SENSORIZATION OF PRODUCTION ACTIVITIES- THIRD INDUSTRIAL REVOLUTION

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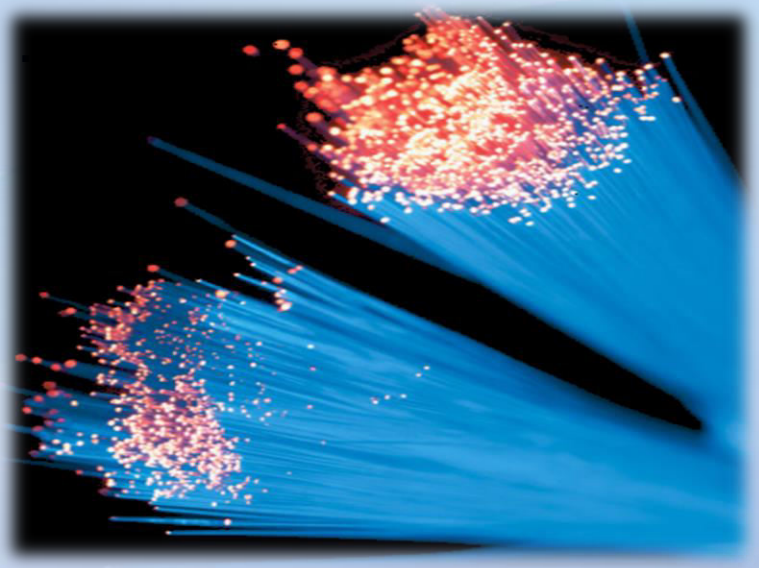
OPTICAL SENSORS COME OF AGE

Nowadays optical sensors are playing undreamed-of roles in industry and research. They monitor bridges from the inside. Spot storms from space. Look into at-risk cells. They're even reshaping sensor science.



by Robert Lieberman

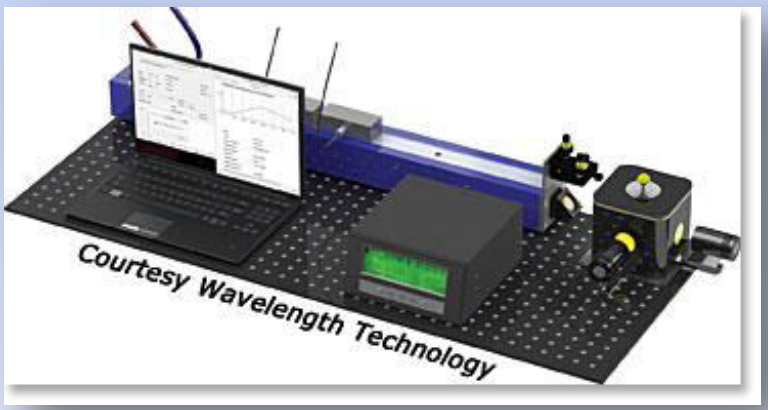
Up close, personal sensors such as a child's "mood ring" can assess your emotions. A sugar-cube size sensor in a football or boxing helmet can measure brain waves, looking for signs of trauma. Sensors might be in your clothes, in your eyeglasses.

Sensor innovators are using many optical technologies for a variety of applications to create the current boom in sensors.

"With laser ultrasound evaluation, you can easily look for cracks or other problem in car doors or airplane wings," said **Robert Lieberman**

ADVANCED OPTICAL SENSORS FOR INSPECTING AND DIAGNOSING

"Wavelength Technology, with its expertise in IR optics and components, is developing sensing tools that are instrumental for quality assurance of advanced optical thin-film coating," said SPIE Senior Member **Robert Huang**, the company's CEO.

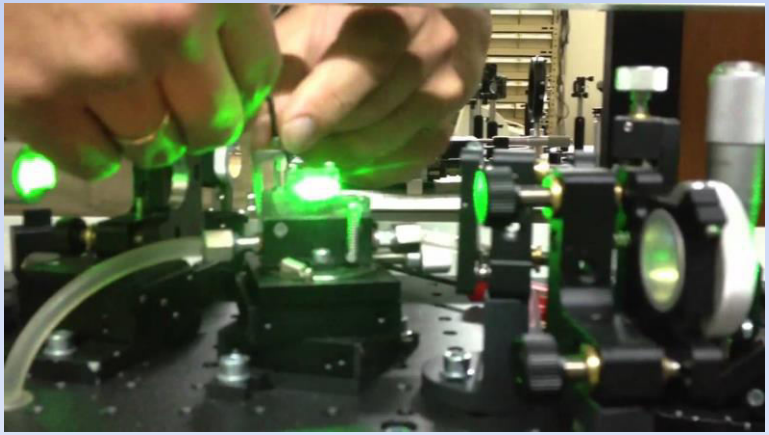


LASER CALORIMETER

Wavelength Technology is also looking into new areas where IR optics can be applied. One such idea is to combine the flexibility of fiber lasers and advanced IR/thermal sensors or sensor arrays for making hand-held inspection tools for nondestructive testing in aerospace, marine, and other industries.

Researchers envision a system where a fiber laser plays the role of a heat source with controllable input power, shape, and temporal characteristics. Thermal response is detected by an IR sensor, and a variety of signatures can help identify defective or abnormal regions by monitoring heat distribution in the region surrounding the laser spot.

For example, in the vicinity of a crack, the lateral heat pattern will be affected, while in the presence of corrosion under insulation, the time response of the surface temperature is used as a defect signature.



By Uri Abrams

SPIE member **Uri Abrams,** CEO of PD-LD, says he admires the fiber-optic sensors from Canadian company Verisante that perform noninvasive skin cancer (melanoma) detection, cell tagging, and sorting. The product, called Aura, won a Prism Award for Photonics Innovation in 2013.

"It gives the dermatologist the ability to scan, say, 300 marks worthy of interest and make a preliminary determination whether there's reason for any concern about two of them," **Abrams** said.

NANOSENSORS CAN PROBE INSIDE A CELL

IOS labs are working with neuroscientists at University of California, Los Angeles on a submicron-scale nanosensor that can investigate what's going on inside a cell. The probe, clearly smaller than a cell, uses a single, very finely tapered optical fiber to make up to six different chemical measurements inside a living cell.

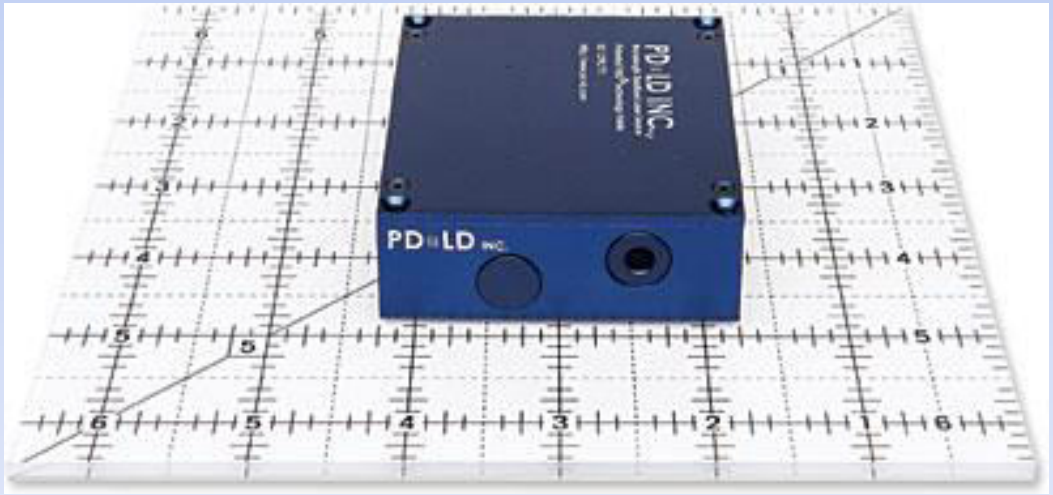
"You can tell how healthy the cell is. You can determine its oxygen use," **Lieberman** said. "We can learn how neurons talk to one another."

Sensors are also important for monitoring highway and building infrastructure. Bridge rust can be costly to repair. One of PD-LD's products can detect corrosion early inside a bridge, inch by inch.

A WAVELENGTH-STABILIZED LASER SOURCE FROM PD-LD

PD-LD placed tiny sensors on the rebar in the concrete for the Riverside-Delanco Bridge, in New Jersey near Philadelphia, during construction of a new deck. The sensors are watching for signs of corrosion.

"Instead of waiting for a huge pothole and having to repave the whole deck, we can know an exact spot to repair," said Abrams of PD-LD. "We'd have to close the bridge for just a few hours."



MONITORING ATMOSPHERIC GASES WITH LASERS

On the laser side of sensing, SPIE member Tim Day, CEO and cofounder of Daylight Solutions, says Daylight's broadly tunable MIRcat, has uses from atmospheric monitoring to nanoscale imaging.

"It does it all, from one box," **Day** said, "and there's very good stuff in that box. It's the only laser of its type with continuous wave (CW) output, for apps where you can't use pulsed light," **Day** said.

Laser sensors can detect pollutants such as nitrogen oxide (NOx), sulfur oxide (SOx), ozone, and methane; exhaled nitric oxide (NO), a biomarker for asthma; and glucose, the key analyte in diabetes.

BIOSENSORS CHALLENGED BY STRAY LIGHT

Stray light may contribute to a wrong medical diagnosis when doctors use a noninvasive optics tool to look inside tissue.

Hyperspectral imaging can provide lesion detection, find retinal disease, and observe blood as it flows, but the imager's optical components that divide the broadband radiation into its spectral components are potential sources of stray light.

Andresen's motto: "To stay healthy, avoid stray light."

SENSORS FIND MANY USES IN SECURITY SCREENING

The European Union required such screening to begin in 2014. Cobalt and a partner in France, Hi-Tech Detection Systems, are installing in Paris airports.

If a police team spots a white substance spilled in a car or airport, they may need a quick assessment of whether it's detergent or an illegal, controlled substance. A new PD-LD product, called SERDS, for shifted excitation Raman differential spectroscopy, represents a significant development in the capabilities of Raman spectroscopy analysis, PD-LD says.

WHY AN OPTICAL SENSOR BOOM NOW?

Low-cost microelectronics and low-power radios are reducing sensor costs to a tiny amount, said SPIE Fellow Stephen Eglash, executive director of Stanford University's Energy and Environment Affiliates Program.

"Things are getting more compact, and computing power is more cost effective," added **Abrams**. Many of the hot new items have been in labs for decades, he said. "Now they are finding homes in the commercial world."

Optical sensors are playing huge role in our life:

- **we can prevent different diseases;**
- **to catch drug dealers;**
- **you can easily look for cracks or other problem in car doors or airplane wings;**
- **Sensors are also important for monitoring**

THANK YOU

FOR YOUR ATTENTION