Bringing Science to the Surface™

Company Background: Platypus Technologies LLC is developing a liquid crystal-based analytical platform that is useful for the ready detection and measurement of chemical and biological substances. The foundation of our technology is the characteristic of liquid crystals (LCs) to align in a preferred orientation on a functionalized surface and to change that orientation in response to a chemical or biological event. This reorientation is similar in principle to the realignment of LCs in high resolution displays, such as LCD monitors, in response to changes in an electric field. We are developing LC sensors that can be configured to provide a rapid optical or electronic response in the presence of target molecules. Platypus has demonstrated the utility of our patented LC technology by fabricating sensor prototypes that can detect: (1) various classes of gases such as simulants of nerve agents, toxic industrial chemicals, environmental pollutants, and (2) markers of infectious agents. These sensors can be formatted to give a visual signal that is easily seen by the operator, an opto-electronic signal that can yield a numerical value reflecting the amount of compound present, or an electronic signal that is resistant to potential optical interference. The LC technology developmental effort is led by Dr. Bharat Acharya, Director of Sensor Development. Dr Acharya holds a doctorate in physics from Kent State University and is an expert in LC material, optics, and interfaces. His efforts are directed toward better understanding the underlying mechanisms involved with LC sensors, the LC interactions at various interfaces, and exploiting them to improve sensor performance.

Platypus R&D efforts have been supported mainly by federal funds through the Department of Defense, the Small Business Innovation Research (SBIR) program at the National Institutes of Health (NIH), and Defense Advanced Research Projects Agency (DARPA).

Technology: Daunting technical challenges of cost, operational simplicity, response time, sensitivity, specificity, and environmental robustness pose barriers to the development of real-time chemical or biological monitoring systems that will be broadly useful to the private sector and the government. Environmental exposure to hazardous agents in the air that we breathe and the water that we drink, whether accidental or intentional, is a frightening certainty. We are addressing these challenges by developing sensors that employ patented *Platypus Technology.*

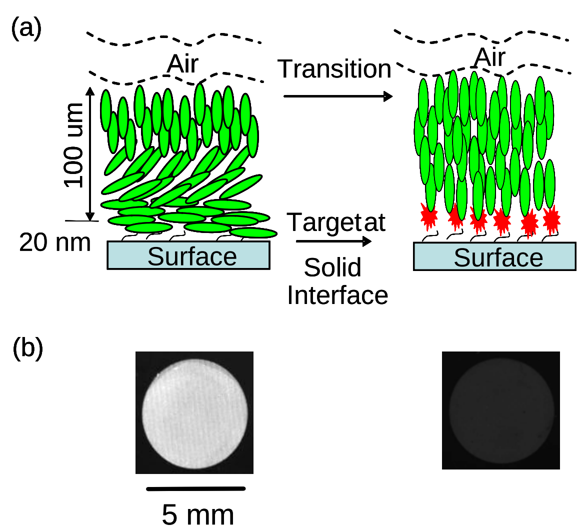

Figure 1. Illustration and images of LC-based sensors for detection of analytes. A surface is chemically treated to align a thin film of LCs in a prescribed orientation. (a) Target molecules present in vapor phase diffuse through the film and compete with the LC for receptors on the surface. The binding event affects a change in the LC alignment at the LC/solid interface that is communicated through the bulk. (b) The images, as viewed through crossed polarizers, show the appearance of the sensor (left) before and (right) after exposure to the target.

Platypus Technology combines chemically functionalized interfaces with LCs to provide the basis of a sensor platform offering a remarkable range of features, including a small footprint (< 5 mm diameter) for portability, a reversible response for real-time monitoring and constant surveillance, direct visual indication or easy integration into optical and/or electronic reporting systems, ease of operation and low manufacturing costs. These properties make possible a range of applications that are prohibited by the cost or complexity of other technologies. Our propriety technology relies on the fact that the molecular orientation and thus the optical characteristics of a film of LC in contact with an interface is highly sensitive to the molecular-level structure of the adjacent interface. Binding events that occur at the interface between the solid surface and LC, as shown in **Figure 1,** lead to changes in the molecular-level structure of the interface and drive transitions in the orientation of the LC film. This process results in the amplification of processes associated with molecular recognition into measurable outputs that can be optically or electrically interrogated.

LC detection technology has been used for detection of chemicals in vapor-phase and biological entities in liquid samples. The LC sensors are tolerant to non-targeted compounds, can be tuned for specificity (e.g., to differentiate between molecules possessing common functional groups), and permit the real-time monitoring of environments without operator intervention. The sensing element is compact, thus reducing the logistics burden. It can be prepared using established processes that are amenable to high throughput manufacturing and from low-cost materials making it affordable for wide implementation in the field. The optical output of visible light from the sensor can be directly observed (see **Figure 1**) or quantified, e.g., use of a light emitting diode (LED) and a photodiode detector. Integrated with simple electronics, the sensor output can also be quantified by measuring changes in capacitance. Past research at Platypus has demonstrated that the LC technology can selectively report the presence of vapor phase compounds including simulants of chemical warfare agents, air pollutants, organophosphate pesticides, physiologically relevant gases and toxic industrial compounds. Successful development and commercialization of sensors that can detect these analytes followed by targeted marketing efforts will allow for broad reach of this technology into diverse market areas.

Preliminary studies performed at Platypus suggest that the LC sensor technology can be incorporated into a gas sensor that will be inexpensive, require minimal training, and provide fast results. For example, we currently detect 5 ppm nitrogen dioxide and hydrogen sulfide in less than 2 minutes. Using the microfluidic approach, we have also demonstrated detection of 5 parts per billion of nitrogen dioxide with just two minutes exposures.

Competition: Products already exist that are used for personal monitoring, confined space sampling, smokestack emission surveys, and environmental testing for presence of hazardous gases. Among the commercially available monitoring systems the types of instruments most commonly used include electrochemical cells, solid-state semiconductors, lead acetate tape, photometric analysis, and gas chromatography with flame photometric detection. These analytical devices can be prohibitively expensive, complex to operate and often require calibration against gas standards. The envisaged Platypus LC-based sensor will be easily operated, provide results within a few minutes, and yield unequivocal results without the requirement for costly and time-consuming calibration.

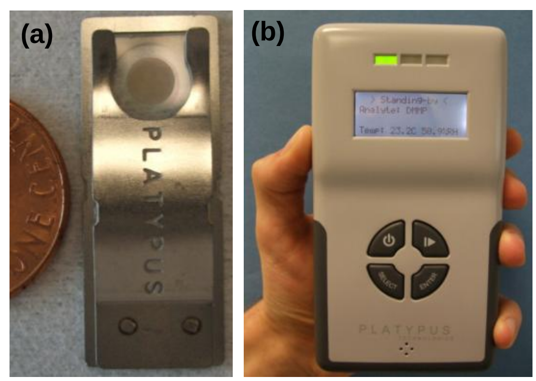

Figure 2. Sensor Chip (a) and Handheld Sensor Device (b).

Business Model: Platypus will identify and target development of the core LC sensor technology to address significant unmet needs in the market. Successful commercial development will require financial and resource commitment for market research, targeted development of final products, manufacturing, regulatory approvals, sales, distribution and marketing. We will engage corporate partners that are effectively positioned to collaborate in the development of specific product and market opportunities.

Products will comprise a device (**Figure 2**), that incorporates the LC sensor as a consumable component, that is specifically designed to a target market segment based on its ability to provide important benefits to the customer. Platypus' role will be as developer and manufacturer of the LC sensor and holder of the related IP. We envision negotiating OEM supply relationships with our partners where Platypus would supply the LC sensor and the partner would design, manufacture and market the final product.

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