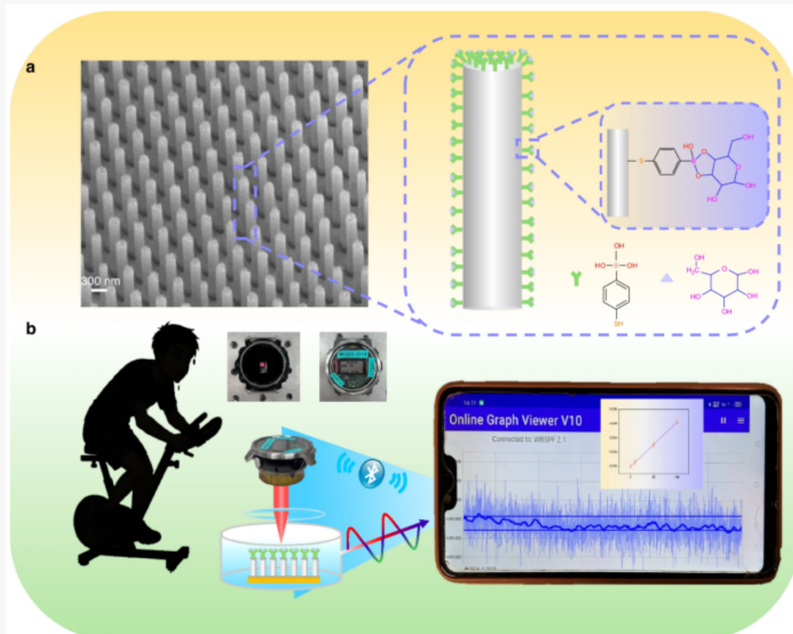
From sweat to signal: A wearable optical system for glucose detection

FAYETTEVILLE, GA, UNITED STATES, February 15, 2026 /EINPresswire.com/ -- Continuous glucose monitoring is essential for effective diabetes management, yet most existing systems rely on invasive sensors that can cause discomfort and skin irritation. To address this limitation, researchers have developed a portable, label-free optical system capable of detecting glucose directly from human sweat. By combining nanostructured plasmonic materials with molecular recognition chemistry, the system achieves high sensitivity in the low micromolar range relevant to real sweat conditions. Integrated into a wearable optical watch prototype, the technology enables real-time signal acquisition and wireless data transmission. This work demonstrates a promising non-invasive alternative to conventional glucose monitoring and highlights how nanophotonics can transform everyday health sensing.



The schematic diagram shows a glucose detection platform that integrates a plasma silver nanopillar sensor with an optical watch system.

Diabetes affects hundreds of millions of people worldwide and requires frequent glucose monitoring to prevent complications. Although continuous glucose monitoring technologies have advanced, most still depend on subcutaneous electrochemical sensors, which can lead to infection risk, inflammation, and reduced long-term compliance. Sweat has emerged as an attractive non-invasive biofluid, as it is easily accessible and contains glucose levels correlated with blood glucose. However, sweat glucose concentrations are typically 10–100 times lower than those in blood and are easily masked by interfering compounds. Based on these challenges, there is a strong need to develop highly sensitive, selective, and wearable technologies for reliable sweat-based glucose monitoring.

On January 26, 2026, a research team from the University of Oulu reported (DOI:

10.1038/s41378-025-01152-6) a new wearable optical glucose-sensing system in Microsystems & Nanoengineering. The study presents a portable platform that integrates plasmonic nanopillar sensors with an optical watch prototype to enable non-invasive, label-free detection of glucose in human sweat. Using red-light illumination and wireless data transmission to a smartphone, the system was validated with artificial sweat and human samples, demonstrating sensitivity suitable for real-world daily glucose monitoring.

At the core of the system is a silicon nanopillar array coated with a thin layer of silver, engineered to generate strong localized surface plasmon resonance under visible light. The nanopillars are functionalized with 4-mercaptophenylboronic acid, a molecular receptor that selectively binds glucose through its cis-diol structure. This binding event alters the local optical environment, producing measurable changes in reflected light intensity without the need for enzymes or fluorescent labels.

The researchers systematically optimized the sensing strategy using Raman spectroscopy and plasmonic reflectance measurements, demonstrating reliable glucose detection across physiologically relevant concentrations. By replacing conventional gold coatings with silver, the sensor achieved sharper plasmonic responses and a detection limit as low as ~22 μmol/L—well within the range of glucose levels found in human sweat.

To translate laboratory performance into a wearable format, the team developed an optical watch prototype equipped with a compact LED (Light-Emitting Diode), photodiode, and Bluetooth module. When tested with artificial sweat and samples collected from human volunteers during exercise, the system successfully tracked sweat glucose levels in real time. Results showed good agreement with standard enzymatic assays, confirming both accuracy and selectivity in complex biological environments.

“Non-invasive glucose monitoring has long been limited by sensitivity and system complexity,” said one of the study’s senior researchers. “By combining plasmonic nanostructures with a simple optical readout, we were able to detect glucose in sweat using low-power visible light. Importantly, this approach avoids enzymes and invasive probes, which opens new possibilities for comfortable, long-term monitoring. Our results show that wearable photonic sensors can move beyond the laboratory and into everyday health applications.”

This wearable optical sensing platform could significantly improve quality of life for people requiring frequent glucose monitoring by reducing pain, skin irritation, and maintenance demands. Beyond diabetes care, the modular design allows the same sensing strategy to be adapted for other sweat biomarkers, including lactate, electrolytes, or stress-related metabolites. With further clinical validation and system integration—such as automated sweat stimulation and microfluidic sampling—the technology could evolve into a fully autonomous “lab-on-a-watch.” More broadly, the study illustrates how nanophotonics and wearable electronics can converge to enable personalized, real-time health monitoring in daily life.

References

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