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Optical parametric oscillator based detection of hydrogen cyanide for bio-medical applications

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Abstract

There is an increasing interest in the development of sensitive and selective methods for HCN detection from biological samples. Here, we report on monitoring the HCN production by *Pseudomonas aeruginosa* (PA) bacteria, *in vitro*. Infections with these bacteria are of particular significance in cystic fibrosis (CF) patients. A sensitive and specific, non-invasive method for the diagnosis of *Pseudomonas aeruginosa* infection would be extremely useful in medical sciences. An attractive, but hardly explored, avenue for non-invasive and fast medical diagnostics is breath analysis. HCN is highly volatile and seems to be a promising indicator for PA infections. In the search for a non-invasive diagnostic biomarker for PA infections, HCN production should be quantified and investigated to a larger extend.

A cw Optical Parametric Oscillator (OPO) combined with sensitive photoacoustic detection is used to achieve the required sensitivity and selectivity for the detection of HCN at the low part per billion volume range. The achieved detection limit for HCN was 0.4 ppbv measured at 3287.25 cm^{-1} in 10 s, which is equivalent to an overall sensitivity of the system of 2.5×10-9 $cm^{-1}Hz^{-1/2}$. The OPO-based photoacoustic spectrometer was successfully tested for trace gas detection of HCN emission from clover leaves, apple seeds, human breath and *Pseudomonas aeruginosa* bacteria, *in vitro*. The OPO-based detection system showed good long term stability over a period of 13 days; the latter is a great advantage when measuring slowly growing biomedical samples such as bacteria.

Biography

Frans J.M. Harren completed in 1988 his PhD at the Catholic University of Nijmegen. At the moment he is Associate Professor and his research focuses on the reliable sensing of minute quantities of trace gases in complicated gas mixtures, on-line, non-invasive, with high selectivity and detection speed using state-of-the-art laser spectroscopy and mass spectrometry. He published over 150 publications in refereed journals and gave over 80 invited lectures in the last 10 years. A part of the activities of the research group has been commercialized via the spin-off company Sensor Sense.