Hannes Richter and Petra Puhlfuerss received this year's Joseph von Fraunhofer Prize. The jury justifies the award by mentioning, among other things, "the first-ever realization for filtration applications within this material class."

The ceramic membranes developed by Hannes Richter, Petra Puhlfürß und Ingolf Voigt (from the left) filter out dissolved organic molecules with a molar mass of only 200 Dalton. Thus industrial sewage water can be cleaned efficiently. © Piotr Banczerowski / Fraunhofer | Image in color and print quality: www.fraunhofer.de/press/research-news

Fraunhofer Institute for Ceramic Technologies and Systems IKTS | Winterbergstr. 28 | 01277 Dresden | www.ikts.fraunhofer.de
Press: Katrin Schwarz | Phone +49 351 2553-7720 | katrin.schwarz@ikts.fraunhofer.de

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A way out of the chromium ban

Whether in the automotive industry, machinery and plant engineering or aerospace, numerous metallic components have to be protected against corrosion and wear. A common method to accomplish this is hard chromium plating. However, this method has serious disadvantages: Not only does it consume a great deal of energy, but the chromium(VI) which is used is also highly damaging to the environment. As of September 2017, it may therefore only be used upon authorization/approval. This ban presents the industry with enormous challenges.

Economical alternative to chromium(VI)

Dr.-Ing. Andres Gasser and Thomas Schopphoven from the Fraunhofer Institute for Laser Technology ILT in Aachen and their colleague Gerhard Maria Backes from the Chair for Digital Additive Production of the RWTH Aachen University have now developed an economical alternative: extreme high-speed Laser Material Deposition or EHLA for short. This process not only offers companies a way out of the ban dilemma, but also provides significant advantages to hard chromium plating: No chemicals are used – which makes the process very environmentally friendly. The resulting layers are dense and can therefore protect the component from corrosion and wear more effectively. In addition, the coating is bonded to the base material in a material-locking manner so it cannot flake off, unlike the case with hard chromium plating. Various materials can be used for the new coatings, such as iron, nickel and cobalt-based alloys.

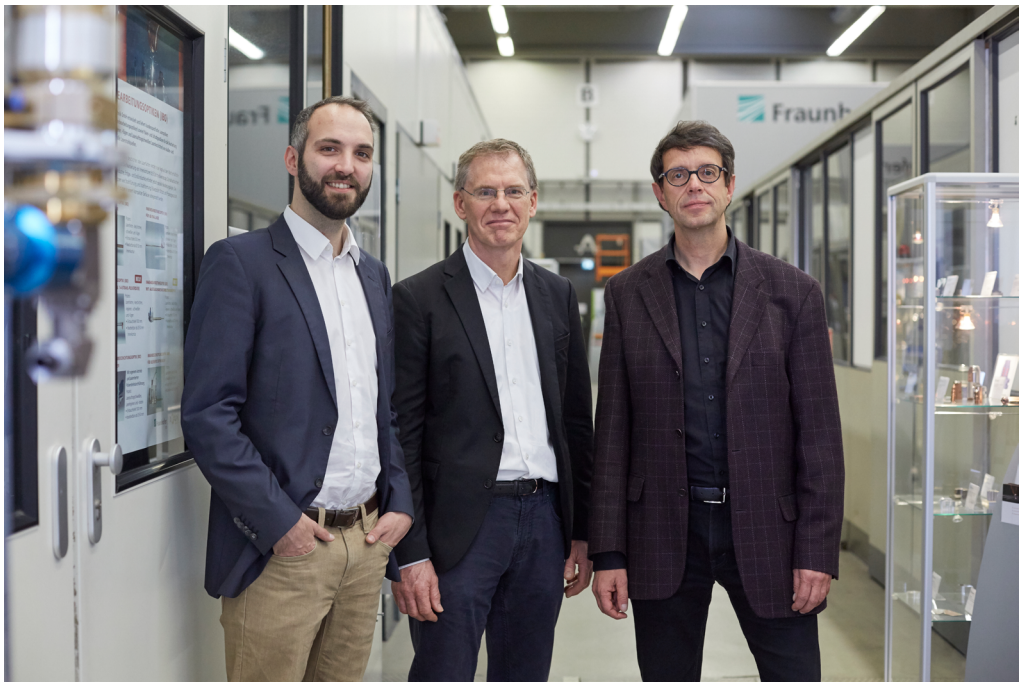
The new process is also attractive compared with thermal spraying – another common way of producing coatings: because about 90 percent of the utilized material reaches the place where it is needed, instead of only about 50 percent. This makes the process far more resource-conserving and, therefore, significantly more economical. "With the EHLA process, we can finally apply thin layers in the tenth-of-a-millimeter range to large areas in a very short time and in a manner which is efficient in terms of resources," explains Dr.-Ing. Andres Gasser, who heads the Laser Material Deposition Group at the Fraunhofer ILT.

EHLA is based on Laser Material Deposition, which is used to produce high-quality coatings for various materials. As far as wear and corrosion protection is concerned, though, conventional Laser Material Deposition has so far only been possible in isolated cases – it is too slow. "With EHLA, we can coat the component at speeds that are 100 to 250 times higher than those used in conventional Laser Material Deposition. In addition, it barely heats up. This allows us to coat heat-sensitive components as well," says Dipl.-Ing. Gerhard Maria Backes. Further advantages: The resulting layer is purer and more effectively protects against corrosion. In addition, completely new material combinations are possible, such as coatings on aluminum or hard-weldable cast iron alloys.

Sustainable, environmentally friendly and saving jobs

The new process is already in use at some companies. For instance at the Dutch company IHC Vremac Cylinders B.V., who are using this process to coat their hydraulic cylinders (which are up to ten meters long) for offshore applications. Thomas Schopphoven sees great potential for the new coating technology: "With EHLA, we could enter into series coating – and, in the future, even coat components that were previously used without coating. This makes new components possible that no longer wear out during the product life cycle. In addition, EHLA could keep coating technology, which is increasingly migrating into low-wage countries, here in Europe."

For the development of the EHLA process, Dr.-Ing. Andres Gasser, Thomas Schopphoven and Gerhard Maria Backes have received this year's Joseph von Fraunhofer Prize. The jury justified the presentation of the award with, among other things, "the already performed implementation as well as the economical replacement of chromium(VI) in essential fields of application."



EHLA developers Thomas Schopphoven, Gerhard Maria Backes and Andres Gasser (from the left). © Piotr Banczerowski / Fraunhofer | Image in color and print quality: www.fraunhofer.de/press/research-news

Fraunhofer Institute for Laser Technology ILT | Steinbachstr. 15 | 52074 Aachen | www.ilt.fraunhofer.de
Press: Petra Nolis | Phone +49 241 8906-662 | petra.nolis@ilt.fraunhofer.de

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RESEARCH NEWS
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Holographic measurement technology in the production cycle

Sometimes every thousandth of a millimeter counts – such as with components for the automotive or aviation industry. In order to determine whether the individual component is fault-free and dimensionally stable, digital holography would be the method of choice. However, this method has so far been slow and sensitive to vibrations. It was therefore not suitable for production environments, and only samples could be tested.

Fast, solid results

Three researchers from the Fraunhofer Institute for Physical Measurement Techniques IPM – Dr. Markus Fratz, Dr. Alexander Bertz and Dr. Tobias Beckmann – have now brought the process of digital holography out of the laboratory and into the production hall. "We have been able to eliminate all the disadvantages and have therefore, for the first time, developed a system that allows one hundred percent inspection in production," says Beckmann, who heads the project together with Fratz. "Our system can measure centimeter-sized rough objects in fractions of a second with micrometer accuracy, thereby compensating for disturbances, such as vibrations." This allows for in-line measurements during the production process for the first time. Instead of taking samples, as before, each individual part can therefore be checked for dimensional accuracy and, at the same time, for the smallest defects. The challenge the three researchers faced was anything but easy to solve. "The search for defects is like trying to measure the shape of a 25-meter-high football stadium from a height of 300 meters so accurately that you can find the footprint of a baby in the grass – and in fractions of a second, even if the stadium is shaken by a light earthquake," Fratz explains.

Laser waves of different wavelengths and intelligent algorithms

But how did the researchers manage to succeed? Instead of interferometrically measuring the object with laser light only at a single wavelength, they illuminate it successively with laser beams of different wavelengths and assess the resulting images in relation to one another. Another highlight are the evaluation algorithms. The researchers have parallelized them so as to take full advantage of the performance of a high-end graphics card. As a result, the system is so fast that it can precisely measure objects to the micrometer within fractions of a second. "For highly accurate three-dimensional measurements, our system is the fastest available on the market worldwide," says Bertz, Group Manager at the Fraunhofer IPM. This speed, in turn, makes the system robust and comparatively insensitive to interferences such as vibrations. This is comparable to taking a photograph: the shorter the exposure time, the less the image blurs.

Production without risk

For Werner Giessler GmbH – a medium-sized company that manufactures components for diesel injection systems – the process was a kind of salvation. From its customer, Bosch, the company was commissioned to start delivering 10 million components per year instead of the previous 6.5 million, and all without a single defective part. With visual inspection, this would have been impossible. With the help of digital holography, though, the medium-sized company was able to accept the contract. "I'm not enough of a risk taker to do without this technology," says Managing Director Thomas Giessler. "Companies that have not learned to inspect the quality of their parts will soon disappear." The system is already integrated into the production process.

Dr. Markus Fratz, Dr. Alexander Bertz and Dr. Tobias Beckmann have received the Joseph von Fraunhofer Prize for the development of production-ready digital holography. The jury justifies the award by mentioning, among other things, "the outstanding scientific work and the first-time presentation of the industrial suitability of the process".

With the development of their holographic measurement technology Markus Fratz, Alexander Bertz and Tobias Beckmann (from the left) made it possible to fully inspect all parts in the production cycle in a matter of seconds. © Piotr Banczerowski / Fraunhofer | Image in color and print quality: www.fraunhofer.de/press/research-news

Fraunhofer Institute for Physical Measurement Techniques IPM | Heidenhofstr. 8 | 79110 Freiburg | www.ipm.fraunhofer.de
Press: Holger Kock | Phone +49 761 8857 129 | holger.kock@ipm.fraunhofer.de