PRESS RELEASE

Hugo Geiger Prize

Next-Generation Researchers Win Awards for Plastic Alternative, New Casting Method and Laser Innovation

On February 19, the Bavarian Ministry of Economic Affairs, Regional Development and Energy (StMWi) and the Fraunhofer-Gesellschaft awarded the Hugo Geiger Prize for the best dissertations in applied research. Three next-generation researchers, one each from Freising, Munich and Aachen, were chosen as the winners for their innovative ideas and applied doctoral work completed in close collaboration with a Fraunhofer institute. The Fraunhofer Founder Award was also presented for a spin-off with an active, successful market presence.

Bavarian economics minister Hubert Aiwanger presented the awards at the Netzwert symposium, Fraunhofer's largest network event, held in Munich. "Through its work, the Fraunhofer-Gesellschaft builds bridges between the research sector and industrial application, making it an essential innovation partner to companies in Bavaria and throughout Germany. That's why I'm especially pleased to be able to present the Hugo Geiger Prize to three promising young researchers for their research work once again this year. In their work, the award winners succeed in vividly demonstrating how to combine scientific quality with practical relevance," Aiwanger noted.

Prof. Holger Hanselka, President of the Fraunhofer-Gesellschaft, highlighted the award winners' achievements: "To strengthen the economic success and competitiveness of Germany and Europe, we partner with companies to transform original ideas and scientific findings into innovations. This transfer approach, combined with scientific excellence and entrepreneurial thinking, is the central theme at the Fraunhofer-Gesellschaft, a common thread that runs through all of the prize winners' outstanding doctoral projects. I warmly congratulate Dr. Kerstin Müller, Dr. Patricia Erhard and Dr. Sarah Klein on their outstanding achievements!"

First place: Thermoformable plastic alternative made from cellulose

In all, 414 million metric tons of plastic were produced worldwide in 2023, over 90 percent of it derived from fossil raw materials. Plastic is practical, versatile in molding and universally usable. But it is also harmful to the environment, does not biodegrade and depends on finite supplies of petroleum. Even so, bio-based plastics made from plants like corn or wood account for just 0.7 percent of all plastic production so far. This is because their properties make these types of plastic much less versatile. Previous chemical

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approaches aimed at making them similarly formable are associated with loss of the natural structure of cellulose, and with it properties such as biodegradability. Chemical methods are also often costly, laborious and time-consuming.

As part of her doctoral studies, Dr. Kerstin Müller from the Fraunhofer Institute for Process Engineering and Packaging IVV found a physical approach that makes it possible to produce thermoformable plastic from plant cellulose. She uses compatible polylactic acid molecules as spacers to create more space and flexibility between the narrow, long-chain cellulose molecules derived from wood, cotton or other plants. To do this, she dissolves the cellulose in an ionic liquid, a special solvent, and binds the molecules with those in polylactic acid. The result is an innovative, biodegradable material that is also thermoformable.

But Müller's work was not confined to optimizing the thermoplasticity of cellulose at the lab scale; she also transferred the material to an industrial process. The mixture she developed can be produced at scale in a conventional extruder and further processed as granulate. This allows the material to be used for a wide range of uses such as in biodegradable tube-style tree protectors, planters or clips for plants in the agriculture sector. Furniture and other molded parts for indoor use are also conceivable. Dr. Kerstin Müller has been awarded first place in the Hugo Geiger Prize for her groundbreaking doctoral work and its real-world applications.

Second place: Slurry-based 3D-printing of ceramic casting cores

Casting technology dates back millennia. Today, it is used to produce increasingly complex components in fields such as automotive technology, aerospace and medical engineering. As part of this, 3D printing of sand cores is already an element of mass production. During the process of casting in molten metal, the casting cores model the internal cavities inside cast components. They are mechanically removed once the casting is complete. As the technical requirements that apply to the complexity of components grow ever more stringent, increasingly intricate casting cores are required to withstand the heavy mechanical and thermal stresses arising during the casting process.

Dr. Patricia Erhard from the Fraunhofer Institute for Casting, Composite and Processing Technology IGCV refined the method used for 3D printing of casting cores in her dissertation. Instead of sand, she applies layers of a ceramic suspension that she then allows to dry and prints with binders afterward. This allows for finer surface structures, greater temperature stability and high strength during the subsequent sintering process, opening up new possibilities for the design of intricate interior structures in cast components.

One challenge was how to remove the ultra-strong cores from the component in the end. Conventional methods call for ceramic cores to be leached out chemically, an environmentally harmful process. To get around this issue, Erhard took advantage of the design freedom afforded by 3D printing to incorporate snap-off points inside the casting cores. She found a suitable casting core design for implementing intricate cooling structures in the housings of electric motors. It withstands the heavy strain involved in casting but fails in a controlled manner as the metal contracts. This new approach enables a sustainable overall process and transfer to additional industries such as aerospace or medical engineering.

Third place: Next step in the evolution of high-performance fiber lasers and laser diodes

Lasers are an integral element of practically all growth industries, from aerospace to the energy sector, medical engineering, the semiconductor industry and telecommunications. A key technology, they unlock greater sustainability and energy efficiency in industrial applications across these sectors. With her doctorate, Dr. Sarah Klein from the Fraunhofer Institute for Laser Technology ILT is paving the way for the further development of industrially relevant high-performance fiber lasers and laser diodes.

Her goal was to increase the efficiency and durability of these laser sources for industrial and medical processes and make them less susceptible to errors. Klein's innovative approach involved incorporating the resonator mirrors for the fiber lasers, which amplify the radiation, directly into the fiber. This simplifies the structure and increases robustness. Previously, the mirrors were attached externally and required laborious and time-consuming adjustment. This fiber-integrated solution is made possible through the use of fiber Bragg gratings (FBGs).

Klein also studied frequency stabilization of laser diodes with an eye to harnessing their power more efficiently. Laser diodes are cost-effective and efficient but limited in their radiance. Development of new FBG techniques can reduce spectral emission bandwidth, thereby increasing the lasers' brilliance. The findings from her dissertation will contribute to innovative fiber and diode lasers that can be used more efficiently and with greater versatility across a range of industries such as in future technologies like laser-based inertial fusion.

Founder Award: Bio-inspired surface functions

In addition to the Hugo Geiger Prize, the Fraunhofer Founder Award was presented for a spin-off with an active, successful market presence. The award went to Fusion Bionic, a spin-off of the Fraunhofer Institute for Material and Beam Technology IWS and TUD Dresden University of Technology. Its laser-based surface functionalization method is inspired by natural surfaces such as the lotus leaf, sharkskin, springtails and the morpho butterfly, which allows for advanced surface features such as self-cleaning, anti-icing, antibacterial action, decoration, drag reduction and more. Fusion Bionic uses innovative laser technology to transfer these effects to technical surfaces.

Hubert Aiwanger (left), Fraunhofer President Holger Hanselka (right) and the winners of the Hugo Geiger Prize 2024 (from left to right): Dr. Patricia Erhard, Dr. Kerstin Müller and Dr. Sarah Klein.

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The Hugo Geiger Prize
On March 26, 1949, the inaugural meeting of the Fraunhofer-Gesellschaft was held at the Bavarian Ministry of Economic Affairs under the patronage of State Secretary Hugo Geiger. On the occasion of Fraunhofer's 50th anniversary, the Bavarian Ministry of Economic Affairs, Regional Development and Energy launched the Hugo Geiger Prize for the next generation of research 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 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.

Hugo Geiger Prize 2024