

Ionicon CEO Lukas Märk releases a breath sample into the PTR-TOFMS trace gas analyzer, which analyzes breath for VOCs (volatile organic compounds) in real time.



Industrial control technology in trace gas analysis

## Real-time breath analysis provisionally approved as COVID-19 test method

The mass spectrometers from Austrian specialist Ionicon are used as trace gas analyzers in many different applications, especially in medical research. One such system in Singapore – which uses reliable and long-term available control technology from Beckhoff – has also achieved a breakthrough as a provisionally approved test method for COVID-19.

The PTR-TOF systems are high-performance tools for non-invasive breath gas analysis. According to Ionicon, the large amount of information – a full spectrum is recorded every second – and the high sensitivity and mass resolving power make them the de facto standard for real-time breath analysis.

The analysis of volatile organic compounds (VOCs) in exhaled air has become a growing field of research in recent years. During the gas exchange at the blood-air barrier of the alveoli, carbon dioxide is released into the inhaled air and oxygen is absorbed from it. This exchange also applies to volatile metabolites (endogenous compounds) or VOCs that have been consumed or previously inhaled (exogenous compounds). Sampling of VOCs in exhaled air is non-invasive, simple and fast.

In real-time breath analysis, the exhaled air is analyzed directly without sample preparation. Recording complete respiratory cycles provides concentrations for the end-tidal (alveolar) portion and also the inhaled (room air) concentrations, both of which can be easily extracted by software. This provides immediate results and avoids complications that often arise from sample collection and storage. Also, real-time analysis may be the only way to measure unstable compounds that undergo rapid degradation.

### Rapid and non-invasive test for COVID-19

Singapore-based startup Breathonix has demonstrated a coronavirus breath test in clinical trials – with impressive results, according to Ionicon. The easy-to-use breath test, which can detect COVID-19 infections within one minute, has received preliminary approval from the Health Sciences Authority of Singapore (HSA) and approval from the Ministry of Health in Malaysia. Ultimately, the aim is to introduce the breath test at airports, seaports and transportation hubs, and it should also be suitable for use at sports venues and major events such as the Olympics.

The highly precise analytical equipment for this new test procedure was developed by Ionicon, as described by CEO Lukas Märk: “The new COVID-19 breath test is based on our PTR-TOF trace gas analyzers as well as special breath sampling systems developed by us. Our devices capture the measurement data in real time, which is then analyzed by scientists using special software.” Using this data, the researchers in Asia were able to detect biomarkers that are indicative of COVID-19 disease.

VOCs occur in very low concentrations in exhaled air. “Taking samples for the breath test is simple. What is difficult is determining and classifying the VOCs.

Our analyzers can measure several hundred VOCs simultaneously from a single exhalation," explains Lukas Märk. Due to the fast and precise evaluation of the measurement results, it can be determined within one minute whether a test person is infected with SARS-CoV-2 or not. In a pilot clinical study, the method achieved an accuracy of over 90%.

Breathonix is working with the Singapore Ministry of Health (MOH) to test the technology at an entry checkpoint where arriving travelers are screened using the system. The breath analysis system has already undergone clinical testing at three different sites. In Singapore, the trials were conducted at the National Centre for Infectious Diseases and Changi Airport, while the third trial in Dubai was conducted in collaboration with the Dubai Health Authority and the Mohammed Bin Rashid University of Medicine and Health Sciences.

### Universal PC- and EtherCAT-based control technology

Ionicon's analytical systems are proton transfer reaction time-of-flight mass spectrometers. In these systems, a gaseous sample is fed via an inlet system to a reaction chamber where the molecules of the sample gas are ionized. The ions formed are accelerated by electric fields and then pass through a flight path, at the end of which they are located by a detector. The time of flight of the ions can be used to identify them and thus determine the composition of the sample.

Stefan Haidacher, Senior Electronics Engineer at Ionicon, describes the details of the PC- and EtherCAT-based control technology: "Our mass spectrometers consist of a vacuum system in which molecules are ionized and detected, pumps for vacuum generation, precise power supplies for generating the electric fields, flow and pressure controllers for the inlet and calibration system, and ultra-fast electronics for detecting the ions. These system components are controlled and monitored by a CX5020 Embedded PC with Intel Atom® processor, on which our TwinCAT-based control software runs. For the user-friendly and efficient display and configuration of basic system parameters, we use the CP2907 multi-touch built-in Control Panel with 7-inch display and DVI/USB Extended connection."

The I/O level includes, among other things, the EL6022 EtherCAT Terminal, which – as a 2-channel serial communication interface – is responsible for communication with various system components, such as turbopumps for generating the high vacuum. In addition, the EK1122 2-port EtherCAT junction enables fast data transmission to other EtherCAT devices such as flow and pressure controllers. Stefan Haidacher confirms the great importance of ultra-fast data communication here: "In our new developments, we are increasingly relying on EtherCAT as a system bus, especially when it comes to time-critical control tasks."

A 19-inch housing with additional Beckhoff EtherCAT Terminals, IP67 EtherCAT Box modules as well as additional terminal blocks, fuses and relays serves as the control unit. Its task is to power and control the system components, which include temperature control of the ionization chamber, acquisition of measured values from vacuum pressure cells and control of valves.

Ionicon's mass spectrometers are available in different versions and with various equipment options, adapted to the respective field of application. For the COVID-19 application, a PTR-TOF 1000 was equipped with a C6920 control cabinet Industrial PC. Stefan Haidacher explains the advantages of

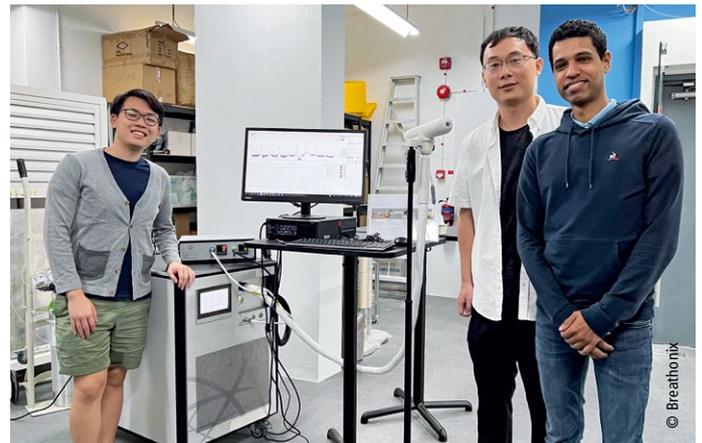
this system as follows: "During operation, our system continuously produces large amounts of data, which are usually recorded and evaluated on an external PC or laptop. With the COVID-19 application there are increased requirements for the stability and safety of the data acquisition system as well as for the long-term availability of components. The C6920 provides the necessary performance and, through integration into our system, gives us more control over the entire setup. The industrial PCs from Beckhoff have also been very good so far in terms of reliability and long-term availability. Added to this is the excellent support provided by the Beckhoff sales office in Innsbruck, which – under George Hampel, Head of the sales office – has been consulting Ionicon about the benefits of New Automation Technology on a daily basis since 2007."

More information:

[www.ionicon.com](http://www.ionicon.com)

[www.beckhoff.com/measurement](http://www.beckhoff.com/measurement)

The Breathonix team with a PTR-TOF analyzer from Ionicon: The scientists from Singapore process the analysis data for the novel COVID-19 breath test using special software and can provide the result after just one minute.



Ionicon's team of experts (from left to right): Lukas Märk (CEO), Gabriel Ivanko (Technician), Judith Bobory (Technician), Simon Niederbacher (Customer Support & Service), Stefan Haidacher (Senior Electronics Engineer), and Marco Lang (Mechatronics Trainee)