

Alivion SmartSelect: Making Gas Sensors Work in the Real World

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Summary:

Gas sensors are attractive for compact, scalable analysis, but often fail when moved from controlled laboratories into real-world applications. Alivion SmartSelect is a system-level platform that makes gas sensors work reliably outside the lab by combining selective sampling, separation, calibration, algorithms and digital workflows. We demonstrate this approach with Nutriion for breath acetone and Spark for methanol and ethanol analysis in liquids.

Keywords: gas sensors, SmartSelect, selective detection, breath analysis, liquid headspace analysis

Background, Motivation and Objective

Gas sensors are attractive for compact, scalable chemical analysis outside the laboratory, but often fail under real-world conditions. Changing humidity, temperature, interferences, complex backgrounds and uncontrolled sampling can make sensor signals unreliable, even when laboratory performance appears promising [1].

Lab-based instruments such as GC-MS, PTR-MS or FTIR solve these challenges through controlled sampling, separation, calibration and advanced data analysis, but they are too bulky, costly and complex for decentralized or high-frequency measurements. Here, we present SmartSelect as a system-level approach to bring lab-like selectivity and workflow control into compact gas-sensing systems. We demonstrate the concept with Nutriion for breath acetone monitoring and Spark for methanol/ethanol analysis in liquids.

SmartSelect Platform Concept

SmartSelect addresses selectivity at the system level rather than relying on the gas sensor alone. The platform combines application-specific sampling, analyte preselection, separation or filtration, calibration routines, quality control and signal-processing algorithms. This creates a controlled measurement environment around compact gas sensors and reduces the influence of humidity, temperature variation and changing chemical backgrounds.

The approach builds on selective gas-sensing architectures in which separation or preselection is combined with compact sensors to overcome cross-sensitivity, as previously shown for methanol detection in ethanol-rich samples [2].

Depending on the application, SmartSelect can be implemented as a handheld instrument or as an OEM sensing module for integration into existing workflows.

Application Examples: Liquid and Breath Analysis

The same SmartSelect architecture is demonstrated in two different matrices: liquid headspace and human breath. Spark applies controlled liquid headspace sampling, selective separation and temperature-corrected signal analysis to quantify methanol and ethanol in liquids (Fig. 1). It enables compact analysis of complex liquid matrices, including alcoholic beverages with high ethanol background, and has been validated in an ISO 5725 interlaboratory study [3].

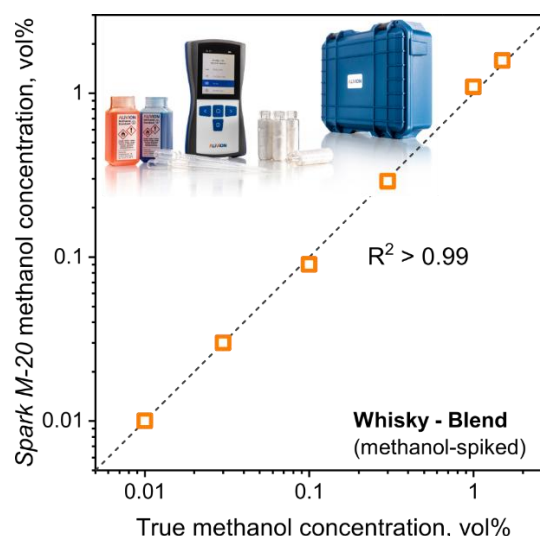


Fig. 1. Validation of Spark handheld methanol detector. Measured methanol concentrations show excellent agreement with true concentrations over 0.01–1.55 vol% in spiked whisky samples.

Nutrition applies the same system-level approach to breath analysis (Fig. 2a). It combines controlled end-tidal breath sampling, μ -GC separation and guided digital workflows to quantify breath acetone, a marker of lipid oxidation and metabolic state. The system enables repeated user-operated measurements outside the laboratory while reducing the influence of humidity, variable exhalation profiles and other breath compounds [4].

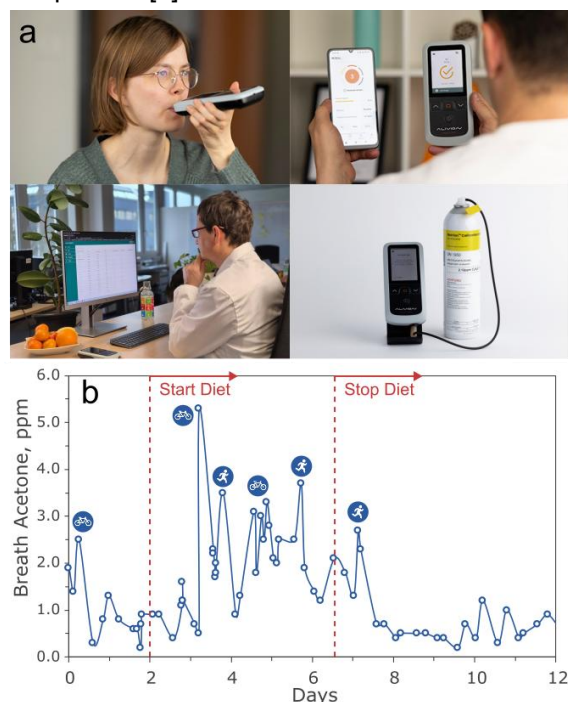


Fig. 2. Nutrition platform and longitudinal breath acetone monitoring. (a) Handheld device, smartphone app and researcher dashboard for guided at-home breath measurements. (b) Representative breath acetone profile during diet and exercise interventions, showing dynamic metabolic changes outside the laboratory.

Results and Discussion

For liquid analysis, Spark was validated in an ISO 5725 interlaboratory trial with 17 independent participants from six countries and 119 measurements. The handheld detector quantified methanol in alcoholic beverages within 2 min, down to 0.01 vol% in liquid, with repeatability below 5.4%, reproducibility below 9.5% and bias below 0.012 vol%. Additional tests showed excellent linearity over 0.01–1.55 vol% methanol (Fig. 1), effective temperature correction from 19–33 °C, and robust recovery across different beverage matrices including whisky, rum, gin, vodka, tequila, port, sherry and liqueur [3].

For breath analysis, Nutriion was validated against PTR-MS using 312 breath samples from 12 volunteers across 8 devices. The system showed strong agreement with the laboratory reference over 0.2–45 ppm acetone, with $r =$

0.995 and $R^2 = 0.990$. It also showed ~2.5% CV repeatability over 0.5–25 ppm, low inter-device variability, ~4.2% humidity-induced bias from 0–90% RH, and stable operation over 8 months without observed drift [4]. In at-home use, repeated measurements captured dynamic breath acetone changes during diet and exercise interventions (Fig. 2b).

Together, Spark and Nutriion demonstrate that SmartSelect can translate gas sensors into validated and commercially deployable analytical systems across different sample types. Both examples follow the same principle: controlling the sample, adding selectivity before detection, and using calibration and algorithms to deliver reliable measurements outside the laboratory.

Conclusion and Outlook

SmartSelect demonstrates how compact gas sensors can be transformed into robust analytical systems by combining controlled sampling, separation, calibration, correction algorithms and application-specific workflows. Spark and Nutriion show this principle in two different real-world settings: liquid headspace analysis for food and beverage applications, and breath analysis for longitudinal metabolic monitoring.

These examples highlight a broader platform strategy in which selectivity is engineered at the system level rather than expected from the sensor alone. Future work will focus on extending SmartSelect into further application-specific modules and OEM integrations, enabling reliable chemical measurements in decentralised workflows where laboratory instruments are impractical.

References

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