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Microfluidics and Stimulus-Responsive Materials – The Key to Next Generation Chemical Sensors for Widely Distributed Environmental Monitoring[1]

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The fields of chemical sensing and microfluidics have promised much, but in terms of functional devices, have delivered relatively little. Issues like biofouling and surface degradation mean that sensor characteristics change rapidly in real samples. Consequently, chemical sensors must be regularly recalibrated to ensure the information they send is reliable. This results in complex and very costly devices that must integrate fluidics, standards, and waste storage, as well as sampling and analytical procedures. The fundamental challenge for realizing sensors for widely distributed environmental monitoring is this - how can we produce low cost sensing platforms that can function reliably in an autonomous manner for periods up to years? The key to progress lies in new, and more sophisticated materials that can respond to external stimuli, and communicate with the external world. For example, materials that can be activated from a passive state, reversibly bind and release targeted guest molecules, and return to a passive form. Activation and deactivation happen as part of an external control system, which can be local (chemical in nature) or external (e.g. photonic), and the material reports its status (passive, activated-free, activated-occupied) optically materials can be incorporated into more sophisticated platforms, such as micelles, beads, or complete fluidic systems that are much more biomimetic in nature than current platforms. They include polymer actuators that expand and contract dramatically under an external stimulus (e.g. light), enabling valve and pumping functions to be fully integrated into the microfluidic device. This lecture, I will present some of the exciting possibilities for chemical sensing that are now beginning to emerge through breakthroughs in fundamental materials science.

[1]Science Foundation Ireland - 07/CE/I1147 - "CLARITY: Centre for Sensor Web Technologies."