Sensors 2014

New Materials and Developments in Sensor Technologies

Conference with Posters and Exhibition

Programme

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

A one day meeting on
Wednesday 18th June 2014

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

Email: conference@aamg-rsc.org
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RSC | Advancing the Chemical Sciences

New Materials and Developments in Sensor Technologies

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Wednesday 18th June 2014
at The Royal Society of Chemistry, Burlington House, London

Programme

09:00 – 09:30 Registration and coffee

Session 1: New Materials and Developments

Chair: **R.Narayanaswamy - AAMG-RSC**

09:30 Developing Optical Fibre Sensors for Industrial Applications
Ken Grattan
City University London, UK

10:00 Recent Advances in Graphene Technology Towards Sensors Applications
Aravind Vijayaraghavan
The University of Manchester, UK

10:30 Recent Advances in Diamond Materials for Chemical Sensing Applications
Emmanuel Scorsone
Institut CEA LIST, France

11:00 - 11:30 Tea / Coffee

11:30 Low Operating Temperature Metal Oxide Sensors for Carbon Dioxide
Natasha McGuire
Sense44, Bristol,UK

11:50 A Nanoparticle Based Sensor for E. Coli Bacteria
Hadi AlQahtani
King Saud University, Saudi Arabia

12:10 Innovative Device with Conducting Polymer Sensors to Detect Early or Hidden Fungal Development in Indoor Environments through Volatile Organic Compounds (VOCs)
Rukshala Anton
C S T B, France

12:30 Polymeric/Gold Plasmonic Crystal for SERS Detection of Leukemia Biomarkers
Carlo F. Morasso,
Fondazione Don Carlo Gnocchi, Italy

12:50 - 14:00 Lunch - Exhibition & Poster Session

Session 2: Sensing and Analytical Monitoring Techniques

Chair: **Alan Braithwaite - AAMG-RSC**

14:00 Detection of Security Threats Using Solid State Gas Sensors
Gerhard Müller
Technical University of Munich, Germany

14:30 Developing Particle Analysis Towards A New Point-Of-Care Assay Platform
Emily Rose Billinge
Loughborough University, UK

14:50 A Novel Non-Invasive and Real-Time Electromagnetic Wave Sensor for The Meat Industry
Muhammad Ateeq
Liverpool John Moores University, UK

15:10 Design of Fast Chip Calorimetry Accessory for In-situ X-ray Nanobeam Experiments
Yaroslav I. Odarchenko
Royal Holloway University of London, UK

15:30 - 16:00 Tea / Coffee

16:00 The Application of Microwave Spectroscopy Analysis on Determining Quality of Vegetable Oils
Salifu Osman
Liverpool John Moores University, UK

16:20 Analysis of Volatile Compounds (VCs) in Complex Samples using Static Headspace Multi-Capillary Column Gas Chromatography Ion Mobility Spectrometry
Chamila J. Denawaka
Northumbria University, UK

16:40 Exhibitor Presentation

16:50 Concluding Remarks and End of Conference

ABSTRACTS

Developing Optical Fibre Sensors for Industrial Applications

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ABSTRACT

Optical Fibre Sensors (OFS) have developed as a result of the advances seen in communications systems, due to the technology available from both optical fibre and laser systems since the late 1970s. As a consequence there have been major developments in both physical and chemical sensing, these being capable of being tailored to meet a wide range of measurement needs outside the laboratory and to compete effectively with conventional sensors for a number of important industrial applications. The availability, manipulation and ultimate use of a range of different materials has been crucial to the success of such sensors, whether it be in the development of special optical fibres themselves or in creating a suite of specialist coatings applied to such fibres. The paper will review the technical background to some of these developments and report on several illustrative areas where optical fibre sensors, using advanced materials, have made significant impact through the development of new industrially-focused instrumentation for modern measurement needs.

Focusing on the materials aspects of the optical fibre itself, an optical fibre must be designed to trap radiation at one end and guide it to the other, using the simple principle of Snell's Law where $n = c / v$ (n is the material refractive index, c is the speed of light in vacuum and v is the velocity of light in the medium). The material(s) used must allow making long, thin, flexible fibres, transparent at the wavelength of interest and be physically compatible to create stable fibre with a defined core and cladding. Glasses and plastics fit these requirements well, with silica (SiO_2) widely used and plastic or polymer materials available (but with higher attenuation than silica, creating a practical limit to the useable fibre length, due to attenuation). Single mode operation is often desirable and helps define the physical dimensions of the fibre and thus influences the materials used. Further the development of 'exotic fibres' such as those with multiple cores, stress-inducing regions, or specific layers within the fibre require specific materials properties and they can be used to demonstrate the potential of such fibres for specific sensor operation(s). In addition, several major developments in fibre design have opened up new vistas for sensor development. These include the doping of fibres with known quantities of materials to give particular characteristics e.g. with germanium or hydrogen to create photosensitivity (and thus permit the writing of either Fibre Bragg or Long Period Gratings longitudinally in the fibre) or with rare earth materials to allow the generation of fluorescence from the fibre and thus fibre lasers. In addition, the development of microstuctured fibres has not only opened up new opportunities in the communications field but also a range of new sensor possibilities.

Over and above this, a range of coatings specifically designed to be sensitive to particular parameter(s) have been developed for use with not only ‘standard’ communications fibre in silica but with several ‘exotic fibres’ of the types discussed above. Coatings needed for these applications can be specially developed both to cross-link to the silica material of the fibre and yet be sensitive to the species to be measured, ranging from. illicit drugs to specific chemical species which may give information on materials degradation in structures.

The paper will focus on both these aspects and discuss examples of different types of sensors designed for industry which use both a number of exotic fibre characteristics coupled to the choice of a variety of materials which can be coated onto fibres, thus to create sensitivity to key chemical species. The design and performance of such sensors will be reviewed and industrial applications considered, with a view to showing the capabilities of a range of optical fibre sensors for today’s, and tomorrow’s industrial problems.

Recent Advances in Graphene Technology Towards Sensors Applications

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ABSTRACT

In this talk, I will present some recent developments in my research group towards applications of graphene for sensor technologies. Graphene possess and unique combination of properties such as high strength, high electrical conductivity, transparency, high specific surface area, high flexibility, etc, which makes it ideal for building sensors. I will discuss two kinds of sensors – bio-sensors and photo-detectors.

In bio-sensors, we have developed a novel way of immobilising biomolecules on the surface of graphene by incorporating them into a self-assembled lipid membrane on the surface of graphene. The lipid membrane is formed with nano-scale resolution by a process known as dip-pen nanolithography. In this case, we have demonstrated biotin-streptavidin binding on the surface of graphene.

In photodetectors, we have developed a system of graphene covering a gold dimer plasmonic antenna. The plasmonic antenna is tuned to be in resonance with incident light of specific frequency and provides a 10^4 enhancement in the absorption of light by graphene, as probed using Raman spectroscopy. We establish this graphene/plasmonics system as a new way to study and enhance the light-matter interaction in graphene, and also propose graphene-covering as a new way to characterise the enhancement efficiency of various plasmonic nano-antennae designs. We have also demonstrated a similar system by coupling a 1-dimensional carbon nanotube (rolled up graphene) with a dimer-antenna with very interesting effects that are relevant to photodetector technologies.

Hirtz, M.; et al; Nature Communications, 2013, 4, 2591(1-8).

Heeg, S.; et al; Nano Letters, 2013, 13, 301-308.

Heeg, S.; et al; Nano Letters, 2014, 14, 1762-1768.

Recent Advances in Diamond Materials for Chemical Sensing Applications

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ABSTRACT

Diamond materials feature a wide range of outstanding chemical and physical properties, which have interested many scientists over the years. The oldest applications of diamond are certainly related to its mechanical properties, in particular its harness, used for cutting, polishing or drilling tools. Also the chemical resilience of diamond associated with its interesting semiconducting properties has also been exploited for the development of radiation detectors. Here we focus on the extreme properties of diamond, being chemical, electrochemical, optical, acoustic, and so forth, which have more recently found excitement for the development of innovative chemical or biochemical sensors. The various forms of diamond, from nanoparticles to bulk single crystals exhibit a true potential to enhance both the sensing performances and robustness of the devices in field operating conditions. A wide range of diamond based chemical sensors have been reported in the form of solid state semiconductor sensors, field effect transistors, electrodes etc. both in the gas phase and in the liquid phase. Such sensors have found various applications in environmental monitoring, security or the medical diagnostic. We gives here an insight into the exceptional assets of CVD grown diamond materials for sensors, through selected examples ranging from DNA detection to artificial olfaction usingacoustic wave and cantilevers sensors. Besides, the great potential of diamond electrodes will also be discussed, for instance for continuous online monitoring applications.The recent advances in hybrid diamond based materials for chemical sensing application will also be developed.

Low Operating Temperature Metal Oxide Sensors for Carbon Dioxide

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ABSTRACT

This work is a proof of concept study on gas sensitive materials for carbon dioxide(CO_2) sensing. The aim is to create a low-cost, low-power sensor by integrating the sensor element with a micro hotplate platform.

Metal oxide formulations, promising for low temperature operation (and therefore reduced power consumption) have been synthesised and developed; then printed in-house onto a 2x2mm sensor platform. Sensor performance is being mapped out using a custom built test unit. This continuously monitors up to ten sensors in addition to air VOCs, humidity and temperature whilst controlling CO_2 levels and exposure to nuisance gases. Sensors have demonstrated reversible sensitivity to CO_2 and optimisation of operating settingsis underway, the latest results of which will be presented. The next stage will be optimisation of formulations where necessary, and completion of performance mapping.

The importance of CO_2monitoring in indoor air quality, automotive cabins, agri-foodand environmental sectors is growing. Current sensor technology is costly, developed around discrete sensors connected to a circuit board containing drive and signal processing electronics. There is a growing market for inexpensive miniature sensors, which is being made possible through the development of micro-electromechanical systems (MEMS). Metal oxide semiconductor (MOS) sensing technology is unmatched in being able to operate in hot hazardous environments and sub-zero temperatures, as well as offering the possibility of a single-component silicon-chip based gas sensor.

A Nanoparticle Based Sensor for E. Coli Bacteria

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ABSTRACT

Escherichia coli bacteria release 1-decanol as a byproduct of their metabolism. We demonstrate the detection of 1-decanol odour at a partial pressure in the order 100ppb by the resistance change of a swelling-based sensor, consisting of Langmuir–Schäfer deposited Au core/organic ligand shell nanoparticle films. This is an exceptionally low limit of detection for swelling-based sensors, and relies firstly, in the careful matching of the CSNPs ligands to the targeted odour, and secondly, in the very low volatility of this odour. Sensor response can be substantially increased further when films are cooled below the freezing point of 1-decanol. We observe unexpected quantitative behaviour of our sensors: response is only weakly dependent on the odour's partial pressure, and scales differently with temperature than the response of other Au-CSNP odours to more volatile odours. This may be related to their unusually strong thermal resistance drift, the difficulties in delivering very low partial pressure odour atmospheres, and the proximity to the analyte's freezing point. We demonstrate a sensor for decanol, a vapour released by E. coli bacteria. Highly sensitive detection of 112ppb decanolvapour is achieved. Sensitivity can be significantly enhanced by cooling to near 0°C. These sensors show a good recovery process.

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Innovative Device with Conducting Polymer Sensors to Detect Early or Hidden Fungal Development in Indoor Environments through Volatile Organic Compounds (VOCs)

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ABSTRACT

In addition to the biodegradation problems encountered in buildings, exposure of their occupants to moulds is responsible for numerous diseases such as respiratory infections, immediate or delayed allergies and different types of irritations. However, current techniques are unable to detect mould at an early stage of development or hidden contaminants.

Moularat *et al*., in 2008 has established chemical fingerprints of mouldy developments from VOCs arising specifically from fungal metabolism and developed the Fungal Contamination Index (FCI). This index has the advantage of detecting fungal development both reliably and rapidly before any visible signs of contamination could be detected [1].

However, even if the FCI has been widely tested [2], VOCs'analysis by GC/MS, which is required for index calculation, is incompatible for indoor environments real-time monitoring strategy.

In this context, researches around FCI exploitation have been followed up in order to provide a monitoring device widely deployable which is the result of the miniaturization of an analytical chain for portable, reliable and low-cost applications. This device is based on one hand on the selection and concentration of chemical compounds from the sample of interest and on the other hand on the development of an array of different conducting polymer based sensors in order to obtain a specific footprint.

This fungal contamination detection device was the subject of patent applications by the CSTB [3, 4].

The modularity of the system (ability to vary both the elements of polymers detection and retention time of interest) allows to expand its use to other pollutants.

References

1. Moularat, S, *Procédé de détection d'une contamination fongique*, in *INPI*. 2007: France.
2. Hulin, M, Moularat, S, Kirchner, S, Robine, E, Mandin, C, and Annesi-Maesano, I, *Positive associations between respiratory outcomes and fungal index in rural inhabitants of a representative sample of French dwellings.* International Journal of Hygiene and Environmental Health, 2013. **216**: p. 155-162.
3. Moularat, S, Joblin, Y, and Robine, E, *Dispositif de détection d'une contamination fongique.* 2010: France.
4. Moularat, S, Joblin, Y, and Robine, E, *Développement d'un microsystème de détection*. 2011.

Polymeric/Gold Plasmonic Crystal for Sers Detection of Leukemia Biomarkers

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ABSTRACT

Surface Enhanced Raman Spectroscopy (SERS) is a powerful analytical technique that combines the excellent chemical specificity of Raman spectroscopy with high sensitivity provided by the plasmonic enhancement. The main advantages of SERS based approaches are related to the fact that observed signals can be even more intense than the ones commonly measured with fluorescence and that this technique has an intrinsic capability for multiplexing.

In this work we developed a SERS based assay for the reliable and reproducible detection of multiples genes based on the use of a 2D crystal of polymeric pillars embedded in a gold layer as substrate. This kind of nanohole-like structure can provide a regularly distributed array of hot spots and offers the facile phase separation advantage of an heterogeneous reaction system. Besides,it can be produced in high number at low cost by a combination of plasma technique and colloidal lithography.

The SERS activity of our substrate has been tested using different dyes and demonstrated to be superior if compared with other commonly used substrates together with an excellent reproducibility (standard deviation of about 5%).

Using our substrate we were able to simultaneously detectWT1,an emerging biomarker for the assessment of minimal residual disease in Acute Myeloid Leukemia,and the housekeeping gene ABL at picomolar concentration. This work represents the first step towards the development of a SERS based microarray for the detection of genetic markers avoiding PCR.

Detection of Security Threats Using Solid State Gas Sensors

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ABSTRACT

Following the 9/11 events a world-wide interest in security issues has evolved. An important part of establishing security is detecting explosives, explosives precursors and illicit drugs carried on persons walking through control points protecting critical infrastructure. The gold standard for detecting such security threats is ion mobility spectroscopy (IMS). IMS instruments are relatively large, bulky and expensive (~50k€) and normally involve radioactive ionisation, which makes them difficult to deploy flexibly and in large numbers.

Solid state gas sensors are simple and inexpensive devices which feature a high sensitivity towards many of these security threats. Solid state gas sensors, however, have not yet made their way into security equipment, largely because of the following reasons:

- Threat substances need to be actively acquired from a suspect environment,
- Threat substances like explosives and illicit drugs do not normally come along in the form of easily detectable gases or vapours,
- Once vaporized, solid state gas sensors do not exhibit the degree of selectivity that is required by end-user demands.

The present talk reports on some of those current activities that have been performed at overcoming these limitations and at arriving at portable, low-cost security detectors.

Developing Particle Analysis Towards a New Point-Of-Care Assay Platform

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ABSTRACT

In recent decades there has been an increased drive towards the creation of point-of-care assay devices. Many current biological tests are not available in resource-poor areas, which rely on centralised laboratories to generate results. In many disease states, time is a major consideration; the introduction of affordable, rapid and simplistic assays to decrease turnaround time would massively improve clinical decision-making.

Due to the emphasis on assay time reduction, many new assay platforms areemerging. Tunable Resistive Pulse Sensing (TRPS) offers an attractive platform for a biological test; the equipment has minimal requirements of space and resources, and only a small sample (~40µL) is required to perform an analysis. This equipment is designed for particle analysis, and producing a suitable biological test based around this equipment presents a challenge.

Using nano-scale beads coated with capture probes, the binding of clinically-relevant proteins to the surface of beads has been observed[1]. Aptamers, short single-stranded oligonucleotides capable of binding with strong selectivity and affinity to a wide range of targets, were chosen as a suitable capture-probe. Aptamers are more cost-effective than antibodies due to their simpler means of generation and improved stability. To simplify wash stages we employ superparamagnetic beads for easy magnetic separation.

Using our proposed assay format we were able to observe aptamer-analyte interactions on the surface of beads by using surface-charge related signal changes. The creation of a rapid, multiplexed TRPS-based assay based on these findings could provide a powerful platform for future clinical testing.

References

[1]Emily R Billinge, Murray Broom and Mark Platt: Monitoring aptamer-protein interactions using tunable resistive pulse sensing. *Analytical Chemistry* 2014, 86 (2) pp1030 – 1037

A Novel Non-Invasive and Real-Time Electromagnetic Wave Sensor for the Meat Industry

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ABSTRACT

Accurate real-time monitoring and analysis of meat quality is a significant problem in the meat industry. Changes in the meat properties, such as water loss, dryness, ageing and curing, are have direct impact on meat quality which makes them relevant parameters for the industry to quantify during processing. This work presents development of a novel electromagnetic wave sensor operating at microwave frequencies for real-time analysis of meat samples. The sensor structure radiates low power electromagnetic waves which interact with the samples, altering the nature of this radiation depending on the aforementioned parameters. This phenomenon has been characterised by correlation of laboratory based tests conducted alongside studies using the developed sensor. These results are presented here, and demonstrate the viability of using electromagnetic wave based sensor for real-time non-invasive measurement of meat in the food industry.

Keywords: microwave sensors; non-invasive monitoring; real-time meat analysis; food industry.

Design of Fast Chip Calorimetry Accessory for In-situ X-ray Nanobeam Experiments

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ABSTRACT

Combining two or more experimental techniques in one single experiment is often beneficial for the in-depth characterization of the sample. As far as the structural analysis by X-ray scattering is concerned, simultaneous thermal analysis provides important complementary information about the type of the sample state and type of thermal transitions encountered during sample preparation/processing. Nowadays, coupling X-ray scattering with Differential Scanning Calorimetry (DSC) has become a routine technique. A need to address complex nanostructured materials with high spatial resolution or to address individual nanogram samples stimulates the race toward the nanosized X-ray beams. However, combining commercial DSC instruments with the nanofocus X-ray setups remains highly problematic. The present work focuses on designing of an fast chip calorimeter accessory suitable for synchrotron micro- and nano-focused X-ray beamlines. To this end a microelectromechanical-systems-based instrument allowing quantitative DC and AC calorimetric measurements over a broad range of heating/cooling rates (≤100000 K/s) and temperature modulation frequencies (≤1 kHz) was designed. The principal possibility of combining nanofocus X-ray scattering with quantitative thermal analysis on the nanoscale was shown. The setup was successfully applied for in-situ structural characterization of metals and industrially relevant polymers. The designed fast chip calorimetric accessory is to our knowledge unique in terms of its compatibility with micro- and nano-focus X-ray scattering.

Application of Microwave Spectroscopy Analysis on Determining the Quality of Vegetable Oils

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ABSTRACT

Recently there has been an increasing interest in the classification of edible oils as an effective means to examine authenticity and to detect possible adulteration of virgin olive oils with seed oils or low-quality olive oils. Classical methods based on gas chromatography (GC) and high-performance liquid chromatography (HPLC) are too expensive for widespread industrial use and require samples to be analysed in dedicated laboratories thus incurring a significant time penalty. This paper demonstrates that microwave spectrometry is able to offer real-time measurement of oils adequate for determining product authenticity. It does this by evaluating a bespoke sensor system which is used to measure the dielectric properties common-place edible oils. In particular, the capability of the system to distinguish between these oils, even when mixed, is demonstrated. This is important as it is a common technique used by fraudsters in the production of counterfeit oils.

Key Words: microwave spectroscopy, sensor, virtual network analyser, edible oils, adulteration, real time analysis.

Analysis of Volatile Compounds (VCs) in Complex Samples using Static Headspace Multi-Capillary Column Gas Chromatography Ion Mobility Spectrometry

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ABSTRACT

An evaluation of static headspace – multi-capillary column - gas chromatography - ion mobility spectrometry (SHS-MCC-GC-IMS) has been undertaken to assess its applicability for the determination of 32 volatile compounds (VCs) in a malodour study.The samples were run on a FlavourSpec instrument (G.A.S. mbH, Dortmund, Germany) fitted with a multi-capillary column (MCC) (i.e. 20 cm x 3 mm ID, containing approximately 1000 parallel capillary tubes, 40 µm ID, coated with 0.2 µm film thickness of stationary phase i.e. OV-5 or Carbowax 20M). Atmospheric pressure ionisation is generated by a Tritium (^{3}H) source. Separation in the IMS drift tube is achieved by applying an electric field of 2 kV to the ionized volatiles in a pulsed mode using an electronic shutter opening time of 100 µs. All data are acquired in the positive ion mode.

A human volunteer study was done in which 11 participants (7 male and 4 female) were invited to wear new socks for a minimum of 10 hours per day in their chosen footwear. Upon collection of the socks they were olfactory graded for malodour against a fixed scale (0 – 10) prior to SHS-MCC-GC-IMS analysis. By comparison with the SHS-MCC-GC-IMS database library. it was possible to identify four VCs in the soiled sock sample odour profiles. The most abundant VCs in the odour profiles, irrespective of gender, were ammonia and dimethyl disulphide with minor components of dimethyl trisulphide and butyric acid identifiable. Ammonia was detected in all samples at high concentration (beyond the extended calibration range).

POSTER ABSTRACTS

Developing a Sensor Platform for the Investigation and Characterisation of Sub 100nm Particles

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POSTER ABSTRACT

Sensor technologies have a vital role in the detection and characterisation of small biological particles, here we are developing a versatile sensing platform that allows for the rapid detection of biomarkers and sub 100nm particles using tunable resistive pulse sensing (TRPS). Analysis of Sub 100nm particles allows for applications that include the detection and characterisation of viral particles and clinically important proteins that will be of great use in gene therapeutics and vaccine development.

Tunable pore based technologies provide a flexible sensing platform for a variety of biological samples. Tunable resistive pulse sensing (TRPS) is a great example of this technology that incorporates a polyethylene nanopore membrane allows for rapid particle-by-particle analysis, even with complex sample mixtures providing detail on size, concentration and zeta potential of particles.

Here we present work on the measurement of biologically active particles and show how to optimise the signal to allow a sensitive and rapid assay. We compare zeta potential, duration, rates and particle diameter to optimise our assay.

Generation of Aptamer-Molecularly Imprinted Polymer Hybrid Materials

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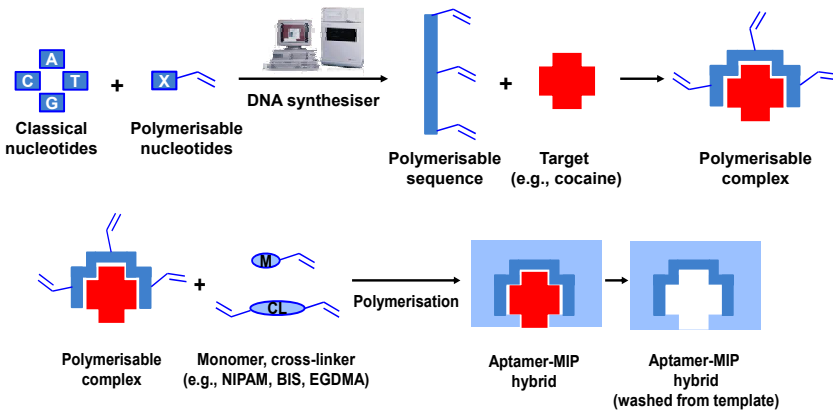
POSTER ABSTRACT

Molecular recognition processes have a key role in (bio)analytical science. Specific recognition usually comes from biomolecules such as enzymes, antibodies and aptamers. These latter are single stranded oligonucleotides (~25-50 bases) derived from combinatorial libraries through selective targeting (SELEX).They exhibit high affinity and selectivity andabsence of immunogenic/toxic properties. These characteristics make them attractive alternatives to antibodies for diagnostic and sensing purposes, even though they are quite susceptible to enzymatic and chemical degradation.

The aim of this work is to use aptamers as recognition elements of a molecularly imprinted polymer (MIP), by slightly changing the chemical structure of the DNA and making it polymerisable. MIPs involve the formation of a binding pocket in a polymer which is sterically/chemically complementary to the target. These "smart materials" arecost effective and can work in extreme environmental conditions, but usually cannot equal the affinity/specificity of biomolecules.The introduction of appropriately modified bases into the oligonucleotides allows the formation of covalent bonds between the DNAand the polymer. After the target removal, the aptamer is retained in the MIP in its correct orientation, thus resulting in a first example of hybrid molecular imprint. The same modified base can be used directly as traditional MIP “functional” monomer (e.g., for imprinting of nucleosides). The aptamer recognition element benefits from being protected from the environment (enzymatic/chemical degradation) by the attached polymer scaffold, whilst maintaining its recognition performance. From an imprinting perspective, this opens up the opportunity of using a new group of “functional” monomers in further studies.



Preparation and Analysis of Caffeine Imprinted Microwave Polymers

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POSTER ABSTRACT

Molecularly imprinted polymers (MIPs) have been studied intensively as recognition materials for various bio-analytical applications for more than two decades now. Traditionally, MIP monoliths are obtained by thermal free radical polymerisation with the aid of an oven or an oil-bath. This results in poor control over the polymerisation kinetics and subsequent batch-to-batch variability. In this study, we report the preparation of caffeine-imprinted polymers obtained using a microwave irradiator. Polymers have been prepared by varying different experimental conditions (e.g., polymerisation temperature, polymerisation time and polymerisation rate) against reference polymers prepared by traditional methods such as oven and photo irradiation. The physical properties of the MIPs prepared in different conditions have been characterised by BET, DSC, TGA and SEM and correlated to their template rebinding performance by using SPE and HPLC. The obtained results suggest that the variation in caffeine rebinding observed between different polymers is greatly influenced by their physical properties, which reflect their different preparation conditions. This indicates that polymers prepared under specifically controlled conditions could exhibit more predictable performance.