Press Release

Fibre optics:
the ideal sensor for monitoring in extreme conditions

Paris, November 9th, 2018 - *The use of optical fibre for more than 20 years in the telecommunications industry has made a significant contribution to reducing the cost and improving the quality of components. This evolution has led to the development of a new type of application: fibre optic sensors, a particularly interesting technology in extreme conditions where the conventional electrical sensors are missing. Alcimed, a consulting company specializing in innovation and new businesses, reviews the functioning and benefits of these sensors.*

A technology already used in several sectors....

Optical sensor technology is used to monitor structures that are difficult to access, such as buried infrastructure in radioactive areas or in high grounds. It is also used for the control of materials throughout their lifecycle by directly integrating the fibre into organic composites, concrete or metallic materials. This is notably the case for temperature measurements but also pressure or mechanical stress measurements.

For example, Omnisens has developed for Peru LNG a fibre optic sensor system for stress measurement to detect and locate soil movement due to erosion, falls, etc. of stones or a seismic incident around a gas pipeline. A fibre is buried near the pipeline and perceives the movements of the ground in order to anticipate the tensions to which the pipework is subjected. This system was used to monitor a 60 km pipeline across the Andes.[1]

What is a fibre optic sensor?

When a light signal is introduced at the entrance of an optical fibre, it propagates to its other end, all whilst partially being reflected by the core of the fibre along its path. However, a change in temperature, the application of mechanical pressure or vibrations on the fibre alters the spectrum of the reflected signal. The measurement of these variations is the principle used in fibre optic sensors.
To do this, at the entrance of the optical fibre, an optical analyser, called an interrogator, manages the introduction of the light signal and analyses the spectrum of the reflected waves to deduce the changes in the physical quantities applied to the fibre.

A wide family of sensors with mainly two approaches....

In a fibre optic sensor, the fibre is both the sensor, sensitive to changes in the environment, and the means of transmitting data to the interrogator.

This family of sensors includes different technologies divided into two main approaches:

- **Fibre optic sensors with discrete measurements**

In this family the measurement is carried out at one or more specific points of the fibre where it has been physically modified during its machining. For example, in the case of Bragg Grating fibres,

[1] http://www.omnisens.com/ditest/3431-power-cables.php

striations are engraved in the core of the fibre at the measurement point. Up to ten measuring points can be counted per fibre.

- **Fibre optic sensors with distributed measurement**

This time, the optical fibre is used as a sensor over its entire length, it is called "continuously sensitive". The desired physical quantity can thus be measured over a length of about ten kilometres, with a spatial resolution order of one metre. The fibre used is almost identical to the one used for telecommunications but the more complex signal processing requires a high-performance interrogator.

Advantageous features to equip infrastructures or installations in extreme conditions....

The characteristics of these sensors are unlike any other sensor family, which is the reason for the growing popularity of these sensors since their discovery 35 years ago.

The first advantage is that the power supply to the sensor and the reading of the results take place at the interrogator, which can be placed several tens of kilometres from the measurement point. In addition, the properties of the optical fibre make these sensors resistant to electromagnetic disturbances, high radiation and extreme temperatures. These sensors are therefore particularly suitable for instrumentation in hard-to-reach areas and/or in harsh environments where conventional electrical sensors no longer function properly.

Another advantage is that fibre optic sensors are very compact and can be directly integrated into structures for measurement such as concrete or composite materials.

Optical fibre and its components, already widely developed for telecommunication applications, have become relatively cheap, which has enabled the development of this application. However, to equip oneself with fibre optic sensors, it is necessary to count "an investment sometimes significant for the interrogator and if necessary for the development of a calculation function specific to the use case" recalls Jakub Rams, project manager at Alcimed.

For example, for a Bragg grating fibre optic sensor, a solution costs about $150-250 per measurement point and between $10 and $30k for the interrogator. For a distributed measurement of optical fibre stress, count instead $10 per kilometre of fibre (excluding protection) and $100k for the interrogator.

A growing market with new opportunities to come...

With these advantages, the market for fibre optic sensors is growing rapidly. In 2016 it was estimated at about $3.4 billion with an expected annual growth of 7.35% to reach $4.8 billion by 2021.[2] In the coming years, market growth will be able to rely on increasingly sophisticated algorithmic solutions to improve measurement resolution and to reduce the cost of interrogators. In addition to this, the increasing number of feedbacks allows a better understanding of their lifespan and makes these solutions more and more attractive for manufacturers compared to conventional electrical sensors.

The opportunities are still being identified. Currently, a whole new field of application, called biophotonics, is being developed in the field of biology, thanks to the development of photonic crystals, a technology that allows optical measurements to be extended to local chemical quantities.

ABOUT ALCIMED - www.alcimed.com

Created in 1993, ALCIMED is a consulting company specialised in innovation and the development of new markets, specialized in life sciences (health, biotech, agri-food), chemistry, materials and energy as well as in aeronautics, space, defence and public policies. It works with major industrial groups,

[2] Etude ElectroniCast Consultants 2017, cité dans G. Allwood et al., *Fiber Bragg Grating Sensors for Mainstream Industrial Process,* Electronics 2017, 6, 92.

ETIs and SMEs, investment funds and institutional players. Thanks to its 180 high-level employees, ALCIMED supports its clients in the exploration and development of their unknown lands: new technologies, market innovations, high-growth countries and prospective analysis. The company, which has its headquarters in Paris, is present in Lyon and Toulouse, as well as in Germany, Belgium, Switzerland, the United States and Singapore.
Alcimed is a member of CroissancePlus and the ACI (Association des Conseils en Innovation).

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