TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

20th June 2014

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1. MULTIPLE SENSOR NETWORK PROVIDES REAL-TIME UPDATES ABOUT AIR QUALITY

Poor environmental air quality is one of the main reasons for severe health diseases such as asthma attacks, lung or heart diseases, respiratory impairment, and so on. Agencies such as the Environment Protection Agency (EPA) employ air monitoring sensors to detect pollutants in the air and provide air quality analysis. EPA measures a range of pollutants at geographically dispersed monitoring stations and provides air quality analysis data regularly. However, there is a need for more comprehensive monitoring of air quality that can be enabled by networks of sensors comprised of different technologies to sense multiple parameters.

PerkinElmer, based in the US, has developed the Elm network to address the above challenges. Elm is an innovative network-based air monitoring technology comprised of Elm nodes that are fully enclosed in a plug with six air quality sensors, including sensors based on electrochemical, light-scattering, and metal oxide sensing technologies. Its design is highly compact, weatherproof, and robust. Elm network detects pollutants such as volatile organic compounds (VOCs), nitric oxide (NO), nitrogen dioxide (NO2), ozone (O3), particulates, as well as humidity. Elm processes, collects, and stores information on a cloud database, and generates a Web-based easy-to-access report.

Elm measures patterns of air quality indicators such as ozone, dust, soil material, and nitrogen dioxide. Elm's primary sensor measures the concentration of a particular pollutant by detecting the gas particles. Elm sends information about the level of concentration to a cloud database. The Information is then processed and a user friendly Web-based report is

generated show casing air quality and concentration of different pollutants. It provides an in-depth report on the trend of the environment and not just the data. Every 20 seconds this process is repeated, keeping users updated in real time about their local environment through Wi-Fi or GSM-enabled devices such as smart phone and tablets.

This solution was fully funded by PerkinElmer, the parent company of Elm. Elm recently established its network in 25 different locations of Boston metro area. The Elm network's report suggested that the poor air quality of the city of Chelsea was due to the high concentration of particulates. In the future, Elm is planning to expand its network in 10 countries with more than 200 sensors and detect more pollutants. By 2015, Elm is planning to anticipate revenue generation. Elm's air monitoring solution will help local communities to make decisions about their air quality, making their environment sustainable and safer to live and work. Elm's solution has opportunities to have strong customer base.

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2. SENSORS TO DETECT LISTERIA MONOCYTOGENES

The increase in number of food-borne diseases has raised concerns over the safety of the food supply system. The presence of pathogenic bacteria in food is a threat to the food industry. Contaminants are mainly getting transmitted because of ready-to-eat foods such as meat, milk, smoked fish, vegetables, and cheese. According to Centers for Disease Control and Prevention, the bacterium *Listeria monocytogenes* causes 260 deaths and 1600 illnesses per year in the United States. It mainly targets people with weak immune systems such as elderly people, new born children, and pregnant woman. Traditional method to test the sample cells in labs can be flawed, and alternative methods can detect cell types but can have difficulty differentiating between harmful dead and live cells. Current techniques take days to detect bacteria and can easily cross contaminate other ready-to-eat products. LM has characteristics facilitating its multiplication and growth. It gets transferred to another food or surface. There is the need to detect LM as early as possible.

The Biolisme Project--a project of the University of Southampton (UK). Betelgeux S.L. (Spain), Ainia Centro Tecnológico (Spain), 40-30 (France), Photek Ltd. (UK), and Dublin City University (Ireland)--has developed the Biolisme sensor for addressing the above challenges. This prototype is capable of detecting and collecting *Listeria monocytogenes*, and preventing food contaminated with the bacterium from entering supermarkets.

The Biolisme sensor uses biofilms and is designed to sample single cells. The cells in a biofilm get stuck to each other on the surface. The cells produce a matrix called extra cellular polymeric substance, which is a polymeric conglomerate of proteins, DNA, and polysaccharides. The biofilms can be formed on any non-living or living things. The Biolisme device is comprised of a sensor and uses water and compressed air to isolate cells from the surface before they can be introduced to an antibody. The antibodies, which are also called as immunoglobulins, help in identifying and removing viruses or bacteria. If *Listeria monocytogenes* is present, it will react with the antibody and produce a fluorescent signal, which will be detected by a special camera. This new device is able to detect and collect *Listeria monocytogenes* on location within three to four hours. By rapid and early detection of contamination, cross contamination can be prevented. For instance, in a supermarket, vegetables contaminated with the bacterium can be detected and removed before the bacterium can contaminate the other vegetables/food stuff.

The Biolisme Project, which concluded in 2011, was funded by European Union's 7th Framework Programme for Research (FP7). After Biolisme, FP7 is funding a project called Biolisme 2 to commercialize the sensor. This sensor will benefit end users in the agri-food industry such as safety consultants, laboratory service providers, and food producers.

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3. CHEMICAL SENSOR INTEGRATED WITH QUANTUM LASER AND DETECTOR

Chemical sensors are devices used to detect the presence or concentration, and quantity of a chemical or a gas, such as measuring oxygen concentration in blood. Chemical sensors are widely used in diverse applications, such as health monitoring, residential gas detection, automotive exhaust gas (that is, oxygen) or cabin air quality sensing, environmental monitoring, industrial hygiene and worker safety, and homeland security. There are varied chemical sensing technologies such as electrochemical, metal oxide semiconductor, catalytic bead, optical, and so on. Chemical sensing can encounter several challenges, such as lack of specificity, vulnerability to false alarms, or instability. There is also an ongoing need for chemical sensors that are very compact, cost-effective, and easy to use; require less adjustment and calibration; are able to work with minimum interference; and are capable of accurate and real-time measurement..

Researchers from the Vienna University of Technology have developed a chemical sensor, that can address the above challenges or needs. It comprises a detector, a surface plasmon polariton (SPP) waveguide (that serves as an optical connection between the quantum cascade laser and detector), and a laser. This sensor can effectively analyze liquid and gaseous chemical compositions.

This bi-functional chip eliminates the need for device adjustments, as key components are integrated on one single chip; making the device compact, cost effective, and easy to use. The total gap between the laser and the detector is 50 micrometers. This gap is bridged with a plasmonic waveguide made of gold and silicon nitride. Silicon nitride is suitable for high temperature oxidation and exhibits high breakdown voltage. This coating helps reduce noise in the signal, thereby enables achieving minimum interference.

For detecting the composition of a liquid, the bi-functional chip can be submerged in the liquid. After light is emitted from the laser, it gets coupled with the surface wave and propagates through plasmon waveguide and reaches the detector. In the plasmon waveguide, light gets coupled with the surface and propagates parallel with the metal interface. When the detector detects the decrease in intensity of light because of the propagating waves getting absorbed by the molecules, the total composition of the liquid can be

determined. The researchers have successfully tested the chemical sensor on a mixture of alcohol and water and have obtained a result with 0.06% accuracy.

Apart from chemical sensing, this sensor also has applications in microbiological diagnosis, medical and environmental monitoring.

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4. RECENT PATENTS IN THE FIELD OF BLOOD GLUCOSE MONITORING

Blood glucose monitoring is used to determine the concentration of glucose in the blood stream. This is important for people affected with diabetes. Diabetes is one of the most common diseases that affect people across the world. It is normally caused when an inadequate amount of insulin is produced by the pancreas. This leads to high-blood sugar levels that can have serious implications if not treated. Type I diabetics need to directly inject insulin into their bloodstream. Type II diabetics can take insulin orally.

To monitor blood glucose, patients are conventionally required to provide a drop of blood sample that is analyzed with support from healthcare professionals. This is usually done using a needle to prick the finger. Since people afflicted with diabetes need to regularly monitor the blood glucose levels, this method can cause discomfort. Hence, there is a need to have non-invasive or minimally invasive techniques that cause minimal or no discomfort to patients. Electrochemical, optical, microwave, or magnetic field technologies are among those that could allow for minimally invasive or non-invasive and continuous analysis of blood glucose. The patent data reveals interest in areas such as multifunctional glucose monitors, non-invasive glucose monitors, continuous measurement of glucose, and body-scale glucose monitoring systems (which can also monitor other health parameters) using a wireless network to transmit data.

PATENT TITLE	PUBLICATION DATE / NUMBER	ASSIGNEE	INVENTORS	ABSTRACT
MULTIFUNCTIONAL GLUCOSE MONITORING SYSTEM AND METHOD OF	12.06.2014; WO/2014/088581	BD TECHNOLOGIES	LOCKHART, Artis	A multifunctional glucose monitoring system and method of measuring glucose level, determining insulin dosage, and indicating insulin dosage on a syringe is disclosed. The multifunctional glucose monitoring system includes standard functionality with respect to

USING THE SAME				acquiring a blood glucose reading. However, in addition, the multifunctional glucose monitoring system includes a dosage algorithm for calculating an insulin dosage based on the blood glucose reading and any other useful parameters, and includes a built-in marking device for marking the calculated dosage level on the barrel of an insulin syringe that is installed in the body of the multifunctional glucose monitoring system. A method includes the steps of measuring the glucose level, determining an insulin dosage, and indicating the insulin dosage on a syringe.
NON-INVASIVE REAGENTLESS GLUCOSE DETERMINATION	30.05.2014; WO/2014/081586	HALAKA, Folim	HALAKA, Folim	Non-invasive apparatus and method for determining and monitoring glucose concentrations in human subjects. Glucose level is estimated through the effect of glucose on biological cells with glucose dependencies, e.g., red blood cells. The invention is based on the interaction of such cells with oscillating electric field gradients. The response of biological cells depends on factors including shape, size, and electrical charge distribution. The field gradient causes the cells to undergo characteristic motion which is detected by light beam scattering. The autocorrelation of the scattered light is computed, and the Fourier transform (FT) is performed to produce a characteristic velocity spectrum in which the peaks are characteristic of the cell "bio-electrical" states. The glucose level is estimated through measurements of changes of FT with changes in glucose levels after calibration with standard glucose methods.
Device For Continuous Measuring Of An Analyte	29.05.2014; US20140148669	Garcia Saban Javier Francisco	Garcia Saban Javier Francisco	The present invention relates to a device for continuous measuring of an analyte which allows monitoring the blood or interstitial glucose level in a minimally invasive, minimally detrimental and painless manner for which it basically comprises a fixed element (1) on which there is fixed a disposable and exchangeable element (2) incorporating an automated multi-puncturing system programmable over time comprising a plurality of puncturing units each formed by a micro-needle (3), means for driving said micro-needle (3), an elastic spring (10) returning it to its resting state and a

				biosensor wherein the glucose data which is subsequently transmitted to an external reading and management device is extracted.
Health Measurement Systems	22.05.2014; US20140142396	Ricks Nathan W.	Ricks Nathan W.	A device for monitoring health is disclosed. The device includes a body scale housing, a controller, one or more sensors, and a communications device. The controller receives measurements from the sensors and determined a user's weight and body mass index, and one or more of a user's blood pressure, body temperature, blood glucose levels, C-reactive protein, ketone levels, oxygen saturation, blood cholesterol levels, testosterone levels, and progesterone levels. These measurements are transmitted to an external database over a wireless network.
DEVICE AND METHOD FOR DETERMINING ANALYTE LEVELS	08.05.2014; US20140128701	DexCom, Inc.	Shults Mark C.	Devices and methods for determining analyte levels are described. The devices and methods allow for the implantation of analyte-monitoring devices, such as glucose monitoring devices, that result in the delivery of a dependable flow of blood to deliver sample to the implanted device. The devices comprise a unique microarchitectural arrangement in the sensor region that allows accurate data to be obtained over long periods of time.
CONTINUOUS ANALYTE MONITOR DATA RECORDING DEVICE OPERABLE IN A BLINDED MODE	24.04.2014; US20140114157	DexCom, Inc.	Valdes Jorge	A system is provided for monitoring analyte in a host, including a continuous analyte sensor that produces a data stream indicative of a host's analyte concentration and a device that receives and records data from the data stream from the continuous analyte sensor. In one embodiment, the device includes a single point analyte monitor, from which it obtains an analyte value, and is configured to display only single point analyte measurement values, and not any analyte measurement values associated with data received from the continuous analyte sensor. Instead, data received from the continuous analyte sensor is used to provide alarms to the user when the analyte concentration and/or the rate of change of analyte concentration, as measured by the continuous analyte sensor, is above or below a predetermined range. Data received from the continuous analyte sensor may also

				be used to prompt the diabetic or caregiver to take certain actions, such as to perform another single point blood glucose measurement. In another embodiment, the device provides for toggling between two modes, with one mode that allows for display of glucose concentration values associated with the continuous glucose sensor and a second mode that prevents the display of glucose concentration values associated with the continuous glucose sensor.
COMMUNICATION PROTOCOL IMPROVEMENT TO RECOVER DATA FROM A CONTINUOUS GLUCOSE MONITOR	17.04.2014; 20140107449	ROCHE DIAGNOSTICS OPERATIONS, INC.	Ecoff Clint A.	Data transmissions between medical devices are governed by various communication protocols. For example, blood glucose measures may be retrieved wirelessly from a continuous glucose monitor in accordance with the ANT wireless communication protocol. Smaller data packets are preferably transferred in a standard data transfer mode which is optimized for speed and power management; whereas, larger data packets are transferred in a file sharing mode. Techniques are presented to address recovering data lost during the standard data transfer mode in an efficient manner and preferably without the use of the file sharing mode.

Exhibit 1 lists some of the recent published patents on blood glucose monitoring.

Picture Credit: Frost & Sullivan

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