

613b Integrated Electrical Sensor Arrays in Microfluidic Networks

Matthew C. Cole and Paul J. A. Kenis

As microfluidic networks continue to decrease in size and increase in complexity, the ability to monitor the passage of material throughout them becomes ever important. Many current microfluidic sensing techniques commonly employ optical methods based on differences in the refractive index of fluids. These techniques, though accurate, can often be complicated and difficult to incorporate with the rest of the microfluidic fabrication process. A promising alternative to these optical sensors involves the use of small electrical elements embedded in microfluidic devices. These electrical sensors can be simpler, less expensive, and can offer a greater number of sensors per unit area than their optical counterparts. We have used thin film resistive heaters to demonstrate the detection of discrete plugs of alternating fluids in a microchannel. A small voltage is applied to a resistor photolithographically patterned on the substrate of a microfluidic channel, and the corresponding current is measured. Changes in current signify changes in the thermal conductivity of the fluid surrounding the resistor, and therefore changes in the type of fluid. Using a low thermal conductivity polyimide as the channel substrate helps amplify heat transfer from the resistor to the fluid. This is a simple method to determine whether or not a certain fluid is present at a certain location in a microfluidic network. A similar system can be envisioned using conductive sensing. In such a system, two electrodes separated by a small gap are patterned on the bottom of a microfluidic channel. A constant current is applied to the circuit, and the voltage drop across the gap is monitored. Fluctuations in the potential correspond to changes in the conductivity of the fluid passing over the electrodes. We will report on our efforts to fabricate, implement, and characterize resistive and conductive sensor elements in large-scale microfluidic networks.