PRESS RELEASE

Hugo Geiger Prize

The Free State of Bavaria and Fraunhofer award prizes for best dissertations

A new material for faster, energy-saving semiconductor memory, efficient 3D audio, and an innovative approach to early detection of cancer: Three next-generation researchers, one each from Dresden, Erlangen, and Leipzig, were awarded the Hugo Geiger Prize on February 28 for their dissertations in applied research. The prize is given out annually by the Bavarian Ministry of Economic Affairs, Regional Development and Energy (StMWi) and the Fraunhofer-Gesellschaft in recognition of outstanding applied doctoral work completed in close collaboration with a Fraunhofer institute.

The awards ceremony was held in Munich as part of the Fraunhofer-Gesellschaft's biggest networking event, the Netzwert symposium. Bavarian state economics minister Hubert Aiwanger, who presented the awards at the evening event attended by Fraunhofer president Prof. Holger Hanselka, said: "I'm delighted to present the Hugo Geiger Prize once again this year to recognize the top young researchers for their impressive achievements. Their work in their individual disciplines is paving the way for new applications in semiconductor technology, home entertainment and cancer diagnosis, thereby contributing to the economic success of our companies, our state's innovative strength, and the wellbeing of our society."

Holger Hanselka, President of the Fraunhofer-Gesellschaft, added: "Development of innovative solutions for real-world applications is the core mission of the Fraunhofer-Gesellschaft. Through our research and close collaboration with trusted partners, we are instrumental in tackling global challenges. I'd like to congratulate Dr. Maximilian Lederer, Dr. Sascha Dick, and Dr. Susann Allelein for their outstanding doctoral work. The top-notch scientific quality and applied focus of their work are impressive examples of our approach, involving the targeted transfer of scientific findings into practice."

First place: new material for non-volatile memory

Hafnium oxide (HfO_2) has been used in the semiconductor industry for transistors and capacitors in the past. A new property of the crystalline material was discovered in 2011: its ferroelectricity. The ability to generate a spontaneous electrical polarization and thus to shift back and forth between memory states like a light switch makes this material interesting for non-volatile ferroelectric memory (FeRAM) and neuromorphic

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components. This could make RAM or USB storage and even neural networks for artificial intelligence (AI) much faster and more reliable in the future while saving energy and cutting costs — and powering new developments industry-wide.

For a long time, researchers did not understand exactly how ferroelectric HfO_2 behaves under which conditions, so it could not be used dependably until now. Dr. Maximilian Lederer changed that with his dissertation. Working at the Fraunhofer Institute for Photonic Microsystems IPMS in Dresden, he studied the material's crystalline microstructure and further developed it. Maximillian Lederer used a new method to find out, for example, how physical processes taking place at the atomic level and deposition and process conditions affect the ferroelectric switching behavior of HfO_2 — and thus also the reliability of components.

Based on his findings, he developed new processes of producing ferroelectric HfO_2, optimizing aspects such as growth and material composition. The electric field-induced crystallization that he showed for the first time drew special interest from across the industry as a new applied method. Global Foundries, a chip manufacturer based in Dresden, is currently testing ferroelectric storage components in a research and development line. Lederer also applied for several patents in the course of his dissertation, which combines elements of solid-state physics, materials science, computer science, and electrical engineering.

Second place: 3D audio — less is more

The listening experience is an important part of any home theater setting. People want the sound to be realistic and immersive, as if they were right in the middle of the action. But 3D surround sound requires a certain bandwidth or storage capacity. After all, the soundtrack to a theatrical release can draw on as many as 128 sources. In his dissertation, Dr. Sascha Dick from the Fraunhofer Institute for Integrated Circuits IIS in Erlangen found a solution that makes it possible to bring this sound experience into home theaters through Internet streaming, without any loss of quality.

Sascha Dick wondered: What do we actually hear spatially, and how can this be harnessed for transmitting and processing 3D audio? He conducted extensive listening tests and discovered when analyzing the results that the accuracy with which people localize spatially distributed sound sources can also be determined through data analysis based on high-resolution sound measurement. Dick used this information to develop a psycho-acoustic model describing various factors, including the perceived spatial distribution of the volume emitted by different sound sources. The model also shows which sources are indistinguishable. When these indistinguishable sources are aggregated, it is possible to reduce the number of sources by a factor of ten — while retaining excellent sound quality.

In practice, this "perceptual coordinate system" makes it possible to develop efficient algorithms for 3D audio coding for a range of applications. This enables not only high-

quality cinematic conversion for home theater use, but also, thanks to significantly reduced data rates, real-time applications in virtual reality and gaming. Intelligent aggregation of sound sources can also help improve the intelligibility of speech, and thus improve acoustic accessibility.

Third place: a novel approach to early detection of cancer

Statistically speaking, one in two people will suffer from cancer at some point in their lives. When tumors are caught early enough, chances of recovery are good. But current detection methods such as imaging and invasive tissue biopsies are often time-consuming and imprecise, plus they require the tumor to have reached a certain size. Biopsies also carry a risk of infection. Studies of blood or urine to identify tumor markers — a liquid biopsy — are more efficient.

Structures known as extracellular vesicles had gone largely unresearched in this context until now. These tiny information packets, just a few nanometers to micrometers in size, are present in the bodily fluids, where they allow all cells to communicate with each other. Their components reflect the composition of the cells, which means they have tremendous potential for detecting cancer earlier and more efficiently. And yet, isolating and characterizing the messages transmitted by cancer cells from among the many vesicles released from all the body's healthy cells is difficult. Dr. Susann Allelein from the Fraunhofer Institute for Cell Therapy and Immunology IZI in Leipzig found solutions to this challenge in her dissertation.

The objective of her work was to find out where extracellular vesicles can be used for early detection of prostate cancer specifically. To answer this question, she developed a specific concentration method that can be used to magnetically separate the relevant vesicles from irrelevant ones in urine or blood samples. The researcher also devised an antibody microarray to analyze the necessary surface proteins on the vesicles. It allows for analysis of significantly more samples and markers per sample than conventional methods. Although the prostate membrane-specific antigen she studied turned out not to be a suitable marker, Dr. Allelein's work is a foundational step toward further research on extracellular vesicles. Aside from simplifying cancer diagnosis, they also have potential to improve treatment monitoring and production of vaccines.

Founder Award
In addition to the Hugo Geiger Prize, the Founder Award was also given out for the best spin-off. This time around, the award went to Logistikbude GmbH for its web-based software solution for reusable load carriers in commercial use. It gives companies a simple, low-cost way to manage pallets and crates without their own IT resources.

Website:
Hugo Geiger Prize

Fraunhofer President Prof. Holger Hanselka and the Bavarian Minister of Economic Affairs Hubert Aiwanger (right) with the winners of the Hugo Geiger Prize 2023: Dr. Maximilian Lederer (Fraunhofer IPMS, 1st place, center left), Dr. Sascha Dick (Fraunhofer IIS, 2nd place, middle right).

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Third place went to Dr. Susann Allelein from Fraunhofer IZI, who unfortunately couldn't be there.
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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.