EE Department
The Hong Kong Polytechnic University

Lasers and Electrooptics Soc.
IEEE Hong Kong Section

Technical Seminar

Remote near infra red gas spectroscopy using fibre optic systems

by

Prof. Brian Culshaw
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Time : 3:00p.m. - 4:30p.m.
Venue : Room BC402
The Hong Kong Polytechnic University, Hung Hom, Kowloon

ABSTRACT

Numerous environmentally sensitive and/or safety critical gases have characteristic absorption spectra overtones in the near infrared (wavelengths 1-2 micrometers). This wavelength region accesses the substantial technological developments, most notably semiconductor lasers and high performance room temperature low noise solid state detectors, stimulated in the burgeoning fibre communications industry. The absorption lines are relatively weak compared to the mid infrared fundamental (typically by 2 to 3 orders), but the processing capability of the component set and the remote accessibility through fibre links can more than compensate for the reduction in sensitivity.

This talk concentrates on our ongoing research and development in fibre linked gas spectroscopy systems. We report on two principal aspects. The first examines field trials to monitor the generation and seepage of methane gas on landfill. The second considers research activity predominantly addressing accurate measurements of line broadening to derive gas pressure (or in some cases temperature).

The most mature of our field trials comprises a network extending over several kilometres utilising a single laser source to address over fifty remote points, located at strategic positions within the site. The principal measurement requirements involve monitoring gas generation where the methane concentration is typically between 40 and 60% and addressing safety assessment for which the lower explosive range of methane (5 to 15% by volume) is particularly critical. Our system readily detects 1% of the lower explosive limit (500 ppm) within all the sensor cells with a response time of the order of 1 second. The architecture facilitates continuous zero point referencing so that scale factor and zero point drifts can be kept within very tight tolerances. Experience with this fibre optic system over a period exceeding three years has confirmed its attributes. It additionally has provided significant insights to landfill site management.

Many applications require total pressure to correct gas concentrations. If temperature is known, line broadening depends on pressure. We have recently demonstrated this using first derivative tuneable diode laser spectroscopy. This requires extremely careful detection systems to locate the peak absorption wavelength and the positions of the maximum absorption slope as a function of wavelength. Pressure monitoring to few millibar is feasible. These results access a range of difficult gas measurements, in process control, in aerospace and in petrochemical storage and distribution.

ABOUT THE SPEAKER

Brian Culshaw is Professor of Optoelectronics at the University of Strathclyde. In the University he has acted as Head of Department and as Vice Dean of the Engineering Faculty. His research, spanning over 30 years has encompassed microwaves, optics and ultrasonics, both at device and system level, and in the context of applications in communications and sensing, measurement and instrumentation. He has published seven research level textbooks in microwave semi-conductors, fibre optic sensing and measurement and smart structures and in excess of 400 journal and conference contributions including many invited. He has also taken an active part in Professional Society development for including two periods as a Director of SPIE, of which he is currently President Elect and as an Editor of Applied Optics. He is a founder director of OptoSci limited, specialists in high performance fibre optic equipment and of Solus Sensors.. He has also chaired numerous technical conferences in the UK and further afield in the areas of optical fibre sensors and smart structures

His recent research activities have been concentrated in two areas, namely advanced spectroscopic systems for optic fibre measurement and structural interrogation using appropriate combinations of ultrasound, optics and signal processing with particular attention to damage detection protocols using signature recognition. He has also been involved with other structural assessment programmes, applied into topics as diverse as assessing the structural deterioration of high performance marine ropes to observing hydrocarbon fuel leaks from storage tanks and pipelines.

Prior to joining Strathclyde in 1983, he was on the academic staff at University College London and had one year visiting appointments at Cornell (1970) and Stanford (1982) Universities. He also spent three years as a member of Technical Staff at Bell Northern Research Ottawa, Canada. He was educated at UCL with a BSc in Physics and a PhD in Electrical Engineering

ALL ARE WELCOME

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