Optical fibers in materials: an artificial nervous system

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(Phys.org)—When placed inside a material, optical fibers act like artificial nerves, transmitting valuable information about a structure's state of fatigue and wear. A new technique developed at EPFL makes it possible to collect this data with vastly improved resolution and efficiency, opening up the possibility of new applications, particularly in much smaller objects.

What if one day our cars or vacuum cleaners could warn us when they're on the verge of wearing out? EPFL's Group for Fibre Optics (GFO) has

just made an important step in this direction. In the context of monitoring infrastructures such as bridges, dams and buildings, the GFO has developed a technology that improves the resolution of measurements taken by optical fibers embedded in these structures. This discovery, recently published in the journal *Laser & Photonics Reviews*, opens up possible new applications for optical fibers, particularly in smaller objects.

Up to this point, data could be collected from points about one meter apart using optical fibers, thin glass threads embedded in the concrete of a construction. But now, measurements can be taken as much as every centimeter – a hundredfold improvement in precision. "Right now, we're mainly measuring changes in temperature and force, but this method should eventually also make it possible to measure pressure variations, or even variations in magnetic field," predicts GFO director Luc Thévenaz.

With this improvement, the fiber can act as a true artificial nerve. It would be able to signal the presence of "hot spots", weaknesses, deformations or liquid or gas leakages much more reliably, significantly improving our ability to monitor large infrastructures.

Follow the vibration…

Placed in certain environments, such as underground, this optical fiber method provides a means of detecting terrain movements or preventing the malfunction of geothermal energy installations. Placed in a glacier, it could provide information on the evolution of the snow pack. Joint research with EPFL's Environmental Fluid Mechanics Laboratory (EFLUM) has been initiated with this objective in mind.

Above all, this new technology makes it possible to use optical fibers in smaller objects, such as robots, household appliances, or skis. It has been proposed to ride aboard the arms of a new project underway in EPFL's

Space Center, "Clean Space One," a small satellite designed for cleaning up space debris floating in near Earth orbit.

From a practical viewpoint, the system puts the fiber into "resonance" by sending, via laser, a beam of light to each end of the fiber. These waves of light generate acoustic vibrations, whose pitch change as a function of temperature. Thus the vibrations reveal valuable information about the temperature in the area surrounding the fiber. By recording the data, the scientists can locate hot spots or unusual forces. "The advantage of this technique," says Thévenaz, "is that it allows us to collect data at a very precise, pre-determined point."

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