The 2015 Boyle Higgins Award Gold Medallist

Professor Dermot Diamond, Dublin City University.

Chemical Sensing with Autonomous Devices in Remote Locations: Why is it so difficult and how do we delivery revolutionary improvements in performance?

Dermot Diamond, Insight Centre for Data Analytics, National Centre for Sensor Research, Dublin City University, Dublin 9, Ireland.

In this paper I will assess the present status of chemical sensing, with particular emphasis on the spectacular lack of progress in delivering low cost ways to perform measurements in remote locations (e.g. distributed environmental sensing of water quality status, or tracking key disease markers inside the body) using autonomous sensing devices that can function reliably for years, without human intervention. And this is despite huge investment in sensor research programs, and the publication of many thousands of papers in the scientific literature on chem/bio-sensors, most of which appear to be more about tweaking the achievements of previous researchers, than producing fundamental breakthroughs.

Long-term medical implants are required to function for at least 10 years, and preferably longer. Yet biosensors and chemical sensors for clinical applications today, at best, are reliable for days. For environmental monitoring, systems are available that can operate for months without a service visit, but these typically cost €15,000 per unit (often considerably more) and they are bulky and expensive to maintain.

The key issue lies in a clearer understanding of the chemistry and biology of the way in which the sensor surface interacts with the (often hostile) sample medium. Processes like biofilm formation, leaching of sensor membrane components, and surface poisoning cause rapid changes in the sensor response characteristics, which lead to unacceptably high errors in estimations of the concentration of the target species. The standard strategy for dealing with this is to calibrate out the changes in response behaviour, which extends the useful lifetime until the response function is degraded to the extent that the device is no longer viable. However, implementing even a modest calibration regime at a remote environmental location is not a trivial matter, as fluid handling components dramatically increase the unit cost (pumps, valves, fluidic interconnects), and standards/reagents are costly and must be stable for the duration of the deployment (months). And while this is realisable at major expense for environmental scenarios, it is impossible for implantable chem/bio-sensors.

Clearly what is needed is a revolution in the capabilities of chem/bio-sensing platforms, and this can only be delivered through re-invention of sensor concepts. It is my contention that such dramatic progress will be created via fundamental breakthroughs emerging from materials chemistry and biomaterials, and in particular, developing functional components that are much more biomimetic in nature than current approaches. Evolution has already solved many of these key challenges and the answers lie in the strategies employed by nature to produce surfaces and materials that are inherently resistant to biofouling, fluidic systems that incorporate valves and pumps based on soft polymer actuators, and sensors that can be created on demand.

We must study these strategies more fully, understand the mechanisms involved, and apply this knowledge to new concepts in chem/biosensing if we are to realise sensors with performance characteristics far beyond our current capabilities.

The Boyle Higgins Lecture of the Institute of Chemistry of Ireland

Chemical Sensing with Autonomous Devices in Remote Locations: Why is it so difficult and how do we delivery revolutionary improvements in performance?

will be given by Professor Dermot Diamond, Insight Centre for Data Analytcs, National Centre for Sensor Research, Dublin City University, Dublin 9, in the

Nursing Building (first building at the Collins Road entrance), Dublin City University, Glasnevin, Dublin 9 at 5.00pm on Thursday 16 April 2015.

The meeting will be followed by a finger buffet reception

BOYLE HIGGINS GOLD MEDAL AND LECTURE AWARDS

The Boyle Higgins Medal and Lecture Award is an award for research work carried out in chemistry under the headings: (a) Pure Chemistry, (b) Applied and Industrial Chemistry or (c) Chemical Education. The award is made for an outstanding and internationally recognised research contribution to the advancement of chemistry by a chemist of any nationality working in Ireland or by an Irish chemist working overseas.

Previous Recipients

1990	Professor Duncan Thorburn Burns (Applied Chemistry)
1992	Doctor Peter E. Childs (Chemical Education)
1993	Professor M. Anthony McKervey (Pure Chemistry)
1996	Professor David A. Brown (Pure Chemistry)
1998	Professor Richard N. Butler (Pure Chemistry)
2000	Professor Dervilla M.X. Donnelly (Pure Chemistry)
2002	Doctor John F. O'Sullivan (Applied Chemistry)
2005	Professor Donald Fitzmaurice (Pure Chemistry)
2007	Professor Rory More O'Ferrall (Pure Chemistry)
2008	Professor Albert Pratt (Pure Chemistry)
2009	Professor Seán Corish (Pure Chemistry)
2011	Professor Frank Hegarty (Pure Chemistry)
2012	Professor Malcolm R. Smyth (Applied Chemistry)
2013	Doctor Sheila Willis (Applied Chemistry)
2014	Professor Patrick J Guiry (Pure Chemistry)