Receptor Doped Ionogels - New Materials for Inherently Biocompatible Molecular Sensors – Results in brief

Project Acronym - Receptor-Doped Gels
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The key challenges currently faced in lab-on-a-chip biochemical sensor developments are device reliability and power consumption. The major issues faced in terms of device reliability are liquid handling over extended periods of time, as the micro-dimensioned fluidic channels are prone to blockage, and unreliable micro pumps/valves. The overall aim of this proposal was to develop a biocompatible molecular sensor that will address these key issues which are holding back biocompatible sensors technologies, and to develop an innovative class of sensing technology at the forefront of molecular sensing. Furthermore, we envisage that the proposed sensing devices can be incorporated into lab on a disc systems for health care devices thus providing clear benefits the public health service.

There have been two clear distinct sets of results from the project. The first involves the development of an Ionogel for use as a biochemical sensor (Fig 1) and the second is the development of a Centrifugal Microfluidic Analysis System (CMAS) prototype (Fig 2) that is beyond proof of concept thereby spanning the gap to commercial prototypes.

It has been demonstrated that the detection of lactate in a relevant physiological range using an Organic Electrochemical Transistor (OECT) sensor with an ionogel solid-state electrolyte is feasible (Fig 1). The significance of this work for sensing applications lies in the configuration of the sensor; we show for the first time a solid state electrolyte on a flexible transistor-based biosensor. This has implications for the wearability of the sensor and the storage of the sensor due to the enhanced stability of the enzyme in the ionogel. We envisaged the use of this sensor as a wearable bandage-type sensor, which can be worn during exercise or health monitoring, allowing sweat to diffuse into the sensor with consequent detection of the lactate analyte. This could also have application for the detection of other sweat components such as pH.

The ionogel sensors were then integrated into a lab on a disc microfluidic technology that provided a platform for rapid and multiple analysis in-situ on a disc form factor. To compliment this technology a fully functional prototype has been developed with the end goal of commercilisation of the system. Two application areas that are attracting a lot of attention both in Ireland and internationally are: water quality monitoring and bio-medical diagnostics, both of which have large projected markets, as outlined in the latest report by Yole development (http://tinyurl.com/d9zqepx). The CMAS system would provide authorities with more data about water quality that could potentially act as an "early warning" system for their scientific monitoring teams.

The Centrifugal Microfluidic Analysis System CMAS is an example of how centrifugal microfluidic technologies can be used to implement a cost effective, accurate and effective sample-to-actionable information for environmental monitoring. To date a sub €200 prototype system has been developed providing the pathway to an affordable diagnostics tool that will both benefit the end user and public health service.

The work described started by a review paper, followed by the synthesis and characterization of ILs, and finally by refinement of a device, that led to a patent submission. Knowledge transfer, through the work performed, was achieved through co-supervision of 4 PhD's and indirect involvement with another 4, as well as through the results obtained. The fellow was also involved in conference organization, and presents details of 10 visits of foreigner scientists, that the fellow was involved in - from the Australian Centre for Electromaterials Science at Monash University, Department of Bioelectronics, from Centre Microelectronique de Provence, Ecole Nationale Superieure des Mines de Saint Etienne, France, from the Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology, and from the University of Muenster, Germany.

Dissemination activities were also performed with success – 1 Patent (Patent application - United Kingdom 1207239.3), 16 peer reviewed publications, 1 Book Chapter (Accepted, Due 2014), 19 Invited oral presentations (Local & International), 21 conference poster presentations and 10 Web based articles. Since becoming a Marie Curie fellow the candidate has been involved in successful local and European grant applications (Enterprise Ireland Commercialisation Fund Program, CF20122768Y, Failte Ireland Conference Ambassador Support Application,

(2012/138), DCU Conference support program, stemming from his research. The candidate was also awarded by the President of Ireland, Michael D. Higgins, for "Recognising leadership of a project in the Seventh EU Framework Programme for Research at Irelands Champions of EU Research 2012".

The novel approach of this project demonstrated excellence and competitiveness in several ways. This project addressed the current constraints in bio-compatible sensor design using the novel functionalized materials but embedding them in a research group with extensive experience in developing prototypes beyond proof of concept thereby spanning the gap to commercial prototypes. The applications space in environmental sensing is already established as a key priority for the European Union and such an approach will have significant academic as well as commercial impact.

Academically, the project resulted in a better understanding of the barriers to continuous autonomous sensing and will provide a new class of compounds that will enrich the researcher community's understanding of unit operations targeting sensor development. A successful outcome in this space shall assist Europe in maintaining a world leading position in novel sensor design and implementation.

Commercially, the project will create IP that has potential for significant economical impact as well. Development of simple and low cost technology for detection of environmentally important targets will allow quick and easy *in situ* detection resulting in safer and healthier living conditions for European Citizens.

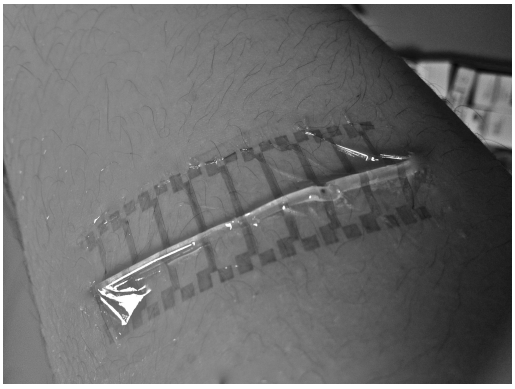
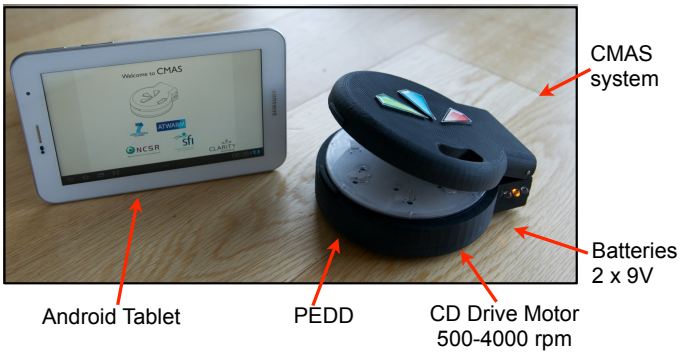


Fig 1: Conformal Organic Electrochemical Transistor with gel shown on a forearm.



Advantages:

- Low cost single use micro-fluidic device
- Multiple samples analysis in a single micro-fluidic device
- Multiplexing capabilities
- Portable system: sample analysis at the point-of-need
- Wireless communication system

Fig 2: Centrifugal Microfluidic Analysis System (CMAS) prototype developed.