Sensors 2018

Innovative Chemical Sensing

Conference with Posters and Exhibition

Programme

Organised by Automation and Analytical Management Group
Analytical Division, Royal Society of Chemistry

A one day meeting on
Wednesday 27th June 2018

At The Royal Society of Chemistry,
Burlington House,
Piccadilly, London W1J 0BA

Email: conf.aamg@gmail.com

Sensors 2018
Innovative Chemical Sensing

Conference with Posters

Wednesday 27th June 2018

at The Royal Society of Chemistry, Burlington House,
Piccadilly, London W1J 0BQ

10:00 - 10:30 Registration and coffee

Session 1 Healthcare Applications

Chair: To be Confirmed

10:30 Smart sensing technologies for healthcare and wellness applications
Luigi Occhipinti
University of Cambridge, UK

11:05 E-skin: From robots to humans
Ravinder Dahiya
University of Glasgow, UK

11:40 3rd Generation high-throughput screening platform for nanomaterials
Nicola William
University of Leeds, UK

12:10 Textile based sensors
Carol Crean
University of Surrey, UK

12:40 - 13:40 Lunch and Poster Session

Session 2 Environmental Applications

Chair: To be Confirmed

13:40 Innovations and solutions for gas sensing in the commercial world
James Covington
University of Warwick, UK

14:15 Development of low cost sensors for urban air quality monitoring and long-term emission measurements
Valerio Ferracci
University of Cranfield, UK

14:50 Organic electronics for gas sensors
Suresh Garlapati
University of Manchester, UK

15:20 - 15:40 Tea and Coffee

15:40 Applying machine learning techniques to microwave spectroscopy for the detection of geosmin
Samuel Ryecroft
Liverpool John Moores University, UK

16:10 Droplet microfluidic sensors for in-situ chemical monitoring of natural waters
Adrian Nightingale
University of Southampton, UK

16:40 Concluding Remarks

End of Conference

ABSTRACTS

Smart sensing technologies for healthcare and wellness applications

Edward K.W. Tan[1], Pelumi Oluwasanya[1], Abdul Anzahrani[1], Varindra Kumar[1], Girish Rughoobur[1,2], and ***Luigi G. Occhipinti[1]***

[1.] *Department of Engineering, Electrical Engineering Division, University of Cambridge, Cambridge, CB3 0FA, UK*
[2.] *Microsystems Technology Laboratories, Massachusetts Institute of Technology, MA 02139, USA*

ABSTRACT

Existing techniques for integration of smart sensors and front-end electronics are limited in terms of mechanical compliance and functionality, when required to fit with soft and malleable tissues and organs. The talk will review some of the integration challenges and solutions that enable flexible, wearable and disposable electronics, with applications in smart sensing for healthcare and wellness. We focus on reliable fabrication strategy to transfer high resolution devices on flexible, biocompatible and stretchable substrates for several applications.

Flexible hybrid wearable devices, and implantable organic bio-electronic sensors are presented, which offer unique capabilities for continuous monitoring physiological parameters and small metabolites in situ and are remotely powered for optimal convenience and ultimate comfort. Electrochemical sensors and nano-resistive based sensors are demonstrated for monitoring small metabolites and volatile organic compounds (VOC), showing rapid response, quick recovery, good sensitivity and selectivity to different biomarkers.

The fabrication methods are compatible with high-throughput manufacturing and conventional lithographic techniques for industrial upscaling, and have been proven to work reversibly at room temperatures with good dynamics on conformable substrates, as required for practical applications such as sweat and breath analysis, also in combination with environmental monitoring ideally suited for sport, fitness and wellness applications.

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E-skin: From robots to humans

Ravinder Dahiya

Bendable Electronics and Sensing Technologies (BEST) Group
School of Engineering, University of Glasgow, G12 8QQ, UK

ABSTRACT

Inspired from human skin, the e-skin is being developed to provide tactile feedbacks in robotics and prosthetics. A range of technologies have been developed to meet the robotics and prosthetics requirements, including various types of soft and stiff sensors and soft and flexible electronics. These technological advances have also opened new application for e-skin technology, particularly in the field of health monitoring and wearable systems. For example, in conformal contact with body parts the e-skin, as second skin, could provide excellent non-invasive means to monitor key physiological parameters such as heart rate, blood pressure and respiration rate etc. This talk will focus on such advances in e-skin technology. In particular, the talk will present the stretchable wireless sensors developed to monitor the sweat pH with graphite-polyurethane based sensors and further steps towards multifunctional sweat monitoring system.

3rd generation high-throughput screening platform for nanomaterials

N. William, M. Kuznecovs, J. Owen, F. Bamiduro, S. Key, S Winter, R.D.Bryson, S.J. Milne, N. Hondow, P.A.Beales, N. Kapur, A.Nelson

University of Leeds

ABSTRACT

The worldwide use of nanomaterials is an acquainted topic; existing in medicine, electronic devices, consumer products and various laboratory chemical pathways. The EPSRC's IMPaCT publicised research projects in March 2018 to exploit this, stating that nano products have undergone rapid growth in the UK market encouraging ever more nanomaterials production.

But how do nanomaterials affect organisms; including ourselves? Studying nanomaterial behaviour can prove challenging especially in larger organisms as sometimes accumulation of time presents the potential toxic discourse. Do nanomaterials aggregate around, bypass or modify membranes leading to toxicity or chronic diseases?

Herein I introduce the development of a high-throughput electrochemical bio-membrane screening platform providing real time membrane modifications and disruptions by a nanomaterial. The platform utilises a DOPC layer sensing element incorporated onto a fabricated electrode chip in a flow cell, connected to a potentiostat where current vs potential profiles are monitored using CV. A microfluidics systems allows dispersions/particles through. Validation with a series of characterised compounds show distinct patterns of behaviour dependent on structure and shape. Many of the nanomaterials studied are bioactive with the ability to selectively modify the membrane layer, differentiated by their physiochemical and surface functionalised properties. Thus, the membrane modifications manifest as current-potential changes which is recorded electroanalytically. The data acquired may challenge our knowledge of the bioactive mechanisms of nanomaterials.

This platform is currently being developed into a multi-modular selective targeting system mimicking tissues and organs all integrated using a microfluidic network which is the heart of a new H2020 funded project HISENTS.

Textile-Based Sensors

Rachel Smith, Mona Sweilam, John Varcoe and ***Carol Crean***

Department of Chemistry,
University of Surrey, Guildford, Surrey GU2 7XH, UK.

Email: c.crean@surrey.ac.uk

ABSTRACT

Wearable electronics have widespread applicability from personal electronics to healthcare applications. In the UK 34 % of children suffer from skin diseases like eczema and psoriasis at some point. Wound care is also a significant burden to the UK healthcare system partly due to inappropriate diagnosis. Technologies that can monitor the pH of wounds and skin in real-time, can indicate healing and the physiological condition of the skin. Fibre-shaped electrodes are a versatile design for wearable applications since they can easily conform to the skin. Guinovart *et al.* converted cotton threads into ion-sensing electrodes, however these sensors require lengthy conditioning protocols before use, limiting their suitability as wearable sensors.

Using carbon nanotubes, conducting polymers and ion-sensing films we have produced flexible fibre electrodes, which do not require conditioning, and evaluated their electrochemical performance in terms of sensing. Skin pH measurements were targeted in addition to measuring the anti-psychotic drug lithium. As a drug, lithium, has a narrow effective therapeutic range (0.4-1.0 mmol/l), therefore blood samples must be analysed to confirm that lithium serum levels are both safe and effective. Wearable sensors could eliminate blood sampling by analysing lithium drug levels under the skin, among other analytes; thereby facilitating point of care analysis for patients. An excellent Nernstian response was generated by these wearable sensors, over a wide pH range (2.0 – 12.0) and the clinically relevant lithium range, with little response observed for physiologically relevant interferents. A study including reverse iontophoresis to access lithium from under the skin is in progress.

Innovations and solutions for gas sensing in the commercial world

Prof James A. Covington
School of Engineering, University of Warwick

ABSTRACT

The area of gas and chemical sensor research is in continual development, with new materials and device operations being proposed on a daily basis. Even with the huge government and institution investment in these developments, the actual number of sensors that have made the leap from academia to high volume commercial reality remains surprisingly small. The reasons behind this are numerous, but are often due to the conservative nature of the field and tight regulatory requirements.

This talk will specifically focus on the design and development of low-cost/high volume products for the mass-market gas sensor field. Covering applications as diverse as safety, environmental monitoring and automotive. The presentation will initial focus on the potential markets and market opportunities for high volume/low cost sensors. Where are sensors being sold now and where there is still scope for researchers to make a difference.

Of the current offering in sensing materials and devices, much of the innovation is now in metal-oxide gas sensing materials. Though at the research level, significant effort has been put into the development of carbon based nano-materials, at the industrial level, these are yet to achieve significant market penetration. However, metal-oxide materials fulfil many of the modern market needs – they have small form factor, cheap to construct, reliable and can be easily integrated into modern electronics. However, their high-power consumption and humidity dependence, cross sensitivity and poor selectivity still could limit their further widespread use.

The development at low power industrial MEMS micro-hot plate platforms has solved many of the power issues. An example of the commercial development of SOI CMOS MEMS gas sensors will be presented. These devices, originally developed at Warwick University, have some of the lowest power consumption of any sensors available today. With advanced operational modes, the power consumption of these sensors is now approaching 1mW and are now sold in high volume. Due to their CMOS compatible platforms, SOI MEMS and similar sensors have now fully integrated electronics, with simple read out and incredible small foot prints – and even now being integrated with a number of other environmental measurements.

However, as stated above, metal-oxides have other more challenging issues that still plague these integrated devices. Further work with industry is now trying to solve these problems with the use of, for example, innovative sensing materials, particularly based on p-type metal-oxides. Work with Warwick University and our industrial collaborators have developed a range of products, particularly for harsh environments where normal sensor solutions fail and also in the detection and monitoring of VOCs (volatile organic compounds) for environmental monitoring needs, where existing products have a high cost point.

Finally, we touch on the latest development in industrial gas sensors and give examples of projects being worked on today. Particularly in developing sensors that provide multiple gas parameters at the same time.

Development of low cost sensors for urban air quality monitoring and long-term emission measurements in remote regions

Valerio Ferracci,[1] Conor Bolas,[2] Iq Mead,[1] Shahrul Nadzir,[3,4] Talib Latif,[3,4] Azizian Abu Samah,[4] Andrew D. Robinson,[2] and Neil R. P. Harris[1]

[1] *School of Water, Energy and Environment, Cranfield University, Cranfield, UK*
[2] *Centre for Atmospheric Science, Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge, UK*
[3] *School of Environmental and Natural Resource Sciences, Universiti Kebangsaan Malaysia, Bangi, Malaysia*
[4] *School of Environmental and Natural Resource Sciences, Universiti Kebangsaan Malaysia, Bangi, Malaysia*
[5] *Institute Of Ocean and Earth Sciences, University Malaya, Kuala Lumpur, Malaysia*

ABSTRACT

The development of relatively low-cost sensors in recent years has had a remarkable impact on the study of atmospheric composition, allowing unprecedented temporal and spatial resolution in the monitoring of key atmospheric species. This talk will focus on the application of these novel sensors to two different environments: urban areas and remote regions.

In urban environments low-cost sensors monitoring key air quality species (CO, CO_2, NO, NO_2, O_3, SO_2, particulate matter, *etc*.) have the potential to expand the existing (relatively) sparse monitoring networks in many cities to offer a fine-scale picture of emissions and transport of pollutants. These sensors have been deployed in a number of studies primarily in Europe and North America, whilst studies in South-East Asia are limited, even though pollution problems are generally more severe. In this talk, a field study in Kuala Lumpur (an established megacity) and in the surrounding Klang Valley area is presented, focusing on sensor network design and presenting the initial outcomes of the deployment.

In remote forested regions (*e.g.*, tropical rain forests), biogenic volatile organic compounds (BVOCs) dominate the local gaseous chemistry. One species in particular, isoprene (C_5H_8), is of great interest to the wider scientific community. Currently one of the largest biogenic emissions on the planet (~ 500 TgC year^{-1}), isoprene emissions are expected to be profoundly influenced by global change (increasing temperatures, enhanced CO_2 and land use change) over the next decades. This work focuses on the development of a novel instrument for the detection of isoprene: the iDirac is a portable, low-cost and low-power gas chromatograph with photo-ionisation detector (GC-PID) designed for long-term measurements in remote and challenging environments such as tropical forests. The advantages of the iDirac over conventional BVOC monitoring techniques are discussed, and the results from its deployment in the forests of Malaysian Borneo and in a palm oil plantation in peninsular Malaysia are presented. The preliminary results of an ongoing field campaign in an oak-dominated forest in Oxfordshire in which isoprene is measured at several heights below, within and above the canopy to better characterise the land-atmosphere exchange of isoprene, are also discussed. Lastly, we introduce further work aimed at extending the iDirac's measurement capability to isoprene oxidation products and other BVOCs of interest (*e.g.*, dimethyl sulphide, DMS, and ethylene, C_2H_4).

Organic electronics for gas sensors

S. K. Garlapati*[1,2]*, S. Faraji[1,2], D. J. Tate[1], M. L. Turner[1], K. C. Persaud[2]

[1.] OMIC, School of Chemistry, University of Manchester, M13 9PL, UK
[2.] School of Chemical Engineering and Analytical Sciences,
University of Manchester, M13 9PL, UK
E-mail: suresh.garlapati@manchester.ac.uk

ABSTRACT

Organic semiconductors based field-effect transistors (OFETs) are the essential components of organic electronics. OFETs have been of significant interest from last few decades both in academia and industries due to their attractive features such as light weight, mechanical flexibility, ease of fabrication using solution processes/printing techniques over large areas, low cost, compatible with different substrates, etc. Furthermore, OFETs can be used in different applications such as radio frequency identification tags, displays, sensors, etc. OFETs are very interesting for sensor applications due to reversible interaction between organic semiconductors and different analyte molecules or gases.

Herein, we report solution processed OFETs, which can detect different volatile organic compounds such as alcohols, ketones, esters and also ammonia gas. The OFETs have been prepared on flexible polyethylene naphthalate (PEN) substrates at low temperatures (≤ 110 °C). An organic polymer semiconductor has been used as active channel material and to reduce the operating voltages of OFETs, a high-k/low-k polymer stack has been used as gate dielectric. The unencapsulated OFETs are stable in ambient conditions and exhibit field-effect mobility of ≈ 1 $cm^2V^{-1}s^{-1}$ with on/off ratio of ≈ 10^3 and operate at low voltages (≤ 3 V). OFETs have shown response to ppm level concentrations of alcohols, ketones and esters. In case of ammonia, the sensitivity level has been very high (≈ 500 ppb). Therefore, these low voltages operated solution processed OFETs have the potential to be used in different applications such as food wastage, environmental monitoring, breath analysis, etc.

Keywords: Organic field-effect transistors, sensors, alcohols, ketones, esters, ammonia

Applying Machine Learning Techniques to Microwave Spectroscopy for the Detection of Geosmin

***Samuel Peter Ryecroft*[1],** Andy Shaw[1], Paul Fergus[1], Patryk Kot[1],
Montserrat Ortoneda Pedrola[1] Adam Moody[2], Laura Conroy[2]

1 Built Environment and Sustainable Technologies (BEST) Research Institute, Liverpool John Moores, Liverpool, L3 2ET
2 United Utilities, Warrington, WA5 3LP, United Kingdom

ABSTRACT

Geosmin is a naturally occurring volatile organic compound and is one the leading causes of complaints for water companies regarding a strange smell and taste of water. Geosmin tantes water with an earthy smell and can be detected by humans at levels as low as 10 nanograms per liter. While water providers are able to remove Geosmin there are currently no real time method of monitoring Geosmin within water catchment areas, instead samples are collected from sites and transported to a centralised testing lab.

Microwave spectroscopy has been applied to create sensors capable of detecting substances such as Nitrates and Glyphosate levels in water. Current detection methods for Geosmin such as Gas Chromatography - Mass Spectrometry require costly equipment, and samples to be collected. Microwave spectroscopy offers a low cost alternative sensing technology that does not require regents and can be deployed unattended. Preliminary experiments were carried out using resonant cavities in the frequency range of 1GHz through to 13GHz both magnitude and phase data were collected for Geosmin concentrations of 1 mg/L, to 0.5 mg/L, 10 ng/L and 5 ng/L in distilled water and a methanol solvent.

The preliminary work applied Information gain and wrapper feature selection techniques to identify frequencies that could be applied to the detection of Geosmin. Preliminary results show strong clustering of the classes at frequencies identified through feature selection approaches, based on the preliminary work a more sensitive sensor can be developed at the identified frequencies.

Droplet microfluidic sensors for *in situ* chemical monitoring of natural waters

Adrian M. Nightingale[1] Gareth W.H. Evans[1] James Zhu[2] Kyriacos Makris[2] Brett Warren[2] Sammer-Ul Hassan[1,2] and Xize Niu[1,2]

1 Faculty of Engineering and the Environment, University of Southampton, UK
2 SouthWestSensor Ltd, Southampton, UK

ABSTRACT

The chemistry of rivers lakes and oceans (natural waters) needs to be accurately monitored so as to detect, characterise, and address problems such as ocean acidification, nutrient enrichment from fertiliser run-off, and other forms of pollution. This has traditionally been achieved by manual or automated spot sampling and subsequent laboratory analysis, however this labour-intensive approach is logistically and economically challenging. Hence there has been a drive to develop sensors that can continuously and autonomously measure water chemistry *in situ*.

Microfluidic-based sensors take laboratory analytical protocols and miniaturise them into autonomous field-deployable units that can sample the environment, chemically treat the sample (e.g. by adding an analyte-specific reagent), then optically quantify, and record the result.[1,2] They offer high sensitivities, excellent long-term stabilities, and can be used to measure a huge range of analytes,[3] however issues with sensor size, expense, power requirement, and reagent usage means that they can be impractical.

To address this, here I will describe a prototype sensor for monitoring water chemistry based on droplet microfluidics. In droplet flow, aqueous samples are carried as discrete droplets within a stream of oil, which gives reduced carry-over between samples and allows water analysis that is much quicker, efficient and cost-effective than the existing state-of-the-art. To our knowledge this is the first field-deployable droplet microfluidic system. I will explain the sensor platform, the underlying principles, and describe its practical application to measure nitrate in a tidal river (River Itchen, Southampton), accurately detailing the variation in levels with the changing tidal cycle.

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POSTER ABSTRACTS

The optimization of a lateral flow immunoassay for detection of aflatoxin B_1 in potable water samples

Xiaoxiang Yan, Krishna C. Persaud and Gyorgy Szekely

School of Chemical Engineering and Analytical Science,
The University of Manchester, M13 9PL, UK

POSTER ABSTRACT

Aflatoxin B_1 is a secondary metabolite produced by fungus of genus Aspergillus. It has been widely found in food, crops and animal feeds which are not properly stored. Aflatoxin B_1 is highly carcinogenic even if its concentration is at ppb levels. AFB_1 contamination in food, crops and animal feeds has raised much concern during recent years. Many methodologies for AFB_1 determination in these commodities have been developed. However, little attention was paid to potable water which is the focus of this project. In fact, potable water can be a potential source of AFB_1 contamination because of the detected existence of Aspergillus in the water. The aim was to build develop a fast and reliable methodology for AFB_1 determination in potable water.

Lateral flow immunoassay (LFIA) is a very popular bioassay format that receives various applications in the food contaminants determination, environmental monitoring as well as clinical diagnosis. Compared to conventional detection methodologies such as high-performance liquid chromatography and enzyme-linked immunoassays, the lateral flow test offers an inexpensive and relatively rapid assay format. It can be used by people without professional training, which makes it popular in areas where no sophisticated laboratory equipment is available. As a result, LFIA was selected as the target method for AFB1 determination in this project.

To achieve this, research was carried out to optimise the construction of the LFIA to achieve sensitivity, reproducibility and good shelf life. The research mainly contains following steps: labelling primary antibody with gold nanoparticles, fabricating lateral flow strip, optimization of sensor parameters, measurements of potable water samples, result verification and evaluation of sensor stability. Final results indicated that the amount of antibody during conjugation has the most significant influence on assay sensitivity and signal intensity. It was found that magnesium and calcium ions in potable water interfered with the assay, and addition of 0.1% ethylene diamine tetra-acetic acid (EDTA) showed excellent performance in reducing these negative effects caused by magnesium and calcium on lateral low immunoassay. The device reached 0.5ppb of visual detection limit for most of the water samples tested and it maintained satisfactory sensing performance for three months when stored in refrigerator.

Co_2 Production as Early Indicator of Pest and Fungal Infestation: Effective Tool for Post-Harvest Decision Support System in Stored Cereals

Esther Garcia-Cela, Elisavet Kiaitsi, Angel Medina, ***Fernando Rubio-Lopez,*** Naresh Magan

Applied Mycology Group, Environment and AgriFood Theme, Cranfield University, Cranfield, Beds. MK43 AL5, U.K.

m.e.garcia-cela@cranfield.ac.uk

POSTER ABSTRACT

At present, temperature (T) and sometimes relative humidity (RH) sensors are used in stored grain silos to monitor quality and detect changes that may be related to initiation of mould growth or pest infestation. However, because grain is a good insulator, changes in temperature occur slowly. Most stored commodities respire naturally and produce CO_2 which permeates the intergranular air spaces significantly more rapidly than changes in T in a grain bulk.

The aim of this study was evaluate the increase of T and CO_2 of naturally stored grain in different environmental conditions. Approx. 1.5 kg of wheat grain were conditioned to different moisture contents and placed in 5L thermos flasks and stored at different temperatures (15 and 20^{o}C) for up to 30 days. Temperature and CO_2 were monitored in real time with integrated sensors every 30 min. In wet grain (30% m.c.) the CO_2 increased rapidly within 2 days storage at 20°C. A similar pattern was followed during storage at 15°C with the CO_2 increasing after 7-8 days. In both cases the T showed a much later increase or no increase at all. Additionally, we monitored the RH, T, and CO_2 production in two pilot scale silos of 2 tonnes of wheat for 10 months in real time every 30 min. This established a baseline for CO_2 production under safe storage conditions at 14.5% m.c. Subsequently, a wet pocket of grain was introduced by adding water into a section of the pilot silo. This again showed an earlier increase in CO_2 in the localized area, prior to changes in T. This suggests that better management of stored commodities may be possible by real time monitoring of CO_2 to facilitate rapid remedial options to be made to avoid spoilage.

Identification of Volatile Organic Compounds (VOCs) during potato storage for the development of a real-time "interactive storage" quality control system

Rubio-Lopez, F., Gutierrez-Pozo, M., Terry, L.A., Medina, A., Kourmpetli, S.

School of Water, Energy and Environment, Vincent Building, Cranfield University, Cranfield, Bedfordshire MK43 0AL, UK

POSTER ABSTRACT

Potato is one of the most consumed staple crops and has a high economic and social value worldwide. Due to the seasonal production, tubers are stored for up to one year at temperatures below 10°C in order to preserve their quality and guarantee a continuous supply to the markets. Two are the main physiological problems that occur during this storage: The end of tuber dormancy that leads to the development of sprouts and the production of reducing sugars due to the low storage temperatures. Sprouts reduce the nutritional value of the potato and increase the levels of solanine, a toxic compound. Increased levels of reducing sugars are undesirable not only because they are associated with increased levels of asparagine, a potential carcinogen, but also because they lead to the development of undesirable brown colour during frying.

The aim of this study is to identify VOCs associated with the above-mentioned physiological processes and use them as biomarkers for the monitoring of potato quality during storage. A Thermal Desorption Gas Chromatography Time of flight Mass Spectrometry method was developed after evaluating 5 different absorbents. Volatiles emitted by four potato varieties stored at 4.5 and 8.5°C were sampled and analysed every 15 days throughout storage life. VOC data were corelated with reduced sugars content of the sampled potatoes and sprouting observations in order to identify possible biomarkers. These will be used for the development of a laser-based interactive sensor system that warehouse managers could use as a decision support tool to reduce waste and therefore economical losses.

Feasibility studies for the Development of a Portable Device to Measure Hydrocarbon Concentrations in Oil Spillage Soil *in situ*

Perpetual E. Idehen, Krishna C. Persaud

School of Chemical Engineering and Analytical Science,
The University of Manchester, M13 9PL, UK

POSTER ABSTRACT

Oil spill is the most environmental threats created by petrochemical industry. Environmental laws require oil companies to keep oil spill total hydrocarbons concentration below 50 mg/kg soil. Most soil analyses for spillage use gas chromatographic methods, but, this is time-consuming, requires high energy consumption and not suitable *in-situ*. Here we aim to develop a cost-effective simple device for hydrocarbon *in-situ* detection in soils using electronic nose concept. Soils from oil spillage sites were studied to determine the types and hydrocarbon concentration levels. Soil samples were collected at different depths and were used to establish standard protocols for an optimal Soxhlet extraction of the hydrocarbons with 80% recoveries. Unknown hydrocarbons samples were analysed using gas chromatography-flame ionisation detector (GC-FID) and classified using Kovats retention index. Results from a 2 months old spill site show concentrations of 62,457 mg/kg (0-20 cm), 19,935 mg/kg (20-40 cm) and 2,766 mg/kg (40-60 cm) while for a 2 years old spill site concentrations of 6750 mg/kg (0-20 cm), 15125 mg/kg (20-40 cm) and 8125 mg/kg (40-60 cm). The results shows concentration of hydrocarbons in the samples exceeds the legal limit.

Sensors (Chemiresistors) using carbon black and poly(methyl methacrylate) materials were prepared and dispersed on interdigitated electrodes. Herein both carbon black and PMMA concentrations play a huge role in determining the responses of the sensors to hydrocarbons. For example, 20% w/w of carbon black yielded non-conducting films while 30% w/w resulted in very high conducting films. The sensors showed responses to a range of hydrocarbons with varying sensitivities dependent on molecular weight and vapour pressure. The developed sensor is responsive to hexadecane. Further optimization is underway to detect lower limits (50 mg/kg soil) of hydrocarbons.

***Index Terms* — oil spill, petroleum hydrocarbons, chemiresistor, soil contamination**

Acknowledgements: Sponsor - Faculty for the future (Schlumberger Foundation)

Ammonia Gas Sensors based on Organic Polymer Semiconductors for Printed Electronics Applications

***P. Mougkogiannis*[1]**, S. Garlapati[2], S. Faraji[2], M. Turner[2], K. Persaud[1]

[1]School of Chemical Engineering and Analytical Science, University of Manchester
[2]School of Chemistry, University of Manchester, Manchester, M13 9PL, UK

POSTER ABSTRACT

Field effect transistors manufactured using printable electronics have demonstrated promising applications offering simplicity and sensitivity at room temperature operation. Detection of low concentrations of ammonia in the presence and absence of humidity is important in environmental applications and in the health care sector (e.g. clinical diagnostics). Here, we report the electrical and morphological characterisation of a solution processed OFET for ammonia gas detection. We have investigated electrical and surface characteristics of thin film transistors based on the extraction of transfer and output characteristics as well as multi-parameter experimental determination from charge carrier mobility, threshold voltage, I_{ON}/I_{OFF}, sub-threshold swing, trap charge carrier's density, and by studying the surface morphology of the deposited thin films with the atomic force microscope (AFM). Herein, we report that the value of the threshold voltage is -0.7 V, the ratio between the highest and lowest drain current is 2000, also the charge carrier mobility estimated from the saturated region ranges between 0.5 -1 cm^2/Vs and finally the subthreshold swing extracted from the transfer curve is 500 mV/decade. We tested the sensor against 5-100 ppm of ammonia. We have found also that with increasing humidity the sensitivity of the sensor increases dramatically due to the complex of ammonia with water. Finally, we evaluated the mean square roughness parameter of the surface morphology (RMS = 0.7 nm).

ACKNOWLEDGEMENT

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Volatile fingerprinting of potato rots during cold storage

Gutiérrez-Pozo, M., Rubio-López, F., Terry, L., Kourmpetli, S. & Medina, A.

School of Water, Energy and Environment, Vincent Building (52a), Cranfield University, Cranfield, Bedford MK43 0AL, U.K.

POSTER ABSTRACT

Potato is one of the main food crops in the world after rice, maize and wheat. Half of it is sold as a fresh product for immediate use, while the rest is stored at cold temperatures (4-10$_{o}$C) for up to 10 months. Storage is a dynamic situation where all environmental factors, mainly temperature (4-10$_{o}$C) and relative humidity (95-98%), need to be optimised. Otherwise, an optimal environment for fungal and bacterial growth can be created. Potato storage diseases have a significant impact on the potato market increasing potato spoilage and consequently, the generation of waste.

The aim of this work is the identification of potato rots VOCs (Volatile Organic Compounds) biomarkers as a quick, non-destructive and real time detection of potato storage diseases. The work focused on the three main diseases affecting potato tubers in the last year; soft rot (*Pectobacterium carotovorum*), gangrene (*Boeremia foveata*) and dry rot (*Fusarium solani coeruleum)*. Potato tubers were inoculated with those pathogens and stored under different temperatures (10-25$_{o}$C). VOCs were sampled using a pre-concentration method, thermal desorption tubes that were analysed on a Thermal Desorption-Gas Chromatography-Time of flight-Mass Spectrometry equipment. A screening of the results were carried out for the identification of possible biomarkers of each of the pathogens studied.

The results will be used for the development of a prototype of an interactive storage system. It will be a low-cost, compact and sensitive multi-species trace gas that monitors emitted gases from fresh agro products under commercial storage conditions.

Development of a microfluidic flow system for toxicity screening of nanomaterials

***Joshua Owen*[1],** Nicola William[2], Andrew Nelson[2], Nikil Kapur[1]

[1] *Institute of Thermofluids, School of Mechanical Engineering, University of Leeds, Leeds, LS2 9JT, United Kingdom*
[2] *School of Chemistry, University of Leeds, Leeds, LS2 9JT, United Kingdom*

POSTER ABSTRACT

Effective and reliable screening techniques for nanosafety assessment are essential to identify nanomaterial hazards. Existing toxicity screening methods require a high level of user skill, limiting their wider potential use. To improve nanosafety assessment procedures, a novel microfluidic screening device has been designed that enables nanomaterial hazards to be identified rapidly with minimal user knowledge using an electrochemical measurement on a lipid coated electrode. The main features of the design include fluid reservoirs to store buffer, lipid and nanomaterial samples; a microfluidic flow cell containing a sensor element on a fabricated electrode for electrochemical analysis and pumps used to control the flow of fluid. Automation of the pumps enabled accurate repeatability of the screening process through precise control of the fluid flow rates and significantly reduced the required skill level of the operator, with the system requiring minimal input on a user-friendly visual control interface to operate. To demonstrate the performance of the system, various nanomaterial samples were screened using the device. Samples were injected into the flow cell to assess their interaction with the lipid coated electrode through analysis of a cyclic voltammetry response, showing good agreement with results obtained using existing test methodologies.

Microfluidic Lab-on-Chip Analysers for the determination of nitrate and phosphate in aquatic systems

Antony Birchill, Alex Beaton, Robin Pascal, Alison Schaap,
Geraldine Clinton-Bailey, Matthew Mowlem

Ocean Technology and Engineering, National Oceanography Centre,
Southampton,UK

POSTER ABSTRACT

In order to understand and quantify the processes leading to oligotrophy and eutrophy, environmental chemists routinely determine the concentration of nitrite + nitrate (hereafter NO_3^-) and soluble reactive phosphorus (hereafter PO_4^{3-}) in aquatic systems. Traditionally, NO_3^- and PO_4^{3-} concentrations are measured by manually sampling; water is collected at known times and depths and then preserved for laboratory analysis either on board ship or on land. This approach is both labour intensive and requires reliable sample preservation. The Ocean Technology and Engineering research group (National Oceanography Centre, Southampton), have developed NO_3^- and PO_4^{3-} Lab-on-Chip microfluidic analysers that can be deployed in the aquatic environment and sample autonomously for months at a time. The NO_3^- and PO_4^{3-} Lab-on-Chip analysers have limits of detection of 0.025 µM and 0.040 µM respectively, meaning these sensors can be utilised in oligotrophic environments. In addition, they have be mounted on remote vehicles and moorings for deployment in remote environments. These LoC analysers represent a step forward in our ability to monitor aquatic environments and are already being used to elucidate processes affecting nutrient distributions in riverine, estuarine, glacial and marine environments.

Testing the Performance of Low-Cost Ozone Sensors

***A. Ripoll*[1],** M. Viana[1], M. Padrosa[1], X. Querol[1], K.M. Hou[2], J.M. Barcelo-Ordinas, and J. Garcia-Vidal[3]

[1]Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Barcelona, 08034, Spain
[2]LIMOS Laboratory, Centre National de la Recherche Scientifique, Clermont-Ferrand, 6158, France
[3]Department of Computer Architecture, Universitat Politecnica de Catalunya (UPC), Barcelona, 08034, Spain

POSTER ABSTRACT

This work aims to test the performance under field conditions of two custom-made types of ozone sensing devices, Captor (metal-oxide) and Raptor (electrochemical) sensors. To this end, 33 Captor and 11 Raptor nodes were inter-compared with ozone reference instrumentation under characteristic summer atmospheric conditions in Spain and Italy. 8 of the Captors and 4 of the Raptors were collocated during the entire monitoring period (May to October 2017), the rest of the nodes (25 Captors and 7 Raptors) were collocated during intensive 2-week campaign before and after the summer period (between May-July, and in September-October).

The individual sensor datasets were calibrated applying multi-linear regression (MLR) analysis, which resulted in mean R^2 between calibrated sensor and reference data of 0.88 and 0.89 for Captor and Raptor nodes, respectively. These results were irrespective of the sample size, given that similar results were obtained for the nodes which were collocated for 5 months and those collocated for 1 month. However, the metal-oxide sensors seemed to have an upper concentration limit (approximately 170 $\mu g/m^3$) which was not the case for the electrochemical sensors. As a result, it was concluded that non-linear regression models might be better suited to calibrate metal-oxide sensors than linear ones, which provide better results for electrochemical sensors.