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Press release

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Britta Widmann

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Cooperation agreements, Research projects
Chemistry, Environment / ecology, Geosciences, Materials sciences, Mechanical engineering
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Seals Without PFAS, Lubricated with Water

Fraunhofer researchers have succeeded in developing sustainable new seals that are free from environmentally harmful substances like PFAS and suitable for water-based lubricants. They will be presenting their solution at the joint Fraunhofer booth (Booth 431, Hall A3) at Laser World of Photonics 2025 from June 24 to 27.

From ship propellers to wind turbine and harvesters, seals are crucial to ensuring functionality in any technical system with moving parts. To increase their durability, they have mainly been made from plastics that contain PFAS, maintained with petroleum-based lubricants. That is true across the many different places where they are used, from power plants to motor vehicles. Defects and damage therefore not only cause economic harm but can also have substantial environmental impact because the lubricants and chemicals enter the environment.

“Known as ‘forever chemicals,’ per- and polyfluoroalkyl substances, or PFAS for short, accumulate in the environment, cannot be broken down and also pose health risks. The upcoming ban in the EU is putting the industry in an even tighter spot. On top of that, about a million metric tons of lubricants containing petroleum are used in Germany alone each year. A single liter can contaminate as much as a million liters of groundwater. And that results in oily soils, contaminated foods and destroyed ecosystems. We set out to find a solution that addresses all of these challenges together,” explains Matthias Trenn, head of the Surface Structuring team at the Fraunhofer Institute for Laser Technology ILT.

Forward-looking seals that benefit the environment

The project was a complete success: With funding from the Fraunhofer-Zukunftsstiftung (Fraunhofer Future Foundation), researchers at the Fraunhofer Institute for Laser Technology ILT and the Fraunhofer Institute for Mechanics of Materials IWM teamed up in the pureWaterSeal project to develop forward-looking seals that are not only PFAS free, but are also suitable for water-based lubricants.

To accomplish this, the experts from Fraunhofer IWM, led by Manuel Mee, head of the Tribological Coatings team, developed diamond-like carbon (DLC) coatings designed for PFAS-free plastic components. In combination with laser structuring from Fraunhofer ILT, the researchers deliberately reduce internal tension and mechanical loading — not equally everywhere but locally at individual points instead. This maintains the structural integrity of the coating while optimizing its functional properties, such as resistance to wear and reduced friction. The seals have significantly longer lifespans as a result. Combining the coating and microstructuring also makes it possible to use water-based lubricants, which was previously not feasible.

“The development of the seals is an important step in advancing ecofriendly production methods since PFAS enters the environment primarily during manufacturing and not as much in application. We are protecting resources and ecosystems by using exclusively non-harmful substances. At the same time, our seals are an optimum fit for even sophisticated functional challenges,” says Christof Koplin, head of the Polymer Tribology and Biomedical Materials

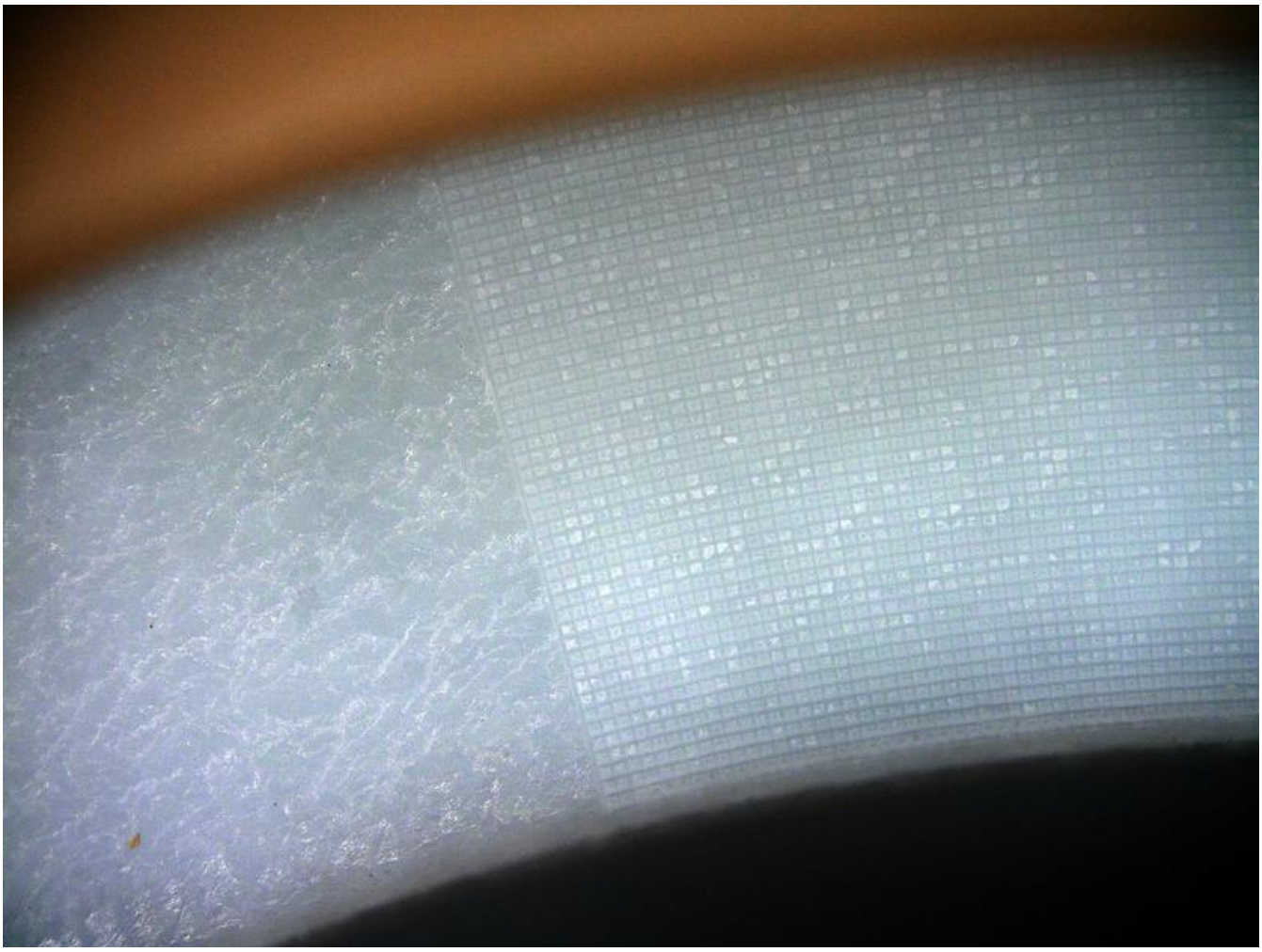
team at Fraunhofer IWM.

Together for fast implementation

The Fraunhofer specialists are working closely with partner companies focusing on different applications to ensure that their solution makes its way into industrial practice quickly, successfully and on the broadest possible basis. Initial prototypes are already in use in pumps at geothermal power plants. Now the goal is to transfer the process to larger facilities and systems and move into series production. At the same time, the research scientists are optimizing their seals on an ongoing basis, targeting different areas of application and customer needs. Plans for a spin-off that markets these developments are already in the pipeline.

Attendees at Laser World of Photonics 2025, being held from June 24 to 27, will have the opportunity to learn about the ecofriendly solution and its future prospects. The researchers will be presenting the results of their project at the joint booth of the Fraunhofer-Gesellschaft, Booth 431 in Hall A3.

URL for press release:
https://www.fraunhofer.de/en/press/research-news/2025/june-2025/seals-without-pfas-lubricated-with-water.html



The combination of PFAS-free coating and laser-based microstructuring (right) enables the use of water-based lubricants.