Simultaneous multi-gas detection needs only sub-μL analyte

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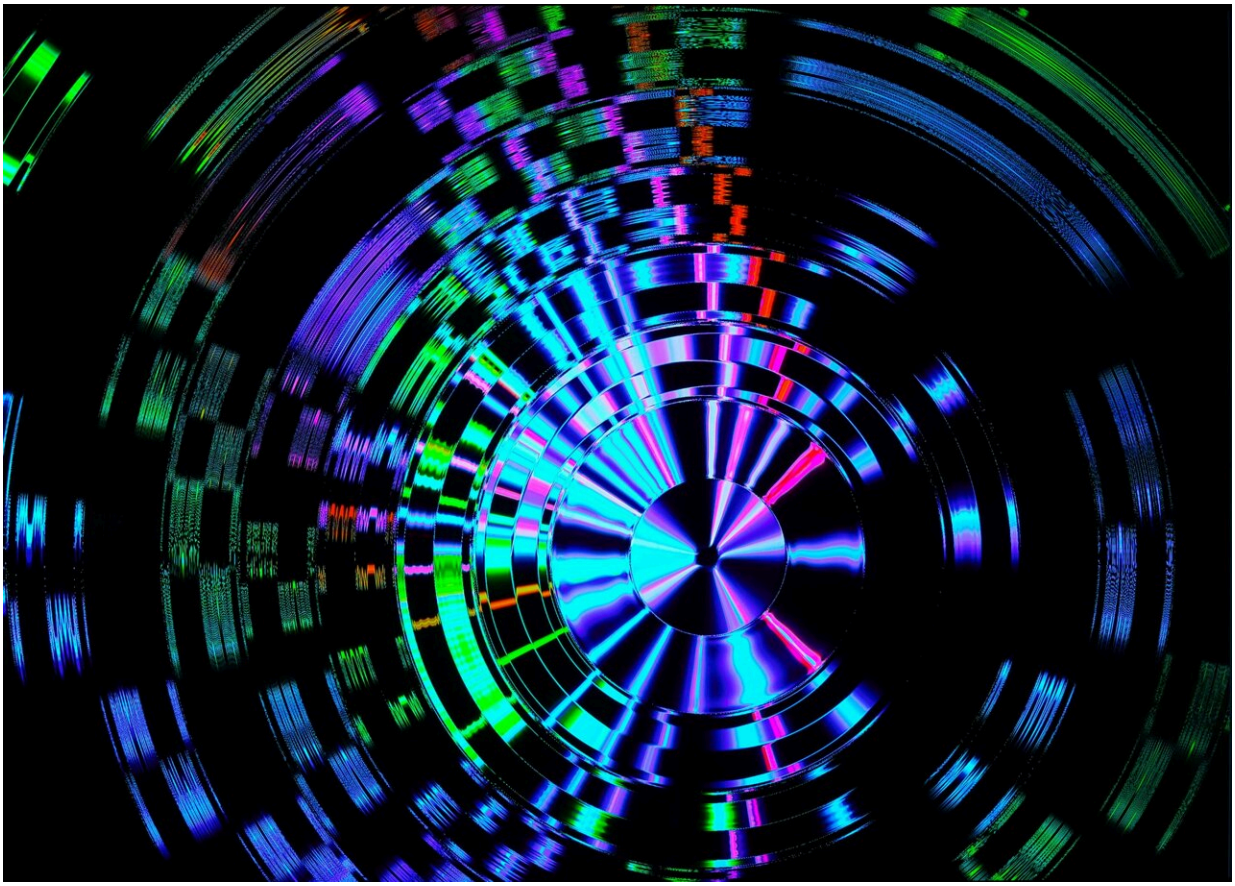

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Trace gas detection based on laser absorption spectroscopy (LAS) is a powerful technique due to its high sensitivity and selectivity, and it is

widely used in many fields. Most of current works are performed using a single frequency laser targeting only one species. Study of the interaction between different components needs simultaneous measurement of multi-species, which is still a challenge.

Recently, Prof. Wang Qiang from the Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP) of the Chinese Academy of Sciences (CAS), and Prof. Ren Wei from the Chinese University of Hong Kong, developed a trace gas sensor with an all-fiber configuration, and achieved simultaneous multi-gas interrogation at the cost of only sub-μL analyte. The study was published in *Sensors and Actuators B: Chemical*.

This technique was performed by blending photothermal spectroscopy (PTS), a method replies on the detection of refractive index of gas-phase analyte, and frequency-division multiplexing (FDM), a strategy modulates the gas by pumping different species at separate frequencies. A hollow-core fiber with a μm-sized mode field diameter worked as a flexible gas chamber to provide a significantly increased light intensity, highly efficient light-molecule interaction, as well as an in-line Fabry-Perot interferometer.

Three diode lasers with center wavelengths located at C-band, L-band and U-band were integrated to interrogate C_2H_2, CO_2, and CH_4, simultaneously. Simultaneous measurement of multiple species was demonstrated by the detection of samples of C_2H_2, CO_2, and CH_4 in a centimeter-long hollow-core fiber, which has a total consumption of only 0.17 μL. Four pre-set cases with different sample concentrations were prepared by diluting the samples with pure N_2. The expected corresponding response curves were obtained.

The researchers also experimentally demonstrated the performance of this compact all-fiber sensor, which achieves a minimum detection limit

of 2.5 ppb (parts per billion), 21 ppm (parts per million) and 200 ppb for C_2H_2, CO_2, and CH_4, respectively, and a good linear dynamic range of three to five orders of magnitude.

The unique features of high sensitivity, low gas consumption, and compact size make the sensor a versatile tool for precise gas analysis.

More information: Zhen Wang et al, Photothermal multi-species detection in a hollow-core fiber with frequency-division multiplexing, *Sensors and Actuators B: Chemical* (2022). DOI: 10.1016/j.snb.2022.132333

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