Low volume gas sensing

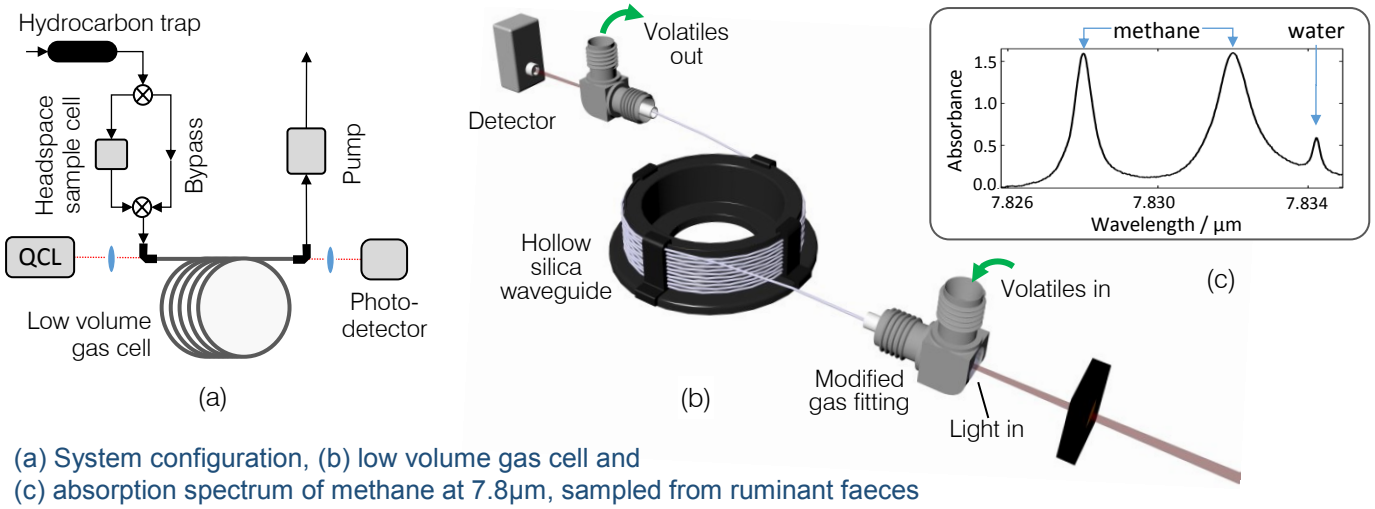
Low volume measurement of gases and volatiles

- Low volume, high sensitivity gas measurements are required for biomedical and environmental applications.
- When measuring volatile emission from headspace samples, low flow rates increase the concentration, improving the signal to noise ratio. Low volume cells are needed to enable measurement within 1-2 minutes.
- Other applications (capnography, flux measurement) need fast response at high flow rate. Low volume cells enable detection at >1Hz.

Our approach

- Cells are based on hollow silica waveguides with internal diameters of 300-1000µm.
- We engineered a novel solution to getting the light and the gas in simultaneously, with no dead volume.
- Quantum cascade laser based mid infrared spectroscopy enables stable and sensitive detection of gases and volatiles at ppb levels.
- Modified gas fittings are compatible with air supply lines and enable lengths of gas cell to be reconfigured or joined.

Implementation



(a) System configuration, (b) low volume gas cell and
(c) absorption spectrum of methane at 7.8µm, sampled from ruminant faeces

Signal to noise ratios depend on cell length, internal diameter and wavelength

Example results for methane at 7.8µm [1]:

Cell dimensions & volume	1000 µm ID × 5m long, 4 cm^3 vol
Limit of detection (1σ)	260 ppb
Response time (t_{90}-t_{10}) at 1 litre / min flow rate	0.8 sec

Further information:

[1] D Francis, J Hodgkinson, B Livingstone, P Black and RP Tatam, "Low-volume, fast response time gas measurement using a hollow silica waveguide gas cell with intra-pulse QCL spectroscopy", *Appl. Opt.*, **55**, pp. 6797-6806, 2016.

[2] D Francis, J Hodgkinson, C Walton, J Sizer, P Black, B Livingstone, D Fowler, M Patel and R P Tatam, "Mid-IR spectroscopic instrumentation for point-of-care diagnosis using a hollow silica waveguide gas cell", *Proc. SPIE*, **10072**-9, 2017.

[3] D Francis, J Hodgkinson and R P Tatam, "Hollow fibre waveguide gas cells", UK patent application no. GB1508115.1, 2015.

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About Cranfield University

Cranfield is an exclusively postgraduate university that is a global leader for transformational research in technology. Cranfield is focussed on the specialist themes of aerospace, defence and security, energy and power, environment and agrifood, manufacturing, transport systems, and water.

Cranfield has the largest number of engineering and technology postgraduates in the UK, awards over five percent of the UK's engineering and technology PhDs each year and currently works with over 1,500 companies and organisations worldwide.

Cranfield is ranked in the top five of UK universities for commercial research income, with 81% of Cranfield's research classed as world-leading or internationally excellent by REF (Research Excellence Framework, 2014). Cranfield University was formed in 1946 as the College of Aeronautics, the first postgraduate college of its kind.

The Centre for Engineering Photonics

Engineering Photonics at Cranfield is recognised internationally as a leading centre for optical sensing and instrumentation, which, since its inception in 1989, has been led by Professor Ralph Tatam. Engineering Photonics undertakes research ranging from blue skies concepts to the development of prototype instrumentation that is used by us and our academic and industrial collaborators in real environments. Further information about the Centre and a full list of publications and links can be found at openoptics.info.

Research areas

Engineering Photonics applies advanced photonic technologies to solve challenging measurement problems. Our research underpins measurements across a wide range of industrially important areas such as: aerospace, healthcare, manufacturing, transport, automotive, environment and agrifoods. We work in collaboration with academia, SMEs and major international companies both nationally and internationally.

Technologies

Optical interferometry; optical fibre sensor technology including interferometry, FBGs and LPGs; optical imaging and image processing; optical gas sensing; speckle interferometry and metrology.

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