FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS

PRESS RELEASE

Robust, chip-based pH measurement available for Research and Practical Applications

New Fraunhofer IPMS Chip makes pH measurements easier and devices more robust and portable

Fraunhofer Institute for Photonic Microsystems IPMS has achieved another breakthrough in pH measurement technology. Researchers have developed a new technology that makes pH measurements significantly more robust, simple, and reliable. Instead of the traditional, often error-prone reference electrodes, a durable chip is now used. This chip can be stored dry, is pressure-resistant, and easily integrated into compact devices. Initial test kits are already available for rapid use in medical, biological, agricultural, and environmental applications.

Precise pH measurement is a major challenge in chemical sensor technology. To date, conventional silver/silver chloride/potassium chloride electrodes have been used. Although these electrodes provide a stable reference potential, they are highly prone to errors. Changes in electrolyte concentration or a clogged or dried-out membrane can make the readings unreliable.
While the pH-sensitive glass electrode has already been successfully replaced by robust chips called ion-sensitive field-effect transistors (ISFETs), replacing the sensitive reference electrode has only recently been achieved at Fraunhofer IPMS with a reference ISFET (REFET). "Our ISFETs are reliable, stable, and durable. They overcome common problems of conventional reference electrodes, such as clogged or charged diaphragms, drift due to concentration changes, and contamination of the measurement solution," explains Dr. Olaf Hild, division director of the Chemical Sensors and Systems department at Fraunhofer IPMS. This makes them particularly suitable for mobile or integrated measurement systems.

Physical Principles of the New pH Measurement Technology

In this technology, developed by Fraunhofer IPMS, a second ISFET is used with a standard pH ISFET instead of a sensitive reference electrode. This reference ISFET has a significantly lower pH slope of 20 mV/pH at 25°C, compared to the usual 59 mV/pH according to the Nernst equation.
The ISFETs are coated with thin layers of niobium pentoxide (Nb_2O_5) or tantalum pentoxide (Ta_2O_5). These materials provide the sensors with high stability, ease of handling, and good storage properties. The two ISFETs operate together via an auxiliary electrode to reliably calculate the pH value from the measured electrical signals.

Editor
Franka Balvin | Fraunhofer Institute for Photonic Microsystems IPMS | Phone +49 351 8823-1144 |
Maria-Reiche-Straße 2 | 01109 Dresden | www.ipms.fraunhofer.de | franka.balvin@ipms.fraunhofer.de

"Unfortunately, we did not develop the ISFET-REFET concept. It was created in the 1980s by Professor Piet Bergveld, the inventor of the ISFET, and his colleagues," explains Hild. "However, the concept has so far not been adopted commercially." The new components aim to change this. Initially pH measurement will be possible in the range of approximately pH 4 to pH 8, which meets the typical measurement requirements for many applications in biology, medicine, agriculture, and environmental monitoring.

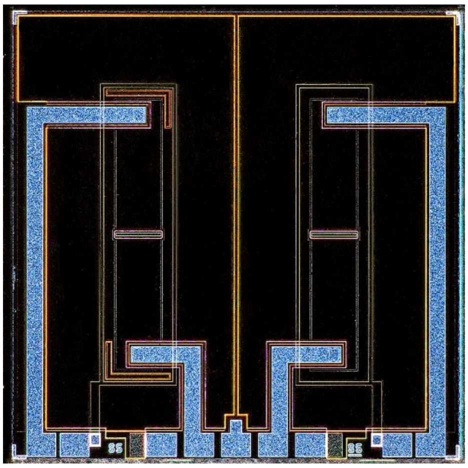
Currently, two 5 mm × 5 mm chips are required for proper wetting, but their size can be reduced upon customer's request. In the future, the both chips are planned to be combined into a single chip of the same size, with integrated temperature measurement.

"Long-term measurements after a 2- or 3-point calibration require precise control of sensor drift. The drift can be compensated for with the help of the control electronics." explains electronics developer Hans-Georg Dallmann, describing how the control system works. This establishes the roadmap for further development at Fraunhofer IPMS: expanding the pH range of the REFET through improved sensor layers, reducing REFET sensor drift, and integrating both functions on a single chip with temperature measurement. "Although much work still lies ahead, we are pleased to already offer test kits and to present them to the professional audience at Analytica 2026 (Hall 3, Booth 312)," Hild concludes. Individual appointments at the Analytica can be arranged in advance via the website of Fraunhofer IPMS.

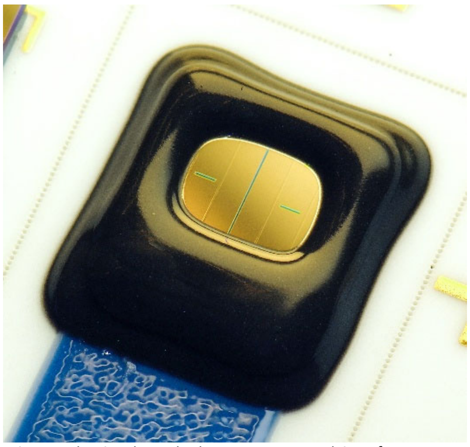
About Fraunhofer IPMS
Fraunhofer IPMS is a leading international research and development service provider for electronic and photonic microsystems in the application fields of Smart Industrial Solutions, Bio and Health, Mobility as well as Green and Sustainable Microelectronics. Research focuses on customer-specific miniaturized sensors and actuators, MEMS systems, microdisplays and integrated circuits as well as wireless and wired data communication. The institute develops systems and components on 200 and 300 mm wafers in their state-of-the-art clean rooms. Services range from consulting and design to process development and pilot production.

FRAUNHOFER INSTITUTE FOR PHOTONIC MICROSYSTEMS IPMS

Images



ISFET-REFET-Chip, 5x5 mm²
©Fraunhofer IPMS



Die- and wire-bonded ISFET-REFET chip after encapsulation – available soon
©Fraunhofer IPMS

Currently available chips as ISFET or REFET, bonded and encapsulated on FR4 circuit board
©Fraunhofer IPMS