Integration of miniature, ultrasensitive chemical sensors in microfluidic devices

Salzitsa Anastasova1, Aleksandar Radu1, Fernando Benito Lopez1, Johan Bobacka2*, Andrzej Lewenstam2*, Dermot Diamond1*

1CLARITY Centre for Sensor Network Technologies, National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin 9, Ireland
2Abo Academi, Tuomiokirkontori 3, FI-20500, Turku, Finland

j.bobacka@abo.fi
alewenst@abo.fi
dermot.diamond@dcu.ie

Simple construction, good detection limit1, very low power demand, and simple experimental setup coupled with miniaturization opportunities arising from solid-state format makes ISEs an excellent prospect for integration in autonomous sensing devices and ultimately their integration in large wireless chemo-sensing networks.2,3 Microfluidics, also known as “lab-on-a-chip” is an emerging technology that is changing the future of instrument design. Microfluidics enables small scale fluid control and analysis, allowing developing smaller, more cost-effective, and more powerful systems.4,5,6

We are working on development of miniature devices featuring sensitive yet simple sensors that could enable rapid access to important environmental information from in-situ deployed sensors, and thereby facilitate timely action to minimize the adverse impact of emerging incidents. Our work involves integration of ultra-sensitive yet simple chemical sensors into a microfluidic device that has integrated wireless communications capabilities. Our ultimate objective is to develop a microfluidic chip that will incorporate polymer-based lead-selective solid-state electrodes. We will test the series of developed chips for the best design to accommodate these sensors. Initially, we are targeting lead-selective sensors and their application to the monitoring of drinking and natural water quality.

Our ultimate vision is the development of a microfluidic-based platform with fully integrated screen-printed solid-state ISEs, and the associated reference electrode, which will be suitable for use as a chemosensing component in a widely distributed wireless sensor network (WSN) for monitoring the quality of a fresh water system. A key challenge in the realization of this vision is to build in advanced system diagnostics, and particular, sensor status tests using simple electronic signals, in a manner similar to those used in physical transducers.7 In this way, it may be possible to assist in distinguishing sensor malfunction or signal artifacts from real events, even in relatively simple, low cost platforms.

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