Sensors 2016

Wearable Smart Sensors and Technologies

Conference with Posters and Exhibition

Programme

Organised by the Automation and Analytical Management Group
Royal Society of Chemistry

A one day meeting on
Tuesday 21st June 2016

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

Email: conference@aamg-rsc.org
Website: http://www.aamg-rsc.org

Wearable Smart Sensors and Technologies

Conference with Posters and Exhibition

Tuesday 21st June 2016
at The Royal Society of Chemistry, Burlington House,
Piccadilly, London W1J 0BQ

09:00 - 09:30 Registration and coffee

Session 1 Technologies and Applications
Chair: To be Confirmed

09:30 Novel Wearable Sensor Technologies - An Overview
Daniel Roggen
Sussex University, UK

10:00 Photonic Textiles for Healthcare
Stephen Morgan
University of Nottingham, UK

10:30 Exhibitors Presentations
Hamamatsu Photonics UK Ltd
NanoFlex Ltd

11:00 - 11:20 Tea and Coffee

11:20 Soft and Stretchable Electronics for Unobtrusive Wearable and Implantable Sensor Systems
Niko Münzenrieder
University of Sussex, UK

11:40 Electric Potential Sensors:
Novel Biosensors for Cardio-Electrophysiology in Embryos
Elizabeth Rendon-Morales
University of Sussex, UK

12:00 Human Skin Volatile Profiling for Point-of-Care Applications
Emer Duffy
Dublin City University, UK

12:20 Application of Tetrapolar Microelectrode Impedance Sensors for the Detection of Dementia Biomarkers
Desiree Acha
Middlesex University, UK

12:40 - 13:30 Lunch - Exhibition & Poster Session

Session 2 Applications

Chair: To be Confirmed

13:30 Wearable Smart Sensors for Management of Parkinson's Disease using Evolutionary Algorithms
Michael Lones
Heriot-Watt University, UK

14:00 Infection Reporting Wound Dressings and Urinary Catheter
Toby Jenkins
University of Bath, UK

14:30 Smart Body Interface Sensor Systems for Prosthetics
Liudi Jiang
Southampton University, UK

15:00 Wearable Biomonitoring Systems
Ahmad Al-Shamma'a
Liverpool John Moores University, UK

15:30 - 15:50 Tea / Coffee

15:50 A Portable Biosensor System for Real-Time Monitoring of Transplant Kidneys between Donor and Recipient Sites
Sally Gowers
Imperial College London, UK

16:10 Smart Tattoo for Monitoring Skin Hydration Using AC Impedance
Aoife Morrin
Dublin City University, UK

16:30 Concluding Remarks and End of Conference

ABSTRACTS

Novel Wearable Sensor Technologies – An Overview

Daniel Roggen

Wearable Technologies, Sensor Technology Research Centre
University of Sussex
daniel.roggen@ieee.org

ABSTRACT

Wearable devices are becoming extremely popular and represent a lucrative new market, with smart watches now sold in tens of millions units a year.

However, what is it that makes "wearable" devices so interesting in research and in the commercial domain? Obviously wearable devices comprise sensors. The close proximity to the body often allows to capture higher quality signals compared to other modalities. By taking advantages of advances in microelectronics wearables can be highly miniaturised - and often integrated within fashionable accessories or even into textile or skin electronics. This enables sensing continuously over long periods of time in a highly unobtrusive manner. This has advantages in many scenarios, such as long-term monitoring of physiological parameters. This can benefit people who suffer from chronic conditions by providing a much more precise and continuous estimation of the user's state that can be used, for instance, to adapt treatment plans.

In reality, wearable’s are more than just sensors: they comprise powerful signal processing and machine learning algorithms to make sense of the sensor readings. Indeed wearable sensors are often used to capture body movement information thanks to miniature accelerometers or orientation sensors. This has been used in biomechanics to measure, for instance, gait parameters. However thanks to advances in low-power machine learning it is now possible to recognise some specific human activities and gestures. While commercial devices are often limited to fitness-related activities, we are able to show in the lab the recognition of much more complex and subtle human activities. This opens the way to new ways to assess skills, perform training, improve safety of workers or automate tasks through implicit interactions. This 'computational behaviour analytics' has also strong potential in the health domain where often change of behaviour indicates the evolution of a condition such as in Parkinson's or in some mental health conditions.

Wearable’s also include communication and feedback capabilities which allow them for form a closed-loop system with the user. By interpreting the signals sensed from the user they can provide tailored information or advice. In other words, a wearable device goes beyond sensing and becomes a smart personal assistant.

We will dig into the unique characteristics of wearable’s based on our ongoing research at the University of Sussex at the crossroads of sensors, electronics, signal processing and human activity recognition. Starting with a timeline of wearable devices we will highlight some of the driving technological enablers. We will showcase our research activities in wearable technologies with examples from the fields of healthcare or industrial assistance to highlight what is possible nowadays in the lab and doesn't exist yet in commercial devices.

Photonic Textiles for Healthcare

Stephen Morgan
Faculty of Engineering, The University of Nottingham
Nottingham NG7 2RD

ABSTRACT

Optical fibres are useful platforms for sensing a range of parameters in healthcare. Due to their small size, light weight and flexibility, they can be used to monitor during everyday life. An example involves integration of optical fibres into textiles in order to monitor physiological parameters such as blood flow, oxygen saturation and heart rate.

Socks have been developed that can monitor pressure and blood flow under the foot in people with diabetes. The aim is to be able to predict when the tissue under the foot is going to break down in order to prevent diabetic foot ulcers. The socks also contain an electrically conducting yarn which can measure pressure. Results will demonstrate blood flow changes and pressure under the foot during walking. Other potential applications such as sensing in wound dressings will also be discussed.

Soft and Stretchable Electronics for Unobtrusive Wearable and Implantable Sensor Systems

Niko Münzenrieder

Sensor Technology Research Centre,
University of Sussex,
Brighton BN1 9QT
United Kingdom

ABSTRACT

The next step to improve the user benefit of wearable devices is the integration of electronic functionality into everyday objects such as textiles, the attachment of electronics to the human body, and the fabrication smart implantable devices e.g. for medical applications. Since human skin, like most of the objects in our daily life, is not static but bendable, foldable and stretchable, the integration of rigid silicon chips is not feasible.

One possibility to fabricate imperceptible devices, compatible with the mechanical and electrical requirements of the envisioned wearables, is the combination of thin-film technology, novel oxide materials, and flexible substrates. Here, it is shown how sensors for different modalities such as temperature, humidity, or strain, and corresponding In-Ga-Zn-O thin-film transistors (TFTs) can be fabricated on polymeric substrates. These TFTs are manufactured using a maximum process temperature of 150°C, exhibit mobility >10 $cm^2V^{-1}s^{-1}$, and can be used to build different conditioning circuits. The integration of sensors and readout circuity on one substrate then leads to flexible sensor systems with tuneable mechanical properties:

For instance, transparent devices fabricated on a 1 µm thin parylene membrane are operational while wrapped around a human hair, and are used to realize a smart contact lens for glaucoma monitoring. Simultaneously, if fabricated using a wavy surface layout the devices mimic the behaviour of human skin, can be stretched by >200% and therefore be used for soft prostheses and electronic robotic skins. Finally, devices on multi-layer substrates enable the realization mechanically active electronics for biomimetic cuff implants.

Electric Potential Sensors: Novel Biosensors for Cardio-Electrophysiology in Embryos

E. Rendon-Morales[1], R.J. Prance[1], H. Prance[1], and R. Aviles-Espinosa[2]

[1]Sensor Technology Research Centre,
School of Engineering and Informatics,
University of Sussex, UK.
[2]The Institute of Photonic Sciences, Mediterranean Technology Park,
Av. Canal Olimpic s/n, Spain.
er241@sussex.ac.uk

ABSTRACT

Currently, there is no effective sensing technology available to monitor the electrocardiogram(ECG) activity of the living zebrafish heart during early developmental stages. Most of the methods are based either on the use of simple visual inspections which are limited to quantifying the heart-rate or invasive methodologies which require the insertion of electrodes or heart explantation techniques, both requiring the use of expensive differential amplifiers and noise isolated environments.

In this paper we report the continuous detection of the cardiac electrical activity in embryonic zebrafish using a non-invasive approach. We present a portable and cost-effective platform based on the Sussex patented Electric Potential Sensing(EPS) technology, to monitor *in vivo* electrocardiogram activity from the zebrafish heart. This proof of principle demonstration shows how electrocardiogram measurements from embryonic zebrafish may become accessible by using the electric field detection method. Fig.1 (right panel) shows the representation of the experimental platform and the Petri-dish chamber containing the central EPS sensor using a metallic Titanium dioxide (TiO2) based central electrode. We present preliminary results using the experimental prototype, which enables the acquisition of cardio-electrophysiological signals from *in vivo* 3, 4 and 5 days-post-fertilization(dpf) zebrafish embryos. An example of the recorded cardiac activity using a 5 dpf zebrafish embryo is shown in Fig.1 (left panel). The recorded waveforms were averaged aiming to show detailed features contained in typical ECG traces such as QRS complex, P and T waves. We believe that these results make accessible a different class of biometric measurement from embryonic living biological organisms non-invasively.

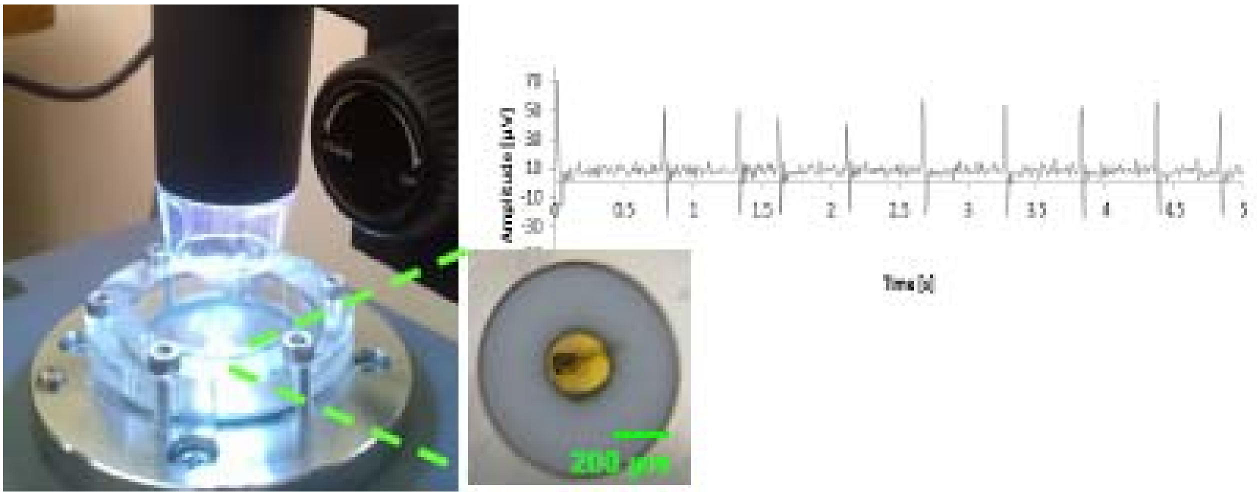


Fig. 1: Right panel: the experimental sensing platform based on Electric Potential Sensor technology. Left panel: an example of the recorded cardiac activity using a 5 dpf zebrafish embryo

Human Skin Volatile Profiling for Point-of-Care Applications

Emer Duffy*[1]*, Matthew R. Jacobs[1], Brian Kirby[2], Aoife Morrin[1]

[1] National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin 9, Ireland
[2] St. Vincent's University Hospital, Merrion Road, Dublin 4, Ireland

ABSTRACT

The human body emits hundreds of volatile compounds that can provide a valuable insight into the underlying biochemical processes of an individual. Skin volatile emissions are derived from glandular secretions and their interactions with bacterial populations on the skin. Studying these emissions from the skin presents a non-invasive route towards monitoring the pathophysiological status, and has been shown to aid in the early detection of diseases (*e.g.* melanoma[1-2]), and to facilitate monitoring of wound healing[3] and fat metabolism processes[4] that are associated with diabetes, diet and exercise.

Volatiles are typically emitted from the skin at very low concentrations (tens of ppb), which complicates direct measurement. A pre-concentration step is required to enable the detection of compounds of interest and to allow the discovery of differences in individual volatile profiles, as well as to facilitate the translation of these results to point-of-care diagnostics. A small wearable concentration platform integrating solid phase micro-extraction (SPME) for skin volatile sampling is reported herein.

Samples from a variety of participants were collected and analysed with GC-FID and GC-MS towards understanding variations in the unique volatile signature. The optimised method has been applied to a clinical study on different skin types including chronic skin conditions associated with a compromised skin barrier. Identification of potentially relevant biomarkers is underway to facilitate the translation of this volatile profiling method to a point-of-care sensor array.

References

1. Kwak, J. *et al.*, *J. Chromatogr. B* **2013**, 931, 90-96.

2. Abaffy, T. *et al. Metabolomics* **2013**, 9, 998.

3. Byun, H. *et al. ETRI Journal* **2010**, 32, 440-446.

4. Yamada, Y. *et al. Anal. Chem.* **2015**, 87, 7588-7594.

Application of Tetrapolar Microelectrode Impedance Sensors for the Detection of Dementia Biomarkers

Desiree Acha[1], Xiaoyan (Scarlet) Wang, Ajit Shah1, Frank Hills1, Ivan Roitt1, Andreas Demosthenous2, Richard Bayford1,2

[1] Middlesex University, London, [2] University College London

ABSTRACT

Diagnosis for Alzheimer's disease (AD), the most common form of dementia, can only be confirmed by MRI imaging or post mortem by brain biopsy. Invasive methods such as lumbar puncture can identify certain biomarkers including tau protein and amyloid beta which have been found in higher than normal concentrations in the cerebrospinal fluid and serum of AD sufferers using methods like Mass Spectrometry and Laser capture microdissections (LCMs). The main objective of this research is to devise a non-invasive and cost effective point of care method for the earlier detection of AD biomarkers. The approach involves the use of a tetrapolar gold microelectrode biosensor and electrochemical impedance spectroscopy to measure Impedance of different concentrations of biomarkers of choice (e.g. Tau) related to AD. The antibody was coupled to the active area of the gold electrode sensor through formation of a self-assembled monolayer (SAM) which bound to protein G followed by anti-Tau. An Impedance Analyser 1260 model connected to a PC was used to conduct impedance measurements between a frequency ranging from 10Hz to 1MHz on the biosensor and the data collected using the Smart software. The sensor was quite sensitive detecting change in impedance measurement from molar concentrations as low as 10f M up to1µM, which is a concentration far lower than has been measured in people living with dementia. Potentially, this method can be developed into a very affordable point of care device for early diagnosis of dementia.

Wearable Smart Sensors for Management of Parkinson's Disease using Evolutionary Algorithms

***Michael A. Lones*[1]** and Stephen L. Smith[2]

[1] School of Mathematical and Computer Sciences, Heriot-Watt University
[2] Department of Electronics, University of York

ABSTRACT

Parkinson's disease (PD) affects approximately 120,000 people in the UK alone and is projected to increase dramatically over the next decade as people live longer. The most effective form of treatment for PD symptoms is a drug called levodopa, but approximately 90% patients who take it for ten years or more develop involuntary movements called dyskinesia. These movements are a major source of disability and severely affect the patient's quality of life with complications of uncontrolled dyskinesia including falls and fractures. Financial implications are also significant; Hauser and Pahwa [1] report "In the year following onset of dyskinesia, overall treatment costs increase by $7795 and PD-related costs increased by $4194 per annum". Management of dyskinesia is particularly difficult as it may occur many times per day and an accurate method of monitoring is not available. Currently, physicians rely on patients' descriptions or in severe cases patients are admitted to hospital for several days to monitor symptoms and adjust their medication accordingly. However, because it is difficult to measure dyskinesia accurately, the changes to the patient's medication can often be ineffective.

We have developed novel technology to objectively measure dyskinesia that is simple, reliable and safe to use. The system simply requires the patient to wear six small wireless sensors (on the limbs, head and trunk) that continually monitor the patient's movements over extended periods of time. The data from these sensors is transmitted via smart phone or tablet computer to a secure server and analysed using specialised model optimisation techniques, which are able to determine how frequently, and how strongly, the involuntary movements (dyskinesia) occur. This can then be presented to the patient's consultant as an easy to interpret time graph, via email or other secure communication.

There are important benefits of this new system:

i) it can measure dyskinesia with more confidence than is currently possible and hence guide treatment;
ii) it is safe and easy to use;
iii) measurements can be undertaken in the patient's home, as well as in hospital;
iv) it will save the NHS money through reduced consultancies, unplanned hospital admissions and reduction in in-patient appointments;
v) it will be useful in evaluating new drugs and other treatments for dyskinesia.

The resulting system is currently being market by the University spin-out company ClearSky Medical Diagnostics and has been introduced in to hospitals in the UK and China.

Infection Reporting Wound Dressings and Urinary Catheter

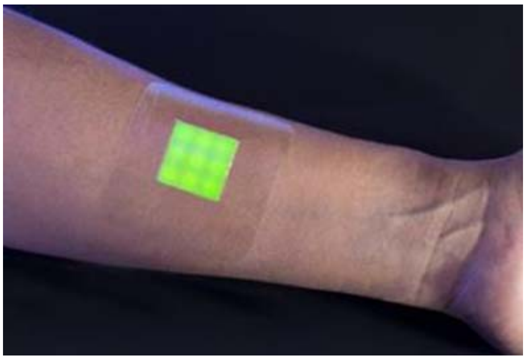
Toby Jenkins

Department of Chemistry
University of Bath

ABSTRACT

This talk will present some of our recent work on the development of active coatings which respond to changes in their local microbiological environment. The aim is to create theranostic coatings: therapeutic / diagnostic films which can be applied to existing medical devices: wound dressings and urinary catheters, for the detection and treatment of critical tissue or bladder infection. The 'trigger' for activation of these devices is local biochemical changes caused by the bacterial infection itself. In the wound dressings, these are cytolytic secretion enzymes from bacteria including *Staphylococcus aureus* and *Pseudomonas aeruginosa*. In the urinary catheter, a simple but effective trigger is a rise in urine pH, caused by ureases secreted by bacteria including *Proteus mirablis*.

In this talk I'll discuss our two current prototype devices (see pictures below) and the model infection systems used in their development. Both are under development, in the talk I'll briefly discuss the challenges of attempting to translate technology from the laboratory towards the clinic.



Prototype infection diagnostic wound dressing

Prototype infection detecting urinary catheter coating

More information at:

http://www.smartwound.co.uk

http://staff.bath.ac.uk/chsataj

Smart Body Interface Sensor Systems for Prosthetics

Prof. Liudi Jiang
Faculty of Engineering and the Environment
University of Southampton, UK

ABSTRACT

In the past few decades there has been rapid technological progress in lower limb prosthetics, especially the emergence of integrated and microprocessor controlled prosthesis. These technical advancements have helped to enhance amputees' mobility and independence. In contrast to this, amputee satisfaction rate has not kept pace. This is in part due to the lack of technology advances at the body-socket interface.

The prosthetic socket is an indispensable part of any prosthesis which attaches the prosthesis to the amputated limb. Sockets are custom made to accommodate individual residuum shapes, tissue variations. Most sockets are made of rigid materials and tightly fitted to the residuum limbs. During ambulation, the amputee's residuum has to sustain prolonged and intensive weight bearing and high impact loading. Unlike plantar skin, the residuum soft tissue is not naturally designed to tolerate such extensive load. It is also worth noting the harsh microclimate at the residuum/socket interface e.g. elevated temperature, excess perspiration & bacterial infection etc. Thus, many amputees suffer from stump ulcers. Amputees with comorbidities e.g. diabetes, peripheral neuropathy, are particularly vulnerable due to reduced sensitivity. Deep tissue injuries could lead to secondary higher level amputation.

In lower limb prosthetics, the remaining great challenge lies at the body–socket interface. Wearable sensors at this critical interface could provide valuable in situ information to amputees and clinicians in real time, which could then be used to enhance the rehabilitation processes. In particular, both pressure and shear exist simultaneously and to date very little is known in terms of the shear loading that is applied. Better understanding of these complex loads could help the socket design and fitting processes. The current fitting process is predominantly based on subjective measures of the prosthetist, a wearable sensor system could be used as an objective fitting tool for the clinicians, and also could be used to alert amputees to prevent tissue injury before it occurs. This talk will focus on the development of a tri-axial pressure and shear sensor system. Initial amputee test results will be presented. Future perspectives of this technology in conjunction with stump microclimate and tissue viability studies as well as its potential application in tele-medicine and amputee care will be discussed.

Wearable Biomonitoring Systems

Ahmed Al-Shamma'a
Liverpool John Moores University

ABSTRACT

Today wearable Biomonitoring Systems are gaining endless interest, they promise to be one of the great developments in the sector of wearable health technology. There are an overwhelming number of trending wearable's, but not all of them are capable of measuring or telling us in more details about our health. Similarly, there are plenty of biosensors that measure physiological inputs but do not have a wearable form factor.

This presentation will provide you with some insight on the exciting developments and applications of the biomonitoring systems that allow for continuous physiological monitoring in a wide range of wearable form factors but non invasively and in real time. The presentation will also cover various industrial applications with some element of understanding of the mathematical models underpinning the statistics of the collected data from the sensors. The presentation will be concluded by the development of the National Sensor City project through the "University Enterprise Zone" which is partly funded the Department for Business, Innovation & Skills, European Regional Development Fund and both University of Liverpool and Liverpool John Moores University to enable the innovation and entrepreneurial spirit of students and academics to be harnessed by industry, as well as providing a focus for young independent sensor technology companies in the Region.

A Portable Biosensor System for Real-Time Monitoring of Transplant Kidneys between Donor and Recipient Sites

Sally A. N. Gowers[1], Isabelle C. Samper[1], Chu Wang[1], Thomas Watts[1], Bynvant Sandhu[2], Vassilios Papalois[2] and Martyn G. Boutelle[1]

[1]Department of Bioengineering, Imperial College London, [2]Department of Surgery and Cancer, Imperial College London

ABSTRACT

Kidney transplantation is the preferred treatment for patients with end-stage renal failure. As a result of the severe shortage of donor organs, kidneys from marginal donors are increasingly being used to meet the demand. These organs are under-utilised as they may have incurred more ischaemic damage prior to recovery, which could impair their function. In order to increase the number of successful transplants it is vital to be able to monitor these organs immediately after donation and in transit between donor and recipient sites in order to gain time-critical viability information.

We are developing a portable analysis system that can by placed inside the organ transplant box during transportation. The system uses microdialysis to continuously sample the tissue and electrochemical biosensors to quantify key metabolic markers of tissue health in real time in the resulting dialysate. Glucose and lactate biosensors are fabricated by coating integrated needle electrodes (1) with a layer of entrapped enzyme (2) and an additional polyurethane diffusion-limiting layer to extend their dynamic range. These sensors are housed within a 3D-printed microfluidic device (3) and coupled to a potentiostat that wirelessly transmits data via Bluetooth to a tablet, which displays the data in real time. The portable system includes an automated calibration board, allowing calibration of the biosensors in transit.

Preliminary results will be presented from initial proof-of-concept experiments.

References:

1. Rogers et al. ACS Chem. Neurosci. 4, 799-807 (2013)
2. Vasylieva et al. Biosens. Bioelectron. 26, 3993-4000 (2011)
3. Gowers et al. Anal. Chem. 87, 7763-7770 (2015)

Smart Tattoo for Monitoring Skin Hydration Using AC Impedance

Keana De Guzman, ***Aoife Morrin***

National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin 9, Ireland

ABSTRACT

Wearable sensors have gained increasing interest in recent years due to their versatility and advantages in real time monitoring of human health or fitness *via* sweat[1,2], or skin pH[3]. Human skin is the largest organ of the human body and is a subject of significant research interest for sensing applications. Epidermal sensors should be lightweight and comfortable for the user. Tattoo electrode sensor platforms have emerged recently as addressing this need. They adhere to the changing morphology of the skin and offer a promising method of probing an individual's health. Such devices require a fabrication method that allows for their conformation to the mechanics of the skin while ensuring good electrical performance.

In this study, screen-printed tattoo electrodes were fabricated comprising silver ink using a concentric electrode configuration. The electrode is applied directly to the skin from a conventional tattoo paper substrate and AC impedance is used to track changes in water content of the stratum corneum. The sensor is being developed for application in atopic dermatitis patients where skin barrier function is impaired, which leads to chronic dehydration. Characterisation of this sensor on a skin phantom as well as porcine and human skin tissues will be presented.

References:

1. Guinovert, T.; Bandodkar, A.J.; Windmiller, J.R.; Andrade, F.J.; Wang J., *Analyst* **2013**,*138*, 7031-7038.

2. Bandodkar, A.J.; Molinnus, D.; Mirza, O.; Guinovart, T.; Windmiller, J.R.; Valdes-Ramirez, G.; Andrade, F.J.; Schoning, M.J.; Wang, J. *Biosens. Bioelectron*. **2014**, *54*, 603-609.

3. Bandodkar, A.J.; Hung, V.W.S.; Jia, W.; Valdes-Ramirez, G.; Windmiller, J.R.; Martinez, A.G.; Ramirez, J.; Chan, G.; Kerman, K.; Wang, J. *Analyst* **2013**, *138*, 123-128.

POSTER ABSTRACTS

Assessing the Utility of Low-Cost Sensors in Exposure Studies

A. Stamatelopoulou [1,2], ***Th. Maggos [1],*** D. N. Asimakopoulos [2], D. Chapizanis [3], S. Karakitsios [3], M. Loh [4], A. Pronk [5], S. Steinle [4], A. Sleeuwenhoek [4],J. Cherrie [4], E. Kuijpers [5], D. Sarigiannis [3]

[1]NCSR "DEMOKRITOS", Environmental Research Lab, Athens, Greece,
[2]Faculty of Physics, University of Athens, Greece,
[3]Environmental Engineering Laboratory,
Aristotle University of Thessaloniki, Greece,
[4]IOM, United Kingdom, [5]TNO, Netherlands

POSTER ABSTRACT

In the frame of HEALS (EC FP7 project) a pilot study was conducted in order to examine the feasibility of using low-cost sensors for the assessment of personal exposure to several environmental hazards. The sensors were evaluated in 150 homes in three 3 European countries (Greece, Netherlands, U.K) using panels of mothers with young children (less than 3 years). Young children comprise a vulnerable subpopulation as they spend the majority of their time indoors at home and their respiratory system is under development.

Indoor air quality was assessed in the main living area of each household using commercially available-low cost sensors such as the Dylos (PM >0.5, >2.5 μm) and Netatmo (CO_2, noise, T, RH), while for validation reasons a Grimm 1.108 (PM: 0.23-20 μm) and an AQ monitor (CO_2, CO, TVOC, NO_2, NO), were also placed. Physical activity, location and diet of the study participants were also considered with the Fitbit device, Moves App and Fatsecret App, respectively.

Using Pearson's Correlation Coefficient, preliminary analysis showed a good correlation between the Dylos and Grimm 1.108 for PM, as well as between Netatmo and AQ monitor for CO_2. Further analysis is planned not only to demonstrate the feasibility of using new sensor and mobile technologies in collecting exposure data, but also to use the current data as inputs in agent based exposure modeling in order to assess environmental exposure of young children and their parents.

Development of a Wireless Portable Microfluidic Sensor Platform for On-Line Monitoring of Transplant Organs in Transit

***Isabelle C. Samper* [1],** Sally A. N. Gowers [1], Chu Wang [1], Thomas Watts [1], Bynvant Sandhu [2], Vassilios Papalois [2], Martyn G. Boutelle [1]

[1] Department of Bioengineering, Imperial College London, [2] Department of Surgery and Cancer, Imperial College London

POSTER ABSTRACT

Although transplantation is the treatment of choice for patients with end-stage organ failure, graft rejection remains a major obstacle. Developing tools to assess organ viability before transplantation is a priority to reduce the frequency of this outcome. As the organ needs to travel from the donor to the recipient site, continuous monitoring during transit would ensure that it could be safely transplanted upon arrival, thus reducing the critical preservation time.

We are developing a fully portable wireless microfluidic biosensor system that can travel with the organs. On-line microdialysis is used to sample the extracellular fluid and the resulting dialysate is monitored for changes in levels of glucose and lactate, key metabolic markers of ischemia. We have built a 3D-printed microfluidic flow-cell [1] that securely mounts microelectrode-based amperometric biosensors [2]. We are now miniaturising the channel further to improve the sensing resolution. The sensors are connected to a small battery-powered wireless potentiostat that transmits the currents in real time to a tablet via Bluetooth. The whole device will be enclosed in a 3D-printed casing, allowing it to sit safely with the organ during transport. A custom-made Android application allows live display of the two signals on the tablet. To assess the sensor sensitivities regularly, a wireless automated microfluidic calibration board was also developed.

We will present progress on this project, as well as preliminary tests on kidneys, the most frequently transplanted organs.

[1] Gowers et al. Analytical Chemistry 87, 7763-7770 (2015)

[2] Rogers et al. ACS Chemical Neuroscience 4, 799-807 (2013)