

Photonic Molecular Probe

The Photonic Molecular Probe® (PMP) identifies and measures the concentration of a target molecule(s) within a mixed specimen. The PMP detects multiple physical property changes to use a specially prepared beam of light as it is affected by the target molecule(s). An extremely sophisticated proprietary signal processing technique is employed, using a Bayesian - based Methodology developed for and used by NASA and the Department of Defense. Unlike technologies based on absorption spectroscopy, its most versatile mode of operation is the transmission/reflection dichroic spectra of targeted molecules.

Significant advances in the biological and pharmaceutical sciences have been spurred by advanced separation of screw-like right handed from left handed (chiral) molecules of the same chemical species (enantioselective analysis). Today, studies can be done routinely that would have been difficult and time-consuming a decade ago. Quality control of chiral products and enantiomeric determinations are now done routinely and more accurately with one or more of a plethora of analytical separation methods. Advanced chiroptical methods—optical methods based on the enantiomeric properties of the molecule of interest—have reached the point that they are widely useful and sufficiently sensitive for a variety of analytical determinations for commercial and research purposes. For example, mass spectrometry determination of enantiomeric systems and chiral analysis, enantioselective separations, enantioselectivity in biological and microbiological systems, technologies for large scale purification of enantiopure materials, analysis of enantiopurity and determination of absolute configuration, enantiomeric separation by capillary electrochromatography, enantioselective synthesis, kinetic resolution, and chiroptical spectroscopy and related phenomena.

Nevertheless, present chiroptical techniques may take anywhere from 10 to 30 minutes, or more, to perform an analysis and are limited to laboratory measurements because of the size of the equipment. The overwhelming majority of applications are *in vitro* (out of living tissue). In the last decade, however, several university researchers have begun to explore the possibilities of using chiroptical techniques *in vivo* (in living tissue), for example, looking at glucose levels in the vitreous humor of the eye. Their results thus far support the scientific principles the PMP is based upon.

The PMP is a huge advancement over present chiroptical technologies. It is a miniaturized, real time measurement technology that encompasses a unique and innovative approach to a completely integrated system of signal preparation, data acquisition, signal processing and optics. Because of its operational capabilities, the PMP has a myriad of potential applications; *in vivo* as well as *in vitro*: non-invasive monitoring of blood metabolites, detection and discrimination of chemical and biological agents, fermentation process control, environmental pollution monitoring, and plastic waste disposal, to name a few.

Moreover, and significantly, the PMP can be effectively used for molecules possessing little or no natural chiroptical activity. This is achieved with an RF (radio frequency) resonance technique described in the PMP patents, thus extending the list of substances which may be effectively and accurately monitored in real time by the PMP. The extended list would include blood alcohol concentration. The implication is real time, accurate, non-invasive roadside testing by law enforcement agents.

A key feature of the PMP integrated system is its highly sophisticated (proprietary) signal processing techniques. Signal processing is a major troubled spot and weakness for just about all non-invasive technologies. In general, the generic problem of locating and identifying a target, to a high degree of certainty, within a noisy, cluttered background, has been done by ad hoc procedures and the use of matched or correlation filters along with standard statistical analysis such as the method of partial least squares. However, correlation methods should be supported by a sound theoretical foundation derived from well-established methods of signal processing which include accurate parameter estimation based on the physics of the target and background. One approach to parameter estimation is from the Bayesian standpoint, according to which prior knowledge regarding the parameters to be estimated. The application of this method to the areas of physiological systems and medical diagnostics, such as the assay of blood constituents, as well as concentration levels, has not been employed before. Our key technical people have very successfully employed Bayesian signal processing methodology on heat seeking missiles, NASA space station experiments, and observational satellites.

Summary of PMP Features:

1. Non-invasive. It does not draw blood or any other body fluids.
 - a. No disposables are needed with each use—only a periodic leasing fee to update the electronic chip
 - b. User friendly. The PMP will allow diabetics to easily monitor themselves numerous times a day without distress.
 - c. Ease of use for police in the field and authorities in the work place. The PMP eliminates the concern for inaccurate or incorrect readings. This will enable a much swifter and legally appropriate decision to be made based on the results of the PMP device.
 - d. The PMP does not require a cooperative subject.
2. Real time, on the spot, analysis instead of waiting for laboratory analysis: faster than technologies currently being used
3. The PMP will establish clinical standards. For example, the clinical test standard for glucose is hexokinase, which requires the extraction of blood. The error associated with this test is $\pm 5\%$. The error associated with the PMP is expected to be $\leq 5\%$. Invasive field technologies currently being used are at best on the order of $\pm 15\%$, i.e. a 30% margin of error in the measurement.
4. The techniques are broad and applicable to multiple applications: monitoring blood constituents such as alcohol, glucose, illicit/licit drugs and triglycerides; food inspection; plastic waste disposal; and continuous alcohol monitoring in brewing vats.
5. The PMP can be miniaturized and portable. (The present proof of principle device is mounted on a 6" x 8" breadboard.)

6. Price advantage over competition's.
 - a. Glucose monitor will be very competitive with invasive devices presently on the market. The cost effectiveness will show up in the basic price of the unit and the fact that there will be no disposables associated with each use of the device. The projected retail cost will be less than \$1000 per portable unit—probably between \$500 to \$700¹. Mildly invasive units (based on electrophoresis in which the skin is tweaked by a small electric current to release tissue fluid, not blood, from which they determine blood glucose levels, or a weak laser which vaporizes the upper tissue layer that is collected and then chemically analyzed) scheduled to be on the market within the next few years have reported price tags of \$1,500 to \$2,000.
 - b. Drug Screening Device: There are no self-contained non-invasive drug screening devices on the market at present. The basic portable unit price will be comparable to the glucose monitoring meter.

¹ Estimated retail cost is based on the part cost of the original demonstration model. That cost was less than \$300.