TECHNICAL INSIGHTS

SENSOR

TECHNOLOGY ALERT

17th October 2014

1. PHOTOVOLTAIC COMPONENT INTEGRATED WITH NANOSENSOR FOR TRANSFORMING SURFACES INTO SOLAR PANELS

According to the World Bank's report on electric power consumption in 2013, the United States has consumed 13,246 kilowatt-hour (kWh) per person in a year. With the growing number of smart products, household energy consumption is increasing. Manufacturing industries also play a key role in energy consumption. According to a report published by the European Factories of the Future Research Association in 2014, approximately 28% of energy is consumed by the manufacturing industry. There is a need to manage energy usage in home appliances and systems. There is a need for cost efficient and easy-to-use device that can convert the natural or artificial light into energy, and power electronic devices without connecting to the grid.

Toward meeting the above-mentioned need, a France-based company, SunPartner Technologies, has developed a device called the Wysips Crystal. The Wysips Crystal is 90% transparent ultra-thin photovoltaic cell. The cell is embedded with a nanosensor and works on light fidelity (Li-Fi) technology.

The idea behind the Wysips Crystal is to transform any surface into a solar panel. The panel will help to generate its own energy from artificial or natural light. The solar cell in Wysips Crystal acts as the light receptor. Wysips Crystal is assembled with a network of micro-lenses that enable the cells to remain invisible to the naked eye. The sensors are integrated into transparent photovoltaic components. This further helps to manage and convert the power generated. As there is no need to connect the sensor to the grid, this technology assures energy self-sufficiency. The moment photovoltaic cells are

exposed to the light, they get activated and start charging the battery. This also powers the electronic equipment they are connected to. Thus, the Wysips Crystal ensures user comfort in offices, homes, and public and industrial facilities.

The Wysips Crystal is expected to be integrated in the windows of houses and offices for converting solar energy into electricity. Some of the applications for Wysips Crystal, such as, integrating the technology below the touchscreen of smart phones, are under development. It will generate approximately 20% of the power requirement of the smart phones, which will be enough for the offline functions, such as, playing music or games on the phone.

SunPartner' Wysips Cameleon, based on the same technology, will be used in outdoor display applications, such as, energy self-sufficient scrolling billboards. Wysips Crystal will be used to power all kind of devices, such as, energy dashboards, humidity detectors, thermostats, and security cameras.

The project was self-funded by SunPartner Technologies. In the past two years, SunPartner Technologies has filed approximately for 30 patents. These patents include elements such as radio frequency identification (RFID) antenna and heat resistance wires, which promise a wide variety of applications. SunPartner's business model is based on licensing. The future plan of SunPartner Technologies is to achieve worldwide acceptance in the field of solar energy. Wysips Crystal and Wysips Cameleon have been commercialized and have received a good response from users because of their low cost and good performance.

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2. TECHNOLOGY WITH POTENTIAL TO REPLICATE SENSE OF TOUCH ELECTRONICALLY

Researchers from Stanford University have invented a wireless pressure sensor that has already been put to use in measuring the brain pressure in lab mice with brain injuries. This new technology offers key potential—it can be used to create skin-like materials that can sense pressure, and in the future, it can be used to create devices that have the electronic equivalent of the sense

of touch. The research team led by Zhenan Bao, professor of chemical engineering, has explained two medical applications of this technology in the journal Nature Communications, published October 6, 2014..

A key area of this research work is the design of the rubber layer used in this device. The rubber used in this project is special because its basic molecular structure can spring back into shape after being compressed. The researchers discovered that a pyramid shaped layer of rubber gave the rubber molecules more freedom to flatten out and spring back into shape.

The wireless sensor's construction involves a thin layer of specifically designed rubber placed between two strips of copper. The copper strip serves as radio antennas, while the rubber provides the insulation. The radio waves are beamed through the antenna and rubber sandwich. When the device is under pressure, the rubber is squeezed by the copper antennas, which changes the electrical characteristics of the device and slows down the frequency of the radio waves reflected by the antennas. When there is no pressure, the copper antennas move apart and the radio waves speed up in frequency. In this process, the researchers were able to measure the pressure exerted on the device by observing the frequency of radio waves passing through the device.

The physics behind the device was modeled by former Stanford University graduate students Lisa Chen and Benjamin C-K, who also calibrated the sensor in simple laboratory tests; Alex Chortos, a graduate student in the department of materials science and engineering, was responsible for making this device robust and reusable.

The wireless pressure sensor was tested as a tool to manage patients with severe brain trauma. The dangerous part of brain trauma is the swelling of the brain. Normally, physicians diagnosed brain swelling with imaging techniques such as computed tomography (CT) scans or by monitoring intracranial pressure (ICP) directly. In ICP monitoring, the probes that penetrate the skull are linked to the external monitor through a cable. This solution has some drawbacks such as the risk of infection, and the possibility of the cable being pulled out. In the experiment with laboratory mice, the researchers monitored the changes in the intracranial pressure continuously by probing the wireless sensor with radio waves.

The researchers said that they are currently working on integrating the device into catheters, which could siphon out cerebral spinal fluid whenever

there is an increase in ICP. In a new direction, the research team is also thinking about using the device to measure the pressure in the eye socket, which is convenient for tracking the intracranial pressure in the brain.

Regarding applications, the researchers say that, over a short term, they are planning to use the device to track packages and monitor health conditions, and over the long term, their dream is to use this technology to create touch sensitive lining for prosthetic devices.

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3. SENSOR TO PROVIDE INSIGHTS ABOUT THE SOUTHERN OCEAN

Researchers at the Monterey Bay Aquarium Research Institute (MBARI) have developed a sensor that could provide new information about the changing Southern Ocean. These sensors will be put to use in Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program. The SOCCOM program, which started last month, is a collaboration between 11 institutions that also includes MBARI. The aim of this six year program is to improve the scientific and public understanding of the role of Southern Ocean in climate change and biogeochemistry.

The chemical sensors to be used in this project were developed by Kenneth Johnson, senior scientist at MBARI, and his team. The sensors can be used to measure the nitrate and pH in the ocean. These sensors will be integrated onto the freely drifting profiling floats and will be used in taking measurements throughout a broad swath of the upper ocean. The floats are battery powered and operate automatically and are mostly situated at depths of 1000 to 2000 meters below the surface. They come up to the surface in every five to ten days to take chemical measurements, and whenever they come to the surface, its position is determined using GPS and the data is sent to the shore based server through the satellite.

In the SOCCOM project, the researchers are planning to deploy 200 profiling floats in the Southern Ocean in the next six years. The floats will enhance understanding about the chemical changes occurring in the Southern Ocean every year. The Southern Ocean is responsible for more than 60% of the ocean’s uptake of heat and half of the ocean’s uptake of carbon dioxide created

by human beings. The nutrients derived from the upwelling in the Southern Ocean are also of great benefit to the ocean ecosystems.

The variability of the chemical properties of the Southern Ocean could give more information about the biological processes such as algal growth and photosynthesis. The cycling of carbon, nitrogen, and oxygen are also of interest to the SOCCOM researchers. The data from the profiling floats will help the researchers to improve the scientific understanding of the ocean and also enhance projections of earth's climate and biogeochemistry. The data will also be used, by the modeling team headed by Joellen Russell, a professor at the University of Arizona, in the analysis of the high resolution earth system models.

There will be significant impacts on the inhabitants because of the rapid changes in the Southern Ocean. The pH levels are dropping because of the increasing concentrations of carbon dioxide and this creates a more acidic ocean. According to the scientists, the ocean acidification may lead to under saturation in aragonite, which is the building material of mollusc shells, and this in turn could affect the population of snails and clams.

The goal of the SOCCOM project also aligns with the MBARI's mission to develop tools locally that can be applied globally.

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4. RECENT PATENTS IN THE FIELD OF FLOW SENSING FIBER OPTIC CABLES

Distributed sensing systems are used to detect many measurement points; for example, to detect pipeline leakage, the condition of underground transmission lines, for optimizing oil production from wells, and so on. Fiber optic sensing systems offer the ability to measure parameters such as strain and temperature at numerous points along a single fiber. Such distributed fiber optic sensing systems are finding opportunities to monitor, for example, elongated structures, such as, oil wells, pipelines, coiled tubing, and flow lines.

A recent patent in the area of fiber optic-based flow sensing at many points (WO/2014/163991) is assigned to Halliburton Energy Services Inc.,

which has been classified under monitoring oil flow rates at multiple points in production well.

From 1946 to October 2014, approximately 884 patents have been registered under flow sensing. From 1957 to October 2014, approximately 62471 patents have been registered under fiber optics. From 1985 to October 2014, approximately 19 patents have been registered under flow sensing by fiber optics.

Fiber optic sensors capable of measuring multiple points can be beneficial for measurement of parameters such as stress, strain, and temperature in several structures. Fiber optic sensing has growth opportunities in various application segments, such as structural monitoring, infrastructure monitoring, downhole oil monitoring applications, and so on.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
FLOW SENSING FIBER OPTIC CABLE AND SYSTEM	09.10.2014; WO/2014/163991	KCHALLIBURTON ENERGY SERVICES, INC.	JAASKELAINEN, Mikko	A system and method for monitoring oil flow rates at multiple points in production wells using a flow sensing fiber optic cable. An illustrative system embodiment includes: a fiber optic sensing system housed within a tube suitable for a downhole environment; and a flow to signal conversion device attached to the tube and deployed in the oil flow.
Optical fiber system and method for wellhole sensing of fluid flow using diffraction effect of faraday crystal	02.07.2009; US20090167297	Schlumberger Technology Corporation	Chee Soon Seong	A system and method for optically determining the rate and/or direction of fluid flow in a conduit within wellholes, using the diffraction effect of Faraday crystals through which continuous light is transmitted within optical fibers.
Fiber optic flow sensing device and method	18.09.2008; US20080225264	Photon Control Inc.	Melnyk Ivan	The invention provides an optical flow meter for measuring fluid flow through a pipe which obviates the need for the flow to be seeded with foreign particles. The meter comprises a fiber optic Sagnac interferometer with optical path crossing the flowing fluid. The interferometer measures velocity of the fluid by measuring the phase difference between the two beams propagating in the optical path in opposite directions. Light, which is deflected by the fluid, is collected by optical means at both sides of the optical path for calculation, the scintillating statistics and compensation for light intensity.
Flow rate measurement for industrial sensing applications using unsteady pressures	03.01.2008; US20080000307	Expro Meters, Inc.	Gysling Daniel L.	An apparatus for use in an industrial process for measuring a velocity of a fluid moving in a pipe includes a probe disposed in said fluid flow. The probe includes a tube and an array of at least two sensors disposed at different axial locations along the tube. Each sensor measures inhomogeneous pressure disturbances at respective axial locations. Each sensor further provides a pressure signal. The apparatus also includes a signal processor, responsive to the pressure signals, to provide a signal indicative of the velocity of the fluid. In one embodiment, the sensors filter out wavelengths above a predetermined wavelength. At least one of the sensors comprises a strain gage disposed on a surface of the pipe. In one embodiment, the strain gage comprises a fiber optic strain gage. The apparatus may be configured to detect the velocity of any desired inhomogeneous pressure field in the flow.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Fiber optic sensor and sensing system for hydrocarbon flow	20.12.2006; EP1734223	VETCO GRAY CONTROLS LTD	MENDEZ ALEXIS	An assembly senses fluid pressure variations within a passageway along a length of a flowline. A fiber optic cable is disposed axially within the passageway of the flowline. The fiber optic cable experiences a mechanical strain responsive to variations in the fluid pressure of the fluid communicating through the passageway of the flowline along the length of the flowline. The assembly also includes an enhancing layer surrounding the fiber optic cable. The enhancing layer is more responsive to the fluid pressure of the fluid communicating through the passageway of the cable than the fiber optic cable, which enhances the responsiveness of the fiber optic cable to the pressure by magnifying the mechanical strain associated with the fiber optic cable within a particular region of varying fluid pressure. Strain associated with the cable is communicated through back-reflected light.
FINE FLOW CONTROLLABLE BUBBLE GENERATOR FOR MODIFIED CHEMICAL VAPOR DEPOSITION COMPRISING A BUBBLER, A LEVEL MEASURING CONTAINER, A RESERVOIR, AN ELECTRIC CONTROL VALVE, A SENSING MEANS AND A CONTROL MEANS	14.09.2006; KP1020060097426	LS CABLE LTD.	KIM, JONG HAE	PURPOSE: A bubble generator for MCVD(modified chemical vapor deposition) which is not influenced by variation of the level of the chemical material according to generation of bubbles when manufacturing an optical fiber matrix by MCVD method, and which constantly maintains quantities of chemical materials within the bubbler by accurately measuring a level of a chemical material filled in a bubbler is provided. CONSTITUTION: A fine flow controllable bubble generator for modified chemical vapor deposition comprises: a bubbler(21) for containing a liquid phase chemical material; a level measuring container(26) which is in communication with the bubbler by a prescribed connecting pipe and is installed parallel to the bubbler; a reservoir(22) which is in communication with the level measuring container by prescribed connecting pipes(30a,30b), and in which the liquid phase chemical material is contained to supply the liquid phase chemical material into the level measuring container; an electric control valve(28) installed on the pipe and opened and closed to supply the liquid phase chemical material from the reservoir to the level measuring container; a sensing means(27) installed on a side surface of the level measuring container to measure a level of the liquid phase chemical material within the level measuring container; and a control means(29) electrically connected to the sensing means to open and close the electric control valve by receiving information on the level of the liquid phase chemical material within the level measuring container from the sensing means.
Apparatus and method of sensing fluid flow using sensing means coupled to an axial coil spring	28.11.2002; US20020174728	THALES Underwater Systems UK Limited	Beresford John Michael	An apparatus and method of sensing fluid flow are provided to measure fluid flow rates in production tubing, pipelines, open wells and tunnels. The proposed invention takes advantage of a sensor with processing means to interpret the fluid flow rate, the sensor being responsive to the mechanical perturbations of the sensor itself arising from the impingement of turbulent fluid flow on the sensor. In operation, the sensor is mounted in the fluid flow such that the fluid flows through an aperture in the sensor and/or around the outside surface of the sensor. The sensor of the invention bears definite advantage over known sensors and it is particularly suited to downhole oil and gas applications. Preferably, the invention employs fiber optic sensing techniques which are amenable to multiplexing a plurality of the sensors with long down leads. Such an arrangement is robust to withstand the high temperature and pressure environment. Advantageously, the invention allows non-intrusive measurement of fluid flow in production pipes and measurement of differential fluid flows along perforated casing or open well sections in the pay zone

Exhibit 1 lists some of the patents related to flow sensing fiber optic cables.

Picture Credit: Frost & Sullivan

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