Electrochemical Detection and Photonic Reporting in Microfluidic-Based Chemical Sensors

This presentation describes a new approach for sensing electrochemically active substrates using microfluidic systems. This two-electrode sensor relies on electrochemical detection at one electrode and electrogenerated chemiluminescent (ECL) reporting at the other. Each microfabricated indium tin oxide (ITO) electrode is located in a separate microfluidic channel, but the channels are connected down-stream of the electrodes to maintain a complete electrical circuit. Because of laminar flow, there is no bulk mixing of the fluids in the detecting and reporting channels. This approach allows the ECL reaction to be physically decoupled from the sensing channel of the device, which greatly expands the number of analytes that can be detected. Because the cathode and anode are electrically connected, electron-transfer processes occurring at the sensing electrode are directly coupled to the ECL reaction. Charge balance permits the ECL light output to be quantitatively correlated to electrochemical reductions at the cathode. The system is used to detect $Fe(CN)_6^{3-}$, $Ru(NH_3)_6^{3+}$, and benzyl viologen and report their presence via $Ru(bpy)_3^{2+}$ (bpy=bipyridine) luminescence. Each redox target turns on ECL at a different potential bias that is related to its standard redox potential. The influence of the concentrations of $Ru(bpy)_3^{2+}$ and the target analytes is discussed. The effect of flow rate is also addressed. Preliminary data involving the detection of biomolecules is described.