A little about PEMC sensor, a versatile device

Presence of pathogenic bacteria in food or the occurrence of a biomarker in blood is often assayed routinely. For example, ground beef is routinely sampled and tested for the disease-causing bacteria. Current methods require in excess of 8 hours to detect the presence, because we do not have sensitive and accurate methods. The method developed by Professor Mutharasan and his PhD students, Gossett A. Campbell (currently at GlaxoSmithKline), Kishan Rijal (currently at Merck) and David Maraldo (currently at Merck) provides accurate answers in ten minutes. An example of this is illustrated in the figure. A sample of beef wash that was spiked with 10 cells was exposed to the sensor called PEMC that was immobilized with an antibody against the E. coli pathogen. As the cells in the sample bound to the sensor its signal decreases. See curve graphed in solid dots. There are two repeat experiments that are overlaid in the graph, and one sees a reproducible sensor reading within ten minutes. We also do controls – in this case, a positive, a negative and a buffer control so that we are sure that the sensor is a reading that is due to the target pathogen. The key and a special advantage the method developed by Professor Mutharasan’s group is, it is very highly selective—meaning it detects the bacteria even though there is a great deal of beef blood and fat particles in the sample; see photo insert.

Another important feature of the sensor is it is very highly sensitive. Mutharasan’s group reported the original work on this in the April issue of *Analytical Chemistry*. Early work was reported in *Biosensors and Bioelectronics* and the more sensitive method in*. The paper in *Analytical Chemistry* was highlighted as a news item by American Chemical Society in its press briefing, Science Daily (http://www.sciencedaily.com/releases/2007/04/070416092206.htm). American Institute of Physics also took wind of the invention and reported the *E. coli* work in “Breakthroughs and Discoveries inside Science” series (http://www.ivanhoe.com/science/story/2006/11/213a.html).

Because the PEMC sensor is sensitive, yet robust in making good quality measurements with real world “dirty” samples that Mutharasan’s group in collaboration with Dr. Garcia (Professor of Pathology, Drexel University School of Medicine) measured a prostate

![Graph](image-url)
cancer biomarker, called AMACR in the urine of prostate cancer patients. The figure attached shows the response of the PEMC sensor immobilized with the antibody to AMACR, where we confirm the binding of the antigen by releasing it with a release buffer. David Maraldo has thus far analyzed seven patient urines and has found this biomarker in all urine samples. The sample is “raw”, meaning it was not treated in any way, and Mutharasan’s group has developed special techniques to quantify the biomarker concentration. We currently confirm the disease prostate cancer by biopsy, which is a painful procedure for the patient. If a method could be found using urine sample it might reduce both cost as well as pain. This work has been accepted for publication recently in Analytical Chemistry.

Another interesting application of the PEMC sensor is in scientific measurements. We illustrate the case of surface adsorption of 1-hexadecanethiol that was recently reported in Langmuir. In this study we showed the chemisorption of a class of molecules called thiols at femtomolar (10^{-15} M) concentration. In the attached figure we expose the sensor sequentially from 1 fM to 100 nM in steps of 10. Because of the chemistry of the system we know how many molecules can be adsorbed from previous work. At 1 fM, the maximum number of molecules that could potentially adsorb is less than 10^{-17} moles, or about six million molecules. This is the first time that we know that we could monitor chemisorption at such low concentration. In other publications we have used the PEMC sensor to measure protein-protein interactions.

Mutharasan’s group has extended the sensitivity of the PEMC sensor down to 100 molecules of ovarian cancer biomarker CA125, a 28 kDa protein in human serum. This was accomplished without sample prep and without the use of labeled reagents. Detection of pathogens via their virulent gene is another application that has been successfully completed by Kishan Rijal as part of his PhD work. Kishan’s work, that is to appear in Analytical Chemistry, shows that detection of small DNA fragments can be detected at 6,000 copies, and that hybridization of DNA strands are not compromised in presence of copious amounts of human serum protein. This important advantage would find new applications in combination with the special biochemical interfaces developed by Mutharasan’s group in many life science and medical applications. We have also shown that 200 E. coli pathogen can be detected in beef washes based on the presence of the virulent gene stx2 in 30 minutes.

The PEMC sensor is a new and a very highly sensitive, yet robust general sensing platform that will find many practical and scientific applications.


