PRESS RELEASE

Hugo Geiger Prizes

Micropumps, quantum sensor technology and a new laser source — the Free State of Bavaria and Fraunhofer honor young researchers for outstanding doctorates

Each year, the Free State of Bavaria and the Fraunhofer-Gesellschaft award the Hugo Geiger Prize to young scientists in recognition of outstanding doctorates in applied research. On March 21, 2023, Roland Weigert, State Secretary at the Bavarian Ministry of Economic Affairs, Regional Development and Energy (StMWi), presented this year's prize to researchers from Munich, Freiburg and Jena.

The three doctorates awarded this year's Hugo Geiger Prize for the next generation of scientists shared some key features: new ideas, numerous experiments and a culmination in scientific success that will facilitate groundbreaking new applications in practice. Each body of work was completed in close collaboration with a Fraunhofer institute and is expected to significantly drive forward developments in the areas of medicine, biology and materials science.

Roland Weigert, State Secretary at the Bavarian Ministry of Economic Affairs, Regional Development and Energy, presented this year's prize at the Netzwert symposium, the largest internal networking event for Fraunhofer researchers. He stated: "With their visionary ideas, the prizewinners have achieved top results in very different fields of research — be it micropumps, quantum sensor technology or laser technology. The Hugo Geiger Prize gives these achievements the recognition they deserve. The winning bodies of work not only stand out through their scientific excellence, but also offer a great deal of potential for practical application and, therefore, commercial success. This highlights all the more just how significant Fraunhofer research is for dynamic innovation in our businesses."

According to Prof. Reimund Neugebauer, President of the Fraunhofer-Gesellschaft, "Ingenuity is our country's most important raw material. Our innovative strength, our success as an economic and technological powerhouse and, ultimately, our prosperity all depend on it. In this context, I am especially delighted to congratulate the prizewinners on their outstanding doctoral theses. Thanks to their incredible creativity, perseverance and scientific excellence, they are forging new paths and responding to research questions focused on needs and problems. As a result, they are shaping key industries such as medical engineering, environmental analysis, material testing and chip production

Contact
Roman Möhlmann | Fraunhofer-Gesellschaft, Munich, Germany | Science Communications | Phone +49 89 1205-1333 | presse@zv.fraunhofer.de

with a view to the long term. With their distinctly applied focus and visionary perspective in their own fields of expertise, they are also making a valuable contribution to excellence and originality in our research."

First place: Medical application of MEMS micropumps

Piezoelectric micropumps hold a great deal of potential for medical applications. They are able to dispense precise doses of medication with slow-release effects for cancer, pain treatment and diabetes. They also facilitate more efficient transport of liquids for three-dimensional bioprinting or organ-on-a-chip applications (as a potential replacement for animal testing). However, despite all the benefits of the energy-efficient, highly adaptable pumps — which measure just five square millimeters — there is not yet a medical solution on the market. This is what Dr. Agnes Bußmann explored in her dissertation, written in collaboration with the Fraunhofer Institute for Electronic Microsystems and Solid State Technologies EMFT in Munich. She found that there was a lack of tests involving medications or biological liquids containing proteins or cells as a means of verifying the extent to which they could be applied to practical products. In addition, her work revealed that the development and approval processes for new medical devices are so costly and time-consuming that companies often just slightly alter existing products instead of using new technologies. The mechanical engineer wanted to change both of these things through her work.

She collaborated with colleague Dr. Claudia Durasiewicz, linking up expertise from materials science, engineering, electrical engineering, physics, chemistry and medicine to develop a technological platform on which individual microfluidic components can be flexibly combined in different dosing units. This approach makes it easier to test different medical applications and spread the initial costs for technical development and approval over multiple products. In turn, this increases economic viability, enabling medical micropumps to be brought to market more quickly.

In addition, Dr. Bußmann advanced the development of metal and silicon-based micropumps to maximize flow and prevent biological liquids from being damaged by the pump process and clogging up the pumps. As a result, the researcher was able to confirm the theoretical potential of the micropumps in both practical and economic terms. "The Fraunhofer concept, which has close ties to industry and an interdisciplinary, applied focus, was a huge advantage in my work," she stressed. She is now working at Fraunhofer in collaboration with industry partners to transfer her research findings to a production environment.

Second place: Improving infrared measurement technology through quantum sensor technology

Used in environmental analysis, pharmaceuticals, material testing and emissions tests, Fourier transform infrared spectrometers detect an extremely wide variety of molecules based on their characteristic transmission spectrum. This makes it possible to analyze the exact composition of gases or plastics, for example. Until now, one of the limiting factors of these devices was their slow and expensive infrared detectors.

In her dissertation conducted with the Fraunhofer Institute for Physical Measurement Techniques IPM in Freiburg, Dr. Chiara Lindner combined the established process with the new field of quantum sensor technology. This allowed her to use entangled pairs of infrared and visible photons to replace the technologically complex infrared detectors, which were of limited quality, with significantly faster, cheaper and low-noise silicon detectors. While the infrared photon interacts directly with the sample, only the visible partner photon is detected. This is where the quantum element comes in: With photons that are so closely correlated, there can only ever be interference for both infrared and visible photons, or for neither of them. If the infrared photon is therefore absorbed by the sample, the interference disappears for the visible photon too. This literally moves the information from the invisible infrared spectrum to the (visible) light.

The combination of Fourier transform analysis and quantum effect allows the spectral properties of different substances to be detected quickly and precisely — with just one millionth of the light intensity of standard spectrometers. This makes the process particularly well suited to biological samples. “In my doctoral thesis, the quantum Fourier transform spectrometer has managed to achieve the gold standard of classic Fourier transform spectrometers in a number of specifications,” said Chiara Lindner. She also received the Quantum Future Award from the German Federal Ministry of Education and Research (BMBF) in recognition of her work.

Third place: Efficient generation of laser-like EUV light

A basic principle of laser optics states that laser radiation is harder to generate the shorter its wavelengths are. Light in the extreme ultraviolet range (EUV) has many advantages, as it can be used to create and analyze smaller structures. In production and quality control processes for energy-efficient microchips, for example, this short-wave light provides a way of accommodating millions of transistors on a wafer the size of a fingernail. Under an EUV microscope, it is also possible to observe bacteria, viruses and biological processes with nanometer dimensions. To date, however, research into and with EUV light has only been possible in large, complex research facilities and involves long waiting times.

During his doctorate written in partnership with the Fraunhofer Institute for Applied Optics and Precision Engineering IOF in Jena, Dr. Robert Klas sought to develop a compact, more efficient method of generating laser-like EUV light with wavelengths of 10 to 50 nanometers. One nanometer is equal to one millionth of a millimeter. The physicist used state-of-the-art, high-performance ultrashort pulse lasers to accelerate electrons with very short light pulses. These electrons then emit EUV radiation. The biggest challenge was to control the released radiation in such a way that its wave crests would accumulate in the extreme ultraviolet spectrum. His work has resulted in the most powerful laser-like EUV source on a laboratory scale to date, delivering one hundred times more power than was available before.

What's more, his design is compact enough to be portable, is easier to use and costs a fraction of a large-scale research facility. Dr. Robert Klas is certain that this will make research much easier: "In the future, I believe that the results of my doctoral thesis will drive forward development in many key areas, such as the energy and storage efficiency of chips, as well as biology and medicine."

The Hugo Geiger Prize
On March 26, 1949, the inaugural meeting of the Fraunhofer-Gesellschaft took place under the patronage of State Secretary Hugo Geiger from the Bavarian Ministry of Economic Affairs, as it was then. On the occasion of the 50th anniversary of the Fraunhofer-Gesellschaft, the Bavarian Ministry of Economic Affairs and Media, Energy and Technology launched the Hugo Geiger Prize for the next generation of scientists. Awarded each year to three young researchers, the prize honors outstanding doctoral theses in the field of applied research that have been completed in close collaboration with a Fraunhofer-Gesellschaft institute. The individual prizes amount to 5,000, 3,000 and 2,000 euros. The submissions are assessed by an expert panel of judges made up of representatives from the worlds of research, development and industry. The assessment criteria are scientific quality, relevance to industry, originality and use of interdisciplinary methods.