Implantable Luminescent Biosensors – Materials and Instrumentation for Next-Generation Monitoring

Mike McShane

Biomedical Engineering and Materials Science & Engineering, Texas A&M University, College Station, TX, USA

Personal health monitoring is becoming increasingly accessible. The ease of producing low-cost, low-power embedded systems has fueled a rapid growth in consumer products aimed at “measuring me.” Common examples include activity trackers, pulse and heart rate monitors, and sleep assessment tools. Future releases will include concussion alert systems, wearable ECG, EEG, and other biopotential signal analyzers, gait trackers, and other noninvasive measurement systems. However, a major technology gap is in the space of continuous chemical sensing.

Commercial devices for continuous glucose monitoring are examples of progress in this area; yet, they are invasive and lack longevity. Fully implantable integrated systems face significant hurdles to implementation. Noninvasive optical approaches have failed due to poor sensitivity and nonspecific interactions. Our proposed solution is to develop miniature, injectable, “passive” implants. To this end, biosensors with microscale and nanoscale organization are being developed to enable observation of the extracellular and intracellular environment. These provide specificity through use of specific receptors and enhance sensitivity through fluorescence or phosphorescence. And they employ materials that can integrate naturally with tissue, such as porous gels and microparticle suspensions.

While aimed primarily toward the long-term goal of personal health monitoring, these systems may provide opportunities for advanced basic research as well as potential clinical applications. Towards this goal, with an emphasis on monitoring of diabetes and other chronic conditions, we have demonstrated hydrogel-based biochemical sensors that change optical properties as measured by luminescence intensity and lifetime.

This talk will describe several examples of these materials and the underlying motivation for their design, particularly highlighting the major challenges to long-term monitoring. To conclude the talk, recent in vivo observations revealing interesting apparent physiological changes will be presented. The data illustrate the feasibility of this approach, but also open new questions and new ideas about the value of collecting chemical information continuously.