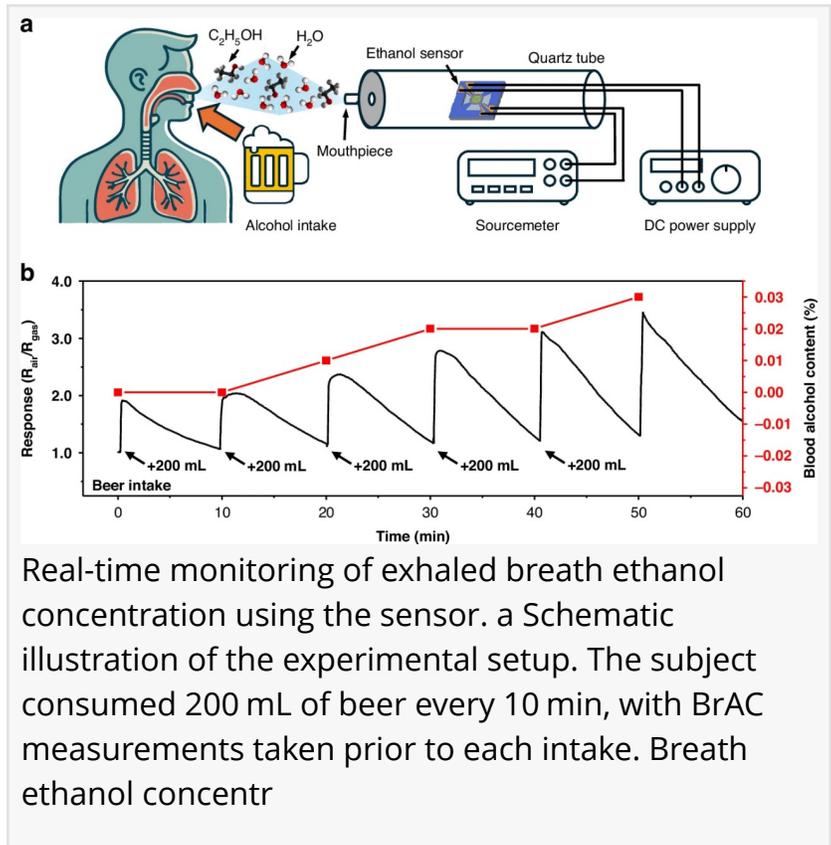


Tiny nanosheets, big leap: A new sensor detects ethanol at ultra-low levels

GA, UNITED STATES, February 4, 2026

[/EINPresswire.com/](https://www.einpresswire.com/) -- Accurate detection of [ethanol](#) at extremely low concentrations is essential for applications ranging from industrial safety to health monitoring, yet existing sensors often struggle to balance sensitivity, selectivity, and power efficiency. In this study, researchers developed a chemiresistive gas sensor that dramatically improves ethanol detection by integrating ultrathin catalytic nanosheets onto a conventional metal-oxide sensing film. The resulting device responds strongly to ethanol at concentrations spanning from parts per million down to a few parts per billion, representing a substantial performance gain over unmodified sensors. By combining enhanced surface reactions with amplified electronic signal transduction, the new sensor achieves exceptional sensitivity while maintaining stable, low-power operation, opening new opportunities for compact and reliable ethanol monitoring technologies.



Real-time monitoring of exhaled breath ethanol concentration using the sensor. a Schematic illustration of the experimental setup. The subject consumed 200 mL of beer every 10 min, with BrAC measurements taken prior to each intake. Breath ethanol concentr

Ethanol is widely used in industrial processing, food production, medical diagnostics, and transportation, but its volatility and potential health risks demand reliable monitoring at low concentrations. Conventional metal-oxide gas sensors are attractive because of their simplicity and low cost, yet they typically require high operating temperatures and show limited sensitivity or poor selectivity at trace ethanol levels. Environmental humidity and signal instability further complicate real-world deployment. Improving sensor performance therefore requires new material strategies that can accelerate surface reactions while amplifying electrical responses without increasing power consumption. Based on these challenges, it is necessary to conduct in-depth research into advanced functional materials that can fundamentally enhance ethanol gas sensing performance.

Researchers from Yonsei University and collaborating institutions reported this advance on November 7, 2025, in *Microsystems & Nanoengineering*. The team designed a microheater-integrated gas sensor in which ultrathin ruthenium dioxide nanosheets were deposited onto a tin dioxide thin film. This hybrid structure enabled ultra-sensitive ethanol detection across a wide concentration range, including parts-per-billion levels, while operating at low power. Beyond laboratory testing, the sensor also demonstrated real-time tracking of breath alcohol concentration, highlighting its potential for practical safety and health-related applications.

The core innovation lies in functionalizing a traditional tin-oxide sensing layer with monolayer-scale ruthenium dioxide nanosheets. These nanosheets provide an exceptionally high surface-to-volume ratio and strong catalytic activity, which together accelerate ethanol oxidation reactions on the sensor surface. At the same time, electronic interactions at the interface between the two materials create an expanded electron depletion layer, amplifying resistance changes when ethanol is present. As a result, the sensor's response to ethanol increased by more than threefold compared with an unmodified device.

The sensor was fabricated on a suspended membrane platform incorporating a microheater, minimizing heat loss and enabling continuous operation below 30 milliwatts. Systematic testing showed reliable detection from 10 parts per million down to approximately 5 parts per billion, placing the device among the most sensitive chemiresistive ethanol sensors reported to date. The sensor also exhibited improved selectivity against common interfering gases, stable operation over nearly a month, and reproducible performance across repeated sensing cycles. Importantly, controlled experiments demonstrated that the device could track dynamic changes in breath alcohol concentration in real time, closely matching readings from a commercial breathalyzer.

"This work shows how nanoscale material engineering can fundamentally change the performance limits of conventional gas sensors," the researchers noted. By leveraging both catalytic and electronic sensitization effects, the design achieves a rare combination of ultra-high sensitivity, low power consumption, and operational stability. They emphasized that the integration of nanosheets onto a scalable thin-film platform makes the approach compatible with existing microfabrication technologies, which is essential for translating laboratory advances into practical sensing devices.

The ultra-sensitive ethanol sensor has implications well beyond laboratory demonstrations. In industrial environments, it could provide early warnings of ethanol leaks or vapor buildup, improving fire prevention and worker safety. In healthcare and transportation, compact and low-power sensors could enable next-generation breath analyzers for real-time alcohol monitoring, supporting medical diagnostics and drunk-driving prevention systems. More broadly, the nanosheet-functionalization strategy can be extended to other target gases, offering a versatile pathway for developing high-performance sensors for environmental monitoring, smart infrastructure, and wearable health technologies.

References

DOI

[10.1038/s41378-025-01055-6](https://doi.org/10.1038/s41378-025-01055-6)

Original Source URL

<https://doi.org/10.1038/s41378-025-01055-6>

Funding information

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea Government (MSIT) (Nos. RS-2023-00208355, RS-2023-00222166, RS-2024-00348205, RS-2024-00457040).

Lucy Wang

BioDesign Research

[email us here](#)

This press release can be viewed online at: <https://www.einpresswire.com/article/889320544>

EIN Presswire's priority is source transparency. We do not allow opaque clients, and our editors try to be careful about weeding out false and misleading content. As a user, if you see something we have missed, please do bring it to our attention. Your help is welcome. EIN Presswire, Everyone's Internet News Presswire™, tries to define some of the boundaries that are reasonable in today's world. Please see our Editorial Guidelines for more information.

© 1995-2026 Newsmatics Inc. All Right Reserved.