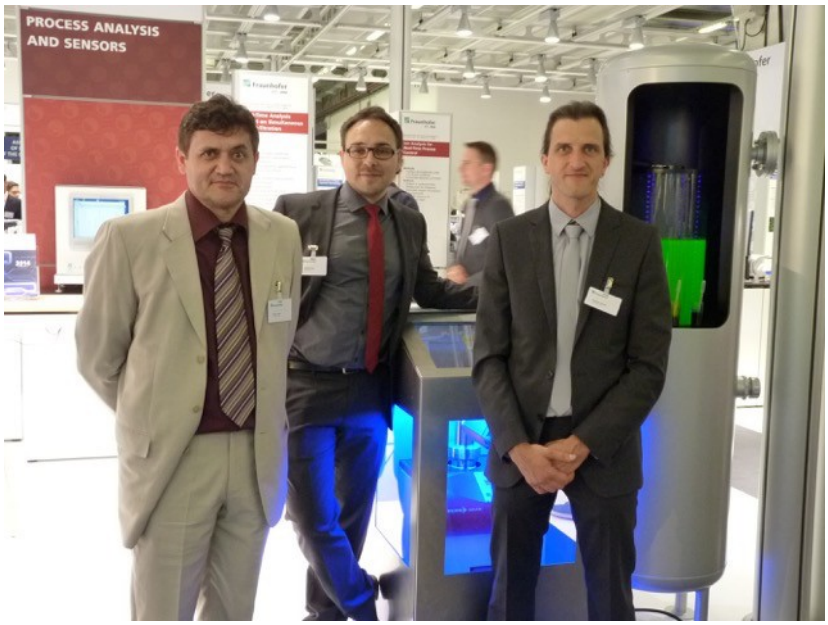
foxySpec – an analysis system with huge potential for bioproduction and diagnostics

The mass spectrometry-based foxySpec system enables the monitoring of gases and liquids simultaneously in real time. These simultaneous measurements make the system interesting for medical diagnostics applications. However, bioproduction can also benefit from foxySpec, which can also be used to measure a large number of products during the production process in real time, thus supporting smooth processes in fermenters.



The team of developers from the Fraunhofer IGB (from left to right: Martin Joos, Matthias Stier, Stephan Scherle) presented foxySpec at ACHEMA 2015 and are planning to establish a start-up at the end of 2017.

foxySpec has won quite a few prizes. The prototype was shortlisted for the Innovation Award at ACHEMA 2015, and in December 2015, the team of developers was one of three "idea phase" winners in the Science4Life Venture Cup for its foxySpec business plan. The team plans to place the system on the market and establish a start-up company by the end of 2017. The developers of the system, all engineers, currently work at the Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB (Matthias Stier and Stephan Scherle) in Stuttgart and the Fraunhofer Institute for Chemical Engineering ICT in Pfinztal (Martin Joos). The development of foxySpec received funding through the "Fraunhofer supports Entrepreneurs" (FFE) programme.

"foxySpec is suitable for a wide range of applications. We deliberately designed the system to be adaptable and are now exploring different application possibilities. We are also looking for additional industry partners," says Stier. "The innovative mass spectrometer-based measurement system is suitable for use in the biotechnology and chemical industries, as well as medical diagnostics. In fact, it can be used for anything that involves the continuous monitoring of substance concentrations, and especially for real-time measurements and simultaneous measurements of the concentration of compounds in liquid and gas phases.

Determining 30 components in gases and liquids simultaneously

This is made possible by a novel, patented inlet system. Mass spectrometers can normally only determine and quantify components in gases. If a liquid needs to be examined, the components have to be transferred into the gas phase. Although this also applies to foxySpec, at least in principle, the novel measurement system can transfer volatile components from a liquid to a gas phase using a clever bypass solution, without any loss of time or need to separate the compound mixtures. The centrepiece of the new system is a microporous PTFE membrane (PTFE: polytetrafluorethylene) mounted on the inlet of the analyser unit. The volatile components from the liquid sample vaporise and pass through the membrane using a vacuum attached to the membrane. This then enables them to be quantified with a mass spectrometer. The detection limit of foxySpec is less than ten micrograms per litre. "The system works with compounds that are volatile in aqueous phases at temperatures of up to 100 °C and pressures of up to ten bar. In non-aqueous solutions, the temperature may be as high as 200°C. foxySpec is also suitable for analysing compounds with a relatively large mass and for lipids with up to eight carbon atoms," Stier explains.

The clever thing about the system is that the analyser unit with the porous membrane-covered inlet is installed in addition to conventional gas inlets. This is why the device is able to carry out measurements in the liquid and gas phases simultaneously. Up to 30 components can thus be monitored simultaneously. Moreover, and this is what makes the system interesting for medical applications, the membrane can be integrated into a newly developed measuring probe. As the membrane is chemically inert, the probe can be used in a fermenter, but works just as well in the bypass unit of a heart-lung machine for measuring volatile active compounds or metabolites. foxySpec might also be used for anaesthesia. Stier explains: "This would be useful for determining the onset and termination of anaesthesia, for example when using laughing gas. The anaesthetist would be able to measure the laughing gas concentration in the blood in real time, and this would make it easier to make readjustments."

The compact mass spectrometer is about the size of a washing machine.
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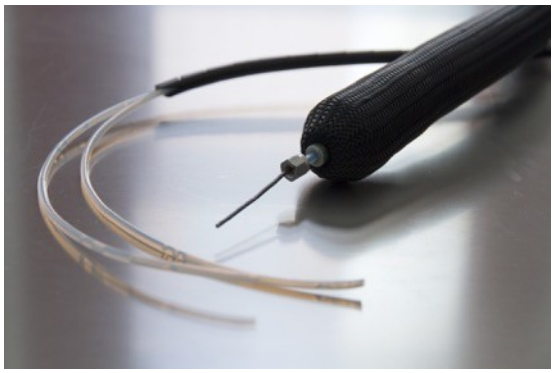

The components to be analysed are fed with the capillaries shown into the mass spectrometer through the liquid and gas inlets.
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A flexible system that can be adapted to many different applications

The standard flexible and robust version of foxySpec that is currently planned for market entry offers many other options across the entire field of diagnostics. For example, it can also be used for monitoring biomarkers. It will be possible to automatically switch between foxySpec valves for gas, liquid and in situ analyses. The rapid selection of appropriate valves leaves room for even more applications. “We are open to enquiries from industry partners; we will tailor the system to the specific requirements of individual clients,” says Stier. Potential business partners could include manufacturers of fermenters, diagnostic device specialists and many other manufacturers. The researchers have developed the Siemens programming themselves. “This ensures smooth communication between the mass spectrometer and the process control unit, enabling us to switch easily between gas, liquid and in situ analyses as required,” says Stier.

The PTFE (polytetrafluorethylene) membrane is hidden behind the module shown. The membrane module acts as a bypass for transferring volatile compounds of a liquid into the gas phase.
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