FOS 2

Fiber Optic SENSORS & SYSTEMS

Monthly Newsletter on Worldwide Developments in Fiber Optic Sensors & Systems

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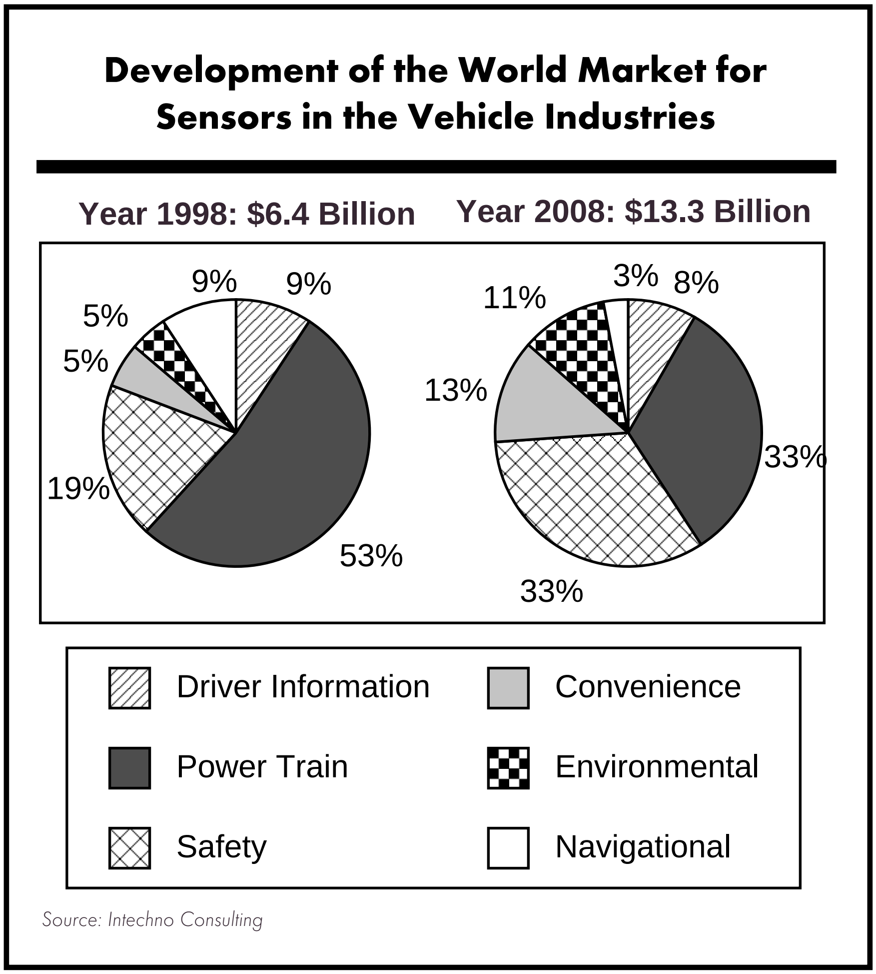

In This Issue...

TESTS/TRIALS

Fiber Optic Sensor Measures Sea's Saltiness

Bathers can tell that the Dead Sea is extremely salty because all they can do in it is float. Physicists at the Universidad

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Complutense say they have a more precise way to measure maritime salinity, a fiber optic sensor.

Although the researchers have only tested it in their laboratory, preliminary results indicate that it has great potential for the real time monitoring of both sea salt and contamination levels.

The sensor will be simpler and less expensive than the traditional method of checking salinity with an electrical conductivity meter, the researchers say. Fiber optics also enable better access to hard-to-reach places and integration into complex monitoring systems. However, the technique is far from becoming a commercial reality. It is part of a three-year European Union research program aimed at developing at integrated system of fiber optic sensors to monitor a variety of physical and chemical parameters in the oceans.

The Spanish team based its technique on water's refractive index. At a constant temperature, the index varies linearly with changes in salt concentration. The researchers compared the sensor's refractive index values with values predicted by theory and found their numbers were on the mark.

Described in the September 1, 1999, issue of *Applied Optics*, the experimental setup was based on a side-polished single-mode optical fiber, on which was deposited a transducing element composed of two thin layers, the first of aluminum and the other of titanium dioxide.

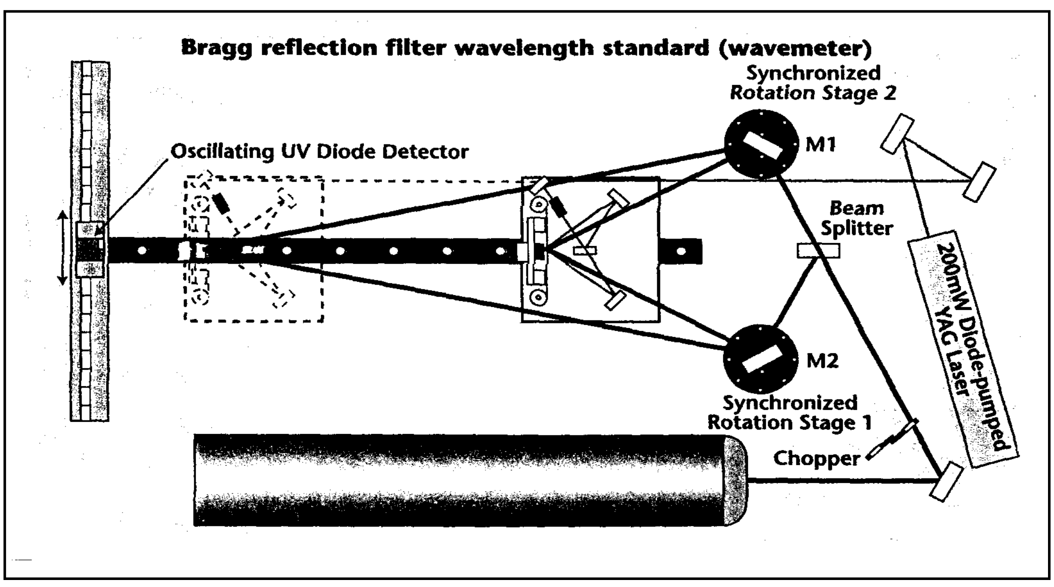
The researchers fit an 807 nm light-emitting diode with a polarizer and guided the light through the fiber, exciting plasmons on the surface of the aluminum and thus attenuating the power transmitted through the fiber.

This attenuation is strongly dependent on the refractive index of the external medium, in this case water. So, by carefully choosing the parameters of the two layers, the researchers can fine-tune the response of the transducing element to changes in salt concentration and make the relationship linear. Their best results came with an 8 nm layer of aluminum coated with 56 nm of titanium dioxide.

RESEARCH AND DEVELOPMENT

Hampton University Professor Develops Touch With Fiber Optics

Hampton University physics professor Dr. Donald Lyons has patented a sensor system that would allow those with artificial limbs the opportunity to "feel" within their plastic appendages.



Lyons' research involves using multisensory-sensory fiber optic Bragg gratings that could ultimately allow a person in need of a prosthetic device to identify and respond to touch. The fibers, consisting of optical wave guides that function as synthetic nerves, are able to detect and respond to touch. The person with the artificial limb in turn will learn how to evaluate the signals and determine feeling. Lyons, who specializes in laser and fiber optic technology, has developed and patented a method of determining precise spacing of wavelengths to establish a Bragg grating wavelength standard. By creating a device that standardizes wavelengths, Lyons is able to pinpoint location of the "touch sensation" in a prosthetic device.

"We're trying to mimic the human body and the nervous system," said Lyons, who has been a professor at HU since 1993. "It could have a dramatic effect for those with lost limbs."

Lyons said tens to hundreds of fibers, about the size of a strand of hair, would need to be evenly spaced under the "skin" over the length of an artificial arm, for example. Approximately a two-fold increase in these numbers would be added in the hand. The fibers will send a signal back to the base, perhaps located in the shoulder, when touched. The person with the artificial limb would learn how to interpret the signal through therapy and rehabilitation.

Lyons has been working on this sensory research for three and a half years at Hampton University's Northrop-Grumman Fiber Optic Sensors Laboratory located within the Research Center for Optical Physics (RCOP) on campus. The fiber optic sensors laboratories in RCOP are fully equipped for creating various types of fiber-based sensory units. Two and a half of the six labs in RCOP and one interdisciplinary lab in HU's Science and Technology Building are devoted to the fiber optic sensors group and are currently valued at more than $1 million.

NASA and the Northrop-Grumman Corporation have provided more than $2 million in research funding and equipment for Lyons' current research projects involving fiber optics, but he is also currently seeking funds from the National Institutes of Health and the Environmental Protection Agency based on the medical and environmental implications of the technology.

Lyons said this sensory system may also be adapted for use in space suits to accomplish the same type of sensory capabilities as with prosthetics.

"This research has so many possible applications," said Lyons, who has five patents to his name and has secured nearly $1.5 million for the university in research proposals over the last five years. "It's really very exciting to learn just how much this can help people."

The fibers may also be applied in other ways. An array of sensors placed in various areas of the body may also benefit from fibers. The fibers, in a more inert form, could be placed around the heart muscle to act as replacements for the damaged nerves where the brain doesn't know when to stop pumping on its own. The fibers working outside the heart may help to reverse that condition.

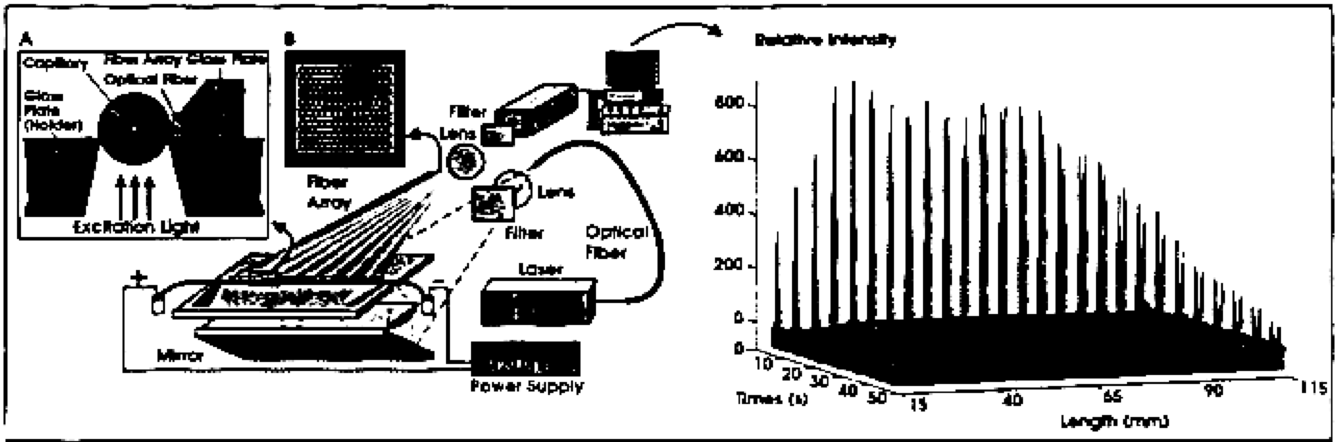
Fiber sensors can also be used in "intelligent skins" to monitor strain and temperature and indicate excessive levels of either, reducing accidental damage or personal injury.

Fiber Optic Array Provides Real Time Gel Analysis

Capillary electrophoresis has become a useful analytical tool, with laser-induced fluorescence imaging offering improved detection.

Researchers from Lund University and the Lund Institute of Technology have taken it a step further, developing an optical fiber array system that allows real time imaging of electrophoretic separations.

In standard laser-induced fluorescence imaging, both the laser and the photomultiplier tube are positioned near the end of the capillary to excite and detect fluorescence. Alternatively, researchers have experimented with imaging the length of the capillary with a camera lens system and a charge-



A fiber optic array allows researchers to image capillary electrophoresis in real time. Courtesy of Staffan Nilsson, Lund University.

coupled device (CCD) camera. This enables real time detection and gives the researchers more insight into how the separations develop.

The new technique, which was detailed in the October 1, 1999, issue of *Analytical Chemistry,* replaces the camera lenses with an array of fiber optics perpendicular to the capillary, making the setup more compact and efficient. Because the fibers can be placed closer to the capillary, the signal-to-noise ratio is improved by a factor of 10.

The setup uses either a 405 nm krypton-ion laser from Coherent Inc. of Santa Clara, CA, or a 488 nm argon-ion laser from Spectra-Physics Inc. of Mountain View, CA, to excite fluorescence from below the capillary. The optical fibers are positioned along the capillary. At the detection end, the fibers form a grid, which delivers the signal through a lens into a CCD camera.

The ends of the 125 nm fibers (from Polymicro Technologies of Phoenix) are slightly rounded so that they act as tiny lenses, increasing the efficiency of the fibers themselves. The system's resolution "is quite sufficient in terms of electrophoretic efficiency," said research leader Staffan Nilsson of Lund University's Center for Chemistry and Chemical Engineering. "Going to a smaller diameter would increase the resolution but at the expense of a lower light collection."

The system has commercial potential in capillary isoelectric focusing, Nilsson said, in which a sample must be presented to the end point detector by force. "The focusing takes two minutes, the presentation of the result for the end point detector takes an additional 15 to 30 minutes, where at least 30 percent of the performance is lost [to bad resolution]," he said. "Why wait for the results when you can follow the whole process in real time?"

Theoretically, the fiber optic system should improve the lens-based system by as much as a factor of 33. With this in mind, the researchers are working to create a fiber array that is wider, has a higher resolution, and is more efficient at collecting light from the sample.

PUBLICATIONS

Understanding Smart Sensors, Second Edition: Randy Frank

Here is a complete, authoritative summary of the latest applications and developments impacting smart sensors in a single volume, now updated to reflect IEEE 1451.2 smart sensor standards.

Utilizing the latest in smart sensor, micro-electromechanical systems (MEMS), and microelectronic research and development, professionals get the technical and practical information needed to keep designs and products on the cutting edge. Plus, it reviews how advances in fuzzy logic and neural networks continue to determine the direction of smart sensor development. This is the first book to combine information on micromachining and microelectronics, two important aspects of smart sensor technology.

Randy Frank is technical marketing manager with ON Semiconductor in Phoenix, AZ. Author of over 200 technical papers, he received his B.S. and MS. in Electrical Engineering, as well as his MBA. in Management, from Wayne State University in Detroit, MI.

Understanding Smart Sensors, Second Edition is available from Information Gatekeepers for $115.00 plus shipping and handling.

NEW PRODUCTS

R55F Fiber Optic Sensors

The R55F is a glass or plastic fiber optic TEACH-mode color mark sensor that provides high-performance color mark sensing in "tight" and other difficult-to-access areas. A choice of visible red, blue, green, or white light sources enables the R55F to detect the toughest color mark contrasts, even 20 percent yellow on white.

The R55F incorporates two types of TEACH-mode programming. Static TEACH is used to manually set two sensing conditions individually. Dynamic TEACH provides a means for teaching a series of sensing conditions on-the-fly: the sensor "averages" the sensing events and automatically sets (and periodically updates) the switch point between the light and dark conditions. R55Fs also provide for manual adjustment when desired, and the sensor may be fine-tuned at any time by pressing the "+" or "-" buttons. R55Fs have rugged ABS/polycarbonate housings rated IECIP67. Mounting brackets (right-angled and flat-surface) are included, and the R55F also mounts to a DIN rail.

"Plug-in" Slot Fibers

Models PDIS4TM12 and PDIS4T4M12 are dual individual fiber optics used for edge-guiding or label sensing applications where control of a moving web is necessary. Housings are plastic, with a 12 mm (0.47 inches) wide slot to accommodate the 1 mm diameter effective opposed light beam. The terminations are designed to plug directly into D12/D11 or Mini-Beam plastic fiber optic sensors (respectively).

High-Temperature Plastic Fiber Optics

Standard plastic fiber optics have an operating temperature range of -30^o to +70^{o}C (-20^o to + 158^{o}F). Banner "HT1" fibers employ a polycarbonate core material and a tougher cross-linked polyethylene jacket material to withstand continuous temperatures of 125^{o}C (257^{o}F). Models are available in core sizes of 1.0 mm and 0.5 mm with a wide array of end tip styles.

Compact, Auto-Adjusting Fiber Optic Sensor Sets Up With the Press of a Button

Balluff's BOS 20K fiber optic sensor with teach-in capability eliminates adjustment hassles for quick and accurate sensor setup. The versatile sensor has a compact 60 x 30 x 13 mm housing and is ideal for small parts detection, part feature checks, counting and part positioning for handling, assembly, and robotics applications.

Setup with the auto-adjusting sensor is simple. Once the part to be detected is brought into position, the sensor setting is locked with a single push of the SET button. Sensitivity can be manually fine-tuned with +/- buttons, then locked with a disable function to prevent tampering and accidental adjustment. Four display elements indicate sensor output: time delay, stability and key lockout condition. Light-on/dark-on capability, external teach inputs, visible red emission, and adjustable switching delay to five seconds increase application versatility.

Powered by 10-30VDC, the BOS 20K is programmable for PNP or NPN operation and has short-circuit and reverse-polarity protection. The sensor is CE-rated and sealed to IP65. It is available with either a 2 m cable or four-pin M8 connector, and is DIN-rail or screw-mountable. Special clamp bushings ensure secure fiber optic attachment.

All-Silica Optical Fiber for Fiber Optic Sensor

An all-silica optical fiber uses a microporous sol-gel silica cladding initially developed by Fiber Optic Fabrications under a Phase II SBIR contract from the US Army. The numerical aperture of the fiber is 0.25 (steady state), and the fiber is as radiation-neutral as pure fused silica. The fiber can be used up to 350°C. It is intended to replace hard polymer-clad silica in data communications networks, as the price and performance is about the same. It further provides a high-temperature, low-cost alternative in long-distance illuminator bundles and remote spectroscopy.

Gauging System Links Directly to PC or Laptop

Microgage 1000 performs measuring, leveling, calibrating, surface measuring, and alignment tasks, with alignment precision of 0.00002 inches. It projects a line of laser light to a portable digital receiver. Readings are displayed on a digital readout, indicating orientation of the receiver relative to the laser. The software module operates on the Windows platform for scaling, recording, and analyzing readings via spreadsheets. Gauge operates over distances of roughly 1 inch to 50 feet.

Aromat Provides Total Automated Control Technology

The Automation Controls division of Aromat Corporation draws on the worldwide resources of the Matsushita family of companies to provide advanced technology products for the automation industry. Sold and supported around the world, these products are an excellent value while meeting international standards. You can review the full line at www.aromat.com/acd.htm.

General Duty Photo Sensors

There's an Aromat sensor for every application. You'll find all shapes and sizes. waterproof models, quick disconnects, background suppression, and accurate triple beam triangulation sensing. These sensors are capable of sensing any shape, size or color and come with automatic cross-talk prevention.

Precise Color Detection, Discrimination

The UZF6 Fiber Color Sensor's features include three color LEDs with precise detectability, push-button setup for manual or auto teaching, a 1 ms response, in order to sense small objects at high speed, and fibers for high precision, small spot, and long range. RGB LEDs last longer and are more immune to ambient light than fluorescent lamps.

UZB & UZJ Micro and Slot Sensors are the smallest sensors in the industry. The UZB is fingertip size, waterproof (IP67 rated), has a high-speed response time 0.5 ms, and has a visible red LED light source.

The UZJ3 has connector and cable types for easy maintenance. It is equipped with two independent outputs. Both NPN and PNP models are available.

Our proximity sensors include models UZQ1, with diameters ranging from 3.8 mm to 8 mm, the UZQ3, with a sensing range up to 12 mm, the UZP for top and front sensing, and the UZR separate amplifier model.

If your application calls for a proximity sensor, we have the product. Models include waterproof, long range, top and front sensing, small size, square, and cylindrical types. All meet wash down and export standards.

We offer industrial limit switches that conform to IP64, IP65, IP66, and IP67 standards, and with CE requirements. They are built with corrosion resistant plastic or rugged, die-cast metal housings for harsh environments.

New Optical Sensor Packs Uncommon Features Into Metalworking Industry's Most Common Form Factor

Balluff's new MiniPro optical sensor brings 1200 psi/140ºF wash down capability and other high performance features to the metalworking and packaging industries. The dual-mount MiniPro housing provides a wide range of installation solutions. It matches the standard form factor with identical dimensions, bracketry and sensing characteristics, allowing a drop-in upgrade for presence sensing and color-mark detection in the food, beverage and drug packaging industries. A wide range of snap-on universal and custom glass fiber optic cables, both stainless steel and PVC-jacketed, is available.

Temperature rated -45º to +275ºC (-50º to +525ºF), fiber optic cables allow beam shaping or remote mounting of the sensor for highest application flexibility.

Key to the MiniPro's IP67 wash down rating is a one-piece molded plastic housing with an integral threaded nose, which eliminates screwed-on assemblies and leakage points. A rugged cord seal at the rear of the sensor protects against damage from pulling and flexing.

Setup LEDs, sensitivity adjustment, and the light-on/dark-on switch are at the rear of the sensor beneath a captive latching door, eliminating problems from lost covers. Sensitivity is adjusted through a five-turn, clutch-protected potentiometer, which simplifies setup and prevents the pot from stripping. LO/DO is set with a simple slide switch, eliminating another rotary switch that can be stripped. Three LEDs indicate power, output and adequate operating margin. The margin indicator flashes if an output is shorted.

Available in two-wire AC/DC or three-wire DC, all models of the MiniPro are protected against short circuit, reverse polarity and false pulse. The MiniPro offers 64 popular sensing modes, including diffuse, wide-angle-diffuse, fixed-focus-diffuse, retroreflective, thru-beam, and fiberoptic.

Standard DC versions of the MiniPro provide response time of 1 ms, while a high speed version reduces that to 300 µs.