

PRESS RELEASE

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Label-free detection methods in medicine using biosensors

Early disease detection in body fluids with photonic biosensors

Standard medical procedures are often time-consuming and generally do not take into account the individual characteristics of patients. This can have a negative impact on the success of treatment and impair quality of life. To solve this problem, a Fraunhofer research team from Fraunhofer IPMS, Fraunhofer IZI and Fraunhofer IOF is developing disposable biosensors that deliver rapid results and have extensive multiplexing capabilities. These biosensors enable the early detection of diseases and have the potential to significantly improve healthcare.

The detection method is based on special bioassays developed by Fraunhofer IZI, in which antigen molecules bind specifically to sensor surfaces that have been functionalized with capture molecules. The binding of the molecules to the sensor surface leads to a resonance wavelength shift in the transmission spectra of the biosensor chip. "Thanks to their high sensitivity, these biosensors can precisely detect biological molecules in liquids so that they can be used for the early detection of diseases using body fluids," explains Dr. Florenta Costache, project manager at Fraunhofer IPMS.

The biosensors consist of specially developed, scalable on-chip multichannel micro-ring resonator architectures with currently up to 7 sensors designed for a wavelength of 1550 nm. They are manufactured on a silicon nitride waveguide platform on 200 mm silicon wafers in the CMOS-compatible process line in one of Fraunhofer IPMS's state-of-the-art clean room facilities. To further increase sensitivity, additional sensor designs are currently being developed that operate in the visible range and are based on micro-ring resonators and Mach-Zehnder interferometers in various unique combinations. This results in cost-efficient, scalable sensors with customized design, high precision and reliability.

Costache adds: "We have also developed and successfully implemented a regeneration process to restore the functional surface of the sensor. This allows the sensor to be recycled and used several times. This saves costs and facilitates mobile use under field conditions."

Demonstrator for the detection of biomarkers in neurodegenerative and oncological diseases

The research team has already successfully developed a portable demonstrator based on a multi-channel silicon nitride micro-ring resonator biosensor system that allows for easy chip exchange by implementing special solutions for light coupling and detection.

Editor

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This system enables the multiplex detection of specific miRNA biomarkers associated with neurodegenerative and oncological diseases. The capture molecules immobilized on the sensor surface for the detection of these biomarkers are DNA-based. The developed sensors and the integrated system are versatile and can be adapted for the detection of nucleic acids, various disease-associated biomarkers and pathogens in different fluids.

The biosensors show great potential for use in rapid, minimally invasive diagnostics, particularly for the early detection of diseases, therapy monitoring and drug development. Collaboration with diagnostics companies and clinics is planned for the near future in order to further advance the development of biosensors for relevant biomedical applications. The aim is to demonstrate the practical use of these biosensors in the healthcare sector in the near future.

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Presentation at the Pacific Rim Conference on Lasers and Electro-Optics

Dr. Florenta Costache will present the development in an invited talk entitled "Silicon Photonic Biosensors for Label-Free Detection of Small Biomolecules" on August 5, 2024 at the CLEO-PR (Pacific Rim Conference on Lasers and Electro-Optics) in Incheon, South Korea - lecture Mo3G-1.

Information on the research work on photonic biosensors is available on the website <https://www.ipms.fraunhofer.de/en/Components-and-Systems/Components-and-Systems-Sensors/Optical-Sensors/Integrated-photonic-devices.html>.

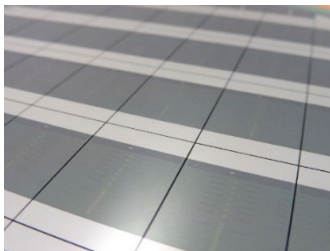
About Fraunhofer IPMS

Fraunhofer IPMS is one of the leading international research and development service providers for electronic and photonic microsystems in the application fields of intelligent industrial solutions and manufacturing, medical technology and health, and mobility. In two state-of-the-art clean rooms and with a total of four development sites in Dresden, Cottbus and Erfurt, the institute develops innovative MEMS components and microelectronic devices on 200 mm and 300 mm wafers. Services range from consulting and process development to pilot production.

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On-Chip 1x7 micro-ring resonator biosensor chips on 200 mm wafer
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Photonic biosensor chip of Fraunhofer IPMS
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