PRESS RELEASE

For high power or the high seas: Innovative sensor designs made possible by glass-integrated waveguides

Waveguides, integrated in glass, have the potential to significantly boost the measuring accuracy of sensors in science and industry. In the "3DGlassGuard" project, a consortium including Fraunhofer IZM is working on a sensor for measuring the density of seawater that can potentially help generate more consistent climate models. The researchers are also planning to create sensors in glass for power electronics, using innovative optical 3D microstructures and AI design processes.

Sensors tasked with electrical measurements are increasingly reaching the limits of what they can do - especially when used in sensitive environments such as in large energy parks or underwater. Established sensor concepts then face problems like power loss and costly production processes. One possible solution could be a sensor concept based on waveguides integrated into glass. A large consortium of major industry and science players is working on this in the "3DGlassGuard" project, funded by the German Ministry of Education and Research. Their idea is to create three-dimensionally structured glass layers that are built right into the circuit boards. These glass-core substrates can open the gates for novel sensor and data transmission applications.

The researchers at the Fraunhofer Institute for Reliability and Microintegration IZM are cooperating with their project partners on innovative sensors that will be attractive for applications in many fields, ranging from energy and infrastructure to environmental science or marine research. Conventional sensor solutions tend to use fiber-based or electrical connections. "3DGlassGuard" is set to change this with a glass layer, structured three-dimensionally by ion exchange and Selective Laser Etching (SLE) and integrated directly into the circuit board.

Applications for science and industry

In the project sensor concepts are being developed for two application scenarios. In cooperation with Siemens, the sensor specialists are building an optical current sensor for power electronic applications, such as currents measurements in high-power electronics. The innovative sensor breaks with the current design orthodoxy of using a circuit of optical fibers, which needs a lot of space on the circuit board and requires extremely careful alignment to work properly. Instead, the sensor uses waveguides integrated in a 3D glass layer on the circuit board. This integrated layer avoids the problem of interference, as the waveguides are galvanically isolated and completely encased in the glass.

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Integrated optical waveguides are characterized by low propagation losses and at the same time allow light to be guided with different wavelengths and states, such as a defined polarization. This makes it possible to measure and transmit much more information than by purely electrical means.

Another sensor is being built in cooperation with Sea & Sun Technology. It will measure the density of seawater, using the interferometer principle of measuring how light waves are superimposed on each other. Current density sensors rely on measuring the electrical conductivity of their medium, which can give an indication of its density. However, this process relies on different reference values worldwide. A more immediate, purely optical measurement with the new sensor design brings a far better resolution and standardization of the measurements, potentially paving the way for more consistent climate models.

The researchers are currently working on a set of working demonstrator units that the industry partners on the project can subject to functionality tests. One particular challenge is the miniaturization of the new sensor concepts in order to accommodate them on a circuit board. However, using planar glass offers far more ways to integrate waveguides or other functional features. While work on the sensors is continuing, the researchers are also cooperating with their partners at TU Berlin on AI-driven simulation tools that can help make individual optical components of the sensors smaller and more efficient than a human developer could make them.

The “3DGlassGuard“ project started on 15 May 2024 and will conclude on 14 May 2027. 69.3% of the total funding of EUR 4.6 million come from the German Federal Ministry of Education and Research as part of the Quantum Systems funding program (funding ID 13N16852). The project is coordinated by Siemens AG and includes Fraunhofer IZM, Contag AG, LightFab GmbH, Sea & Sun Technology GmbH, the Technical University of Berlin, and Schott AG as associate partners.

(Text: Steffen Schindler)

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A power electronics measuring and testing station.
Ill.: Siemens AG | Picture in color and print quality:
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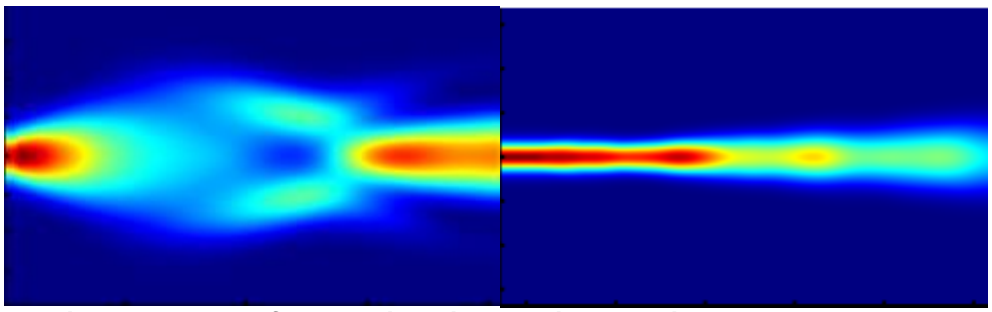

Simulation pictures* from work in the „3DGlassGuard" project.
Picture: Fraunhofer IZM, generated with Ansys Lumerical | Picture in color and print quality: www.izm.fraunhofer.de/pics

*Left: A multi mode interference coupler (MMI) for splitting of light to different integrated waveguides
Right: A taper, that widens or tightens the integrated waveguide to simplify the coupling to an optical fiber

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