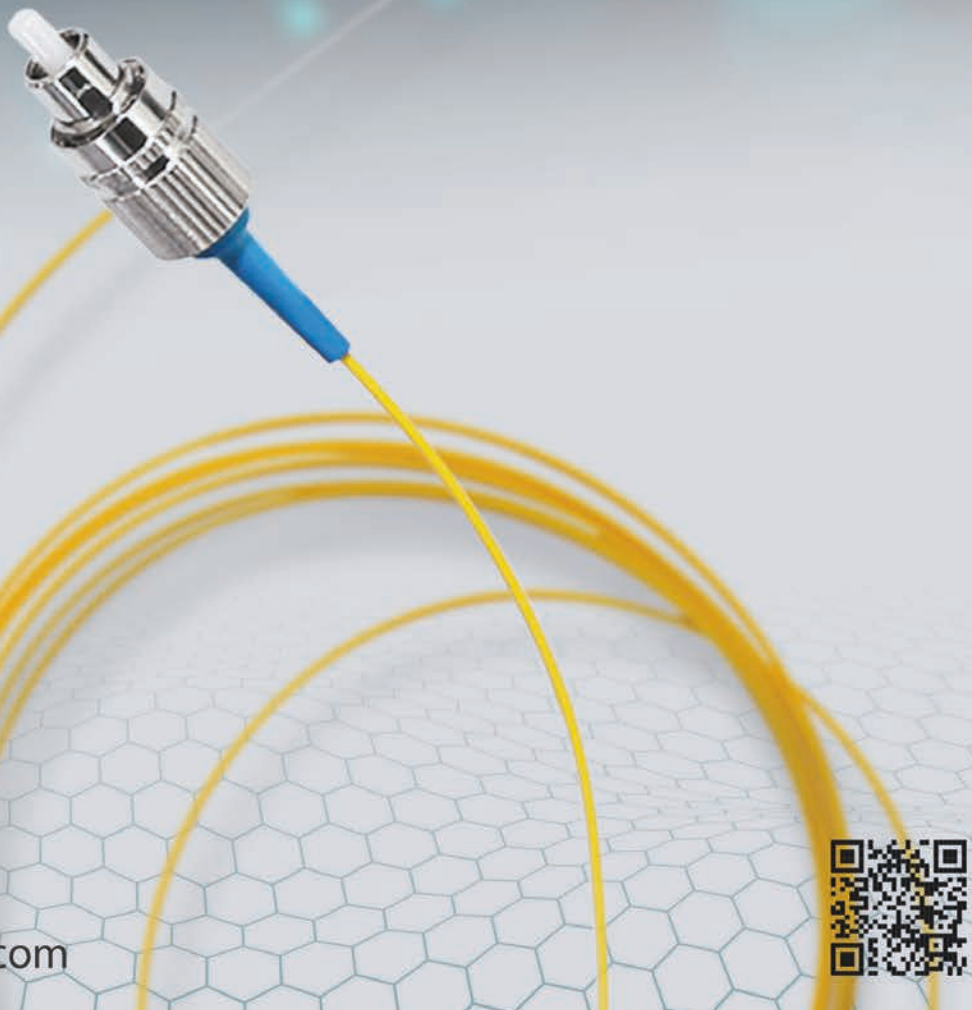
EON
PHOTONICS

FIBER BRAGG GRATING SENSOR



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As EON Photonics Opto Electronics Group, we have carried our knowledge and experience on laser photonics field to fiber sensor technologies, Fiber Bragg Grating sensors specifically.

The biggest motivation for having deep interest on FBG sensors was that; they are applicable to wide range of industries from aerospace and defence to composite material manufacturing due to it's light weight, extremely narrow thickness, durability and many other advantages.

CONTENTS

WHAT IS FBG ?

(Fiber Bragg Grating)

In literature, optical fibers are famous with being as thin as human hair, flexible and durable.

In this context, FBG sensors are basically manufactured by causing refractive index modulation at a specified location within the fiber optical cable that is having 9 micrometers of core and 125 micrometers of clad diameter.

As a Hi-Tech product FBGs take over the place of the conventional sensors especially at the fields given below;

FBGs can be embedded into composite materials and allow smart material production:

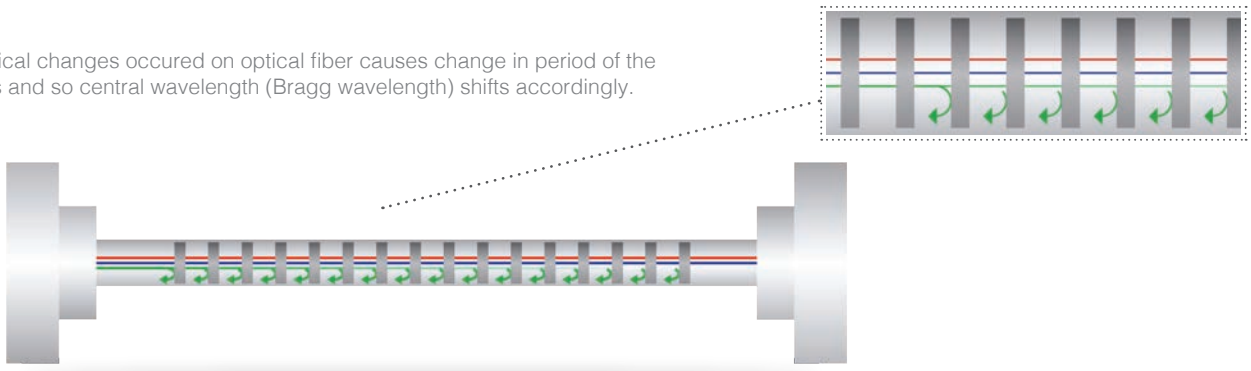
• FBGs can be used in new generation aerospace and air vehicles (such like; airplanes, unmanned air vehicles (UAV), wind turbines, drones, satellites and etc.) in order to track the trip quality and structural health of the devices.

FBGs can be used in smart city organizations by simply assembling them into the various consantrated structures such as asphalt,concrete and cement:

• FBGs can be simply used in highways, bridges, railways as well as in gas and oil industry in order to track strain levels along the line and determine deformation/crack locations to prevent any possible danger.

WORKING PRINCIPLE

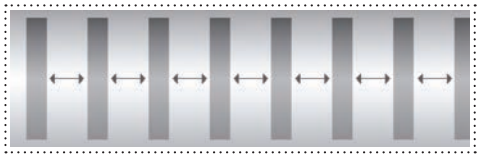
* Physical changes occured on optical fiber causes change in period of the fringes and so central wavelength (Bragg wavelength) shifts accordingly.

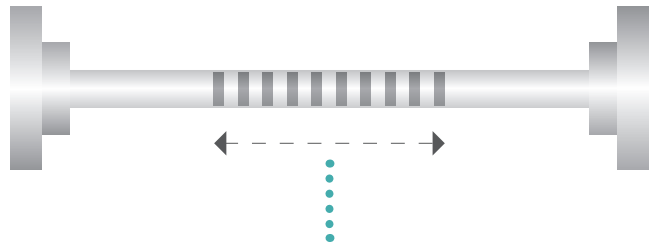


When a broadband light beam is sent over optical fiber, fiber Bragg gratings reflects only a specified wavelength (Bragg Wavelength) while transmits all others. This reflected wavelength is direclty inter-related with manufacturing characteristics of the FBG and so that guides FBG to measure various parameters such like strain, vibration, acceleration.

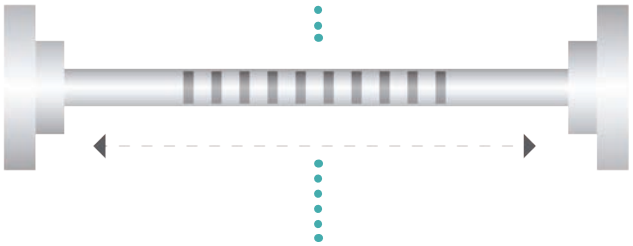
MEASURING WITH FBG SENSORS

When structure that optical fiber placed is exposed to various physical effects such as strain and temperature, Bragg wavelength shifts and so amount of mentioned shift is detected by the sensor and so calibrated system allows ones to measure amount of effect.

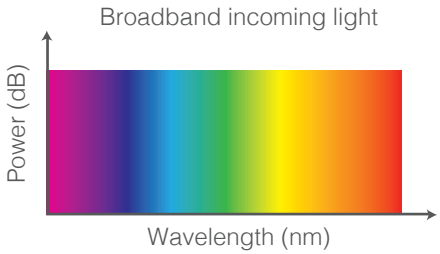




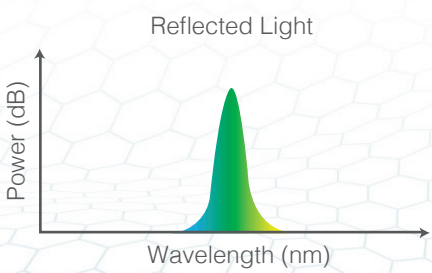
* When there is no tension

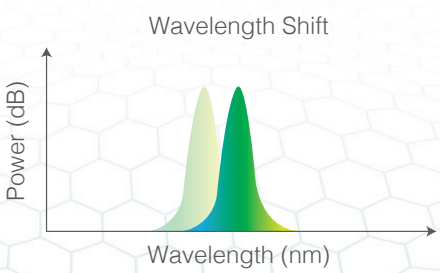


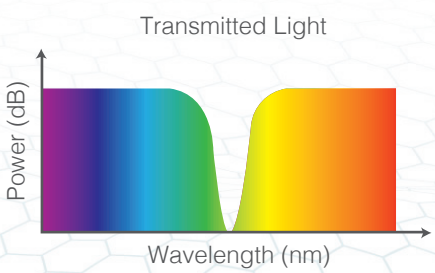
* Under tension



* When fiber is exposed to a physical affect, length of the fiber extends further and so period between the gratings change proportionally.







ADVANTAGES

MEASURING AT LONG DISTANCES

All the applications those FBG sensors are used are mainly based of recognition and numerically interpretting of change in the light it self. In this context, it is well known that dependency of light is at its minimum in terms of distance. Thereby, FBG sensors allow ones to easliy measure any physical changes for long distances.

ACCURATE TEST RESULTS

In harsh environments in which conventional sensors can not stand, FBG sensors might be easily used in order to monitor the mechanical behavior (vibration, acceleration, frequency waving, mechanical fatigue) of a particular structure.

LOW SETUP COST

FBG sensors manufactured by EON Photonics might be in form of an array. Thereby, there will be reduction at cost of the setup as cabling amount will be less. Besides that, each of the FBG sensors that is in optical measurement chain (called as FBG array) might be characterized one by one.

IMMUNITY TO ELECTRO-MAGNETIC FIELD AND RADIO FREQUENCY INTERFERENCES

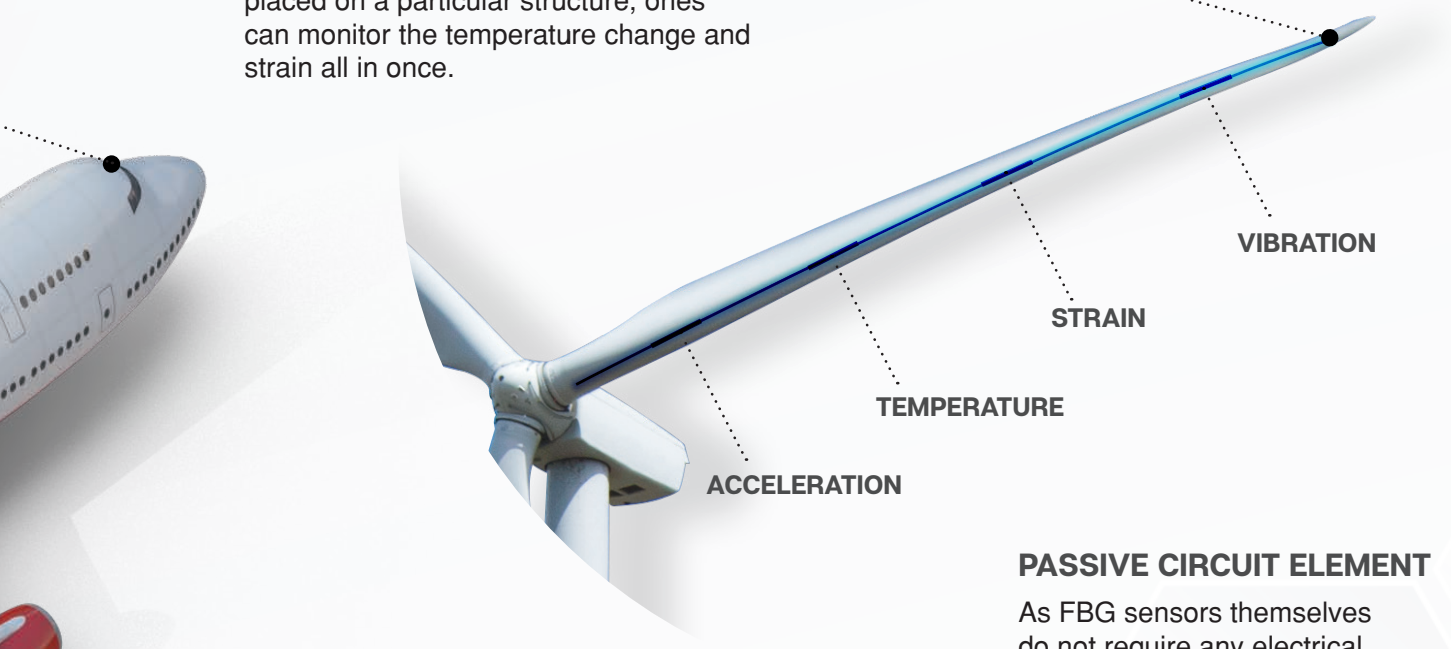
Due to physical characterstics of the raw material of optical fiber, FBG sensors are immune to electro-magnetic field and radio frequency intereferences. Thereby, FBG sensors mostly preferred at the fields those require high level of privacy.

A TECHNOLOGY PROMISES FOR SENSORS SMALL IN SIZE, FLEXIBLE AND LIGHT WEIGHT

FBG sensors are oftenly preferred at various high technology industries from aerospace to composite due to it's properties such like being small in size, flexible, high durability in harsh environments.

MEASURING VARIOUS PHYSICAL PARAMETERS SIMULTANEOUSLY

Due to any number of FBGs can be included in a single fiber optical cable, various physical parameters can be measured over same fiber optical cable. For instance, when an FBG array is placed on a particular structure, ones can monitor the temperature change and strain all in once.

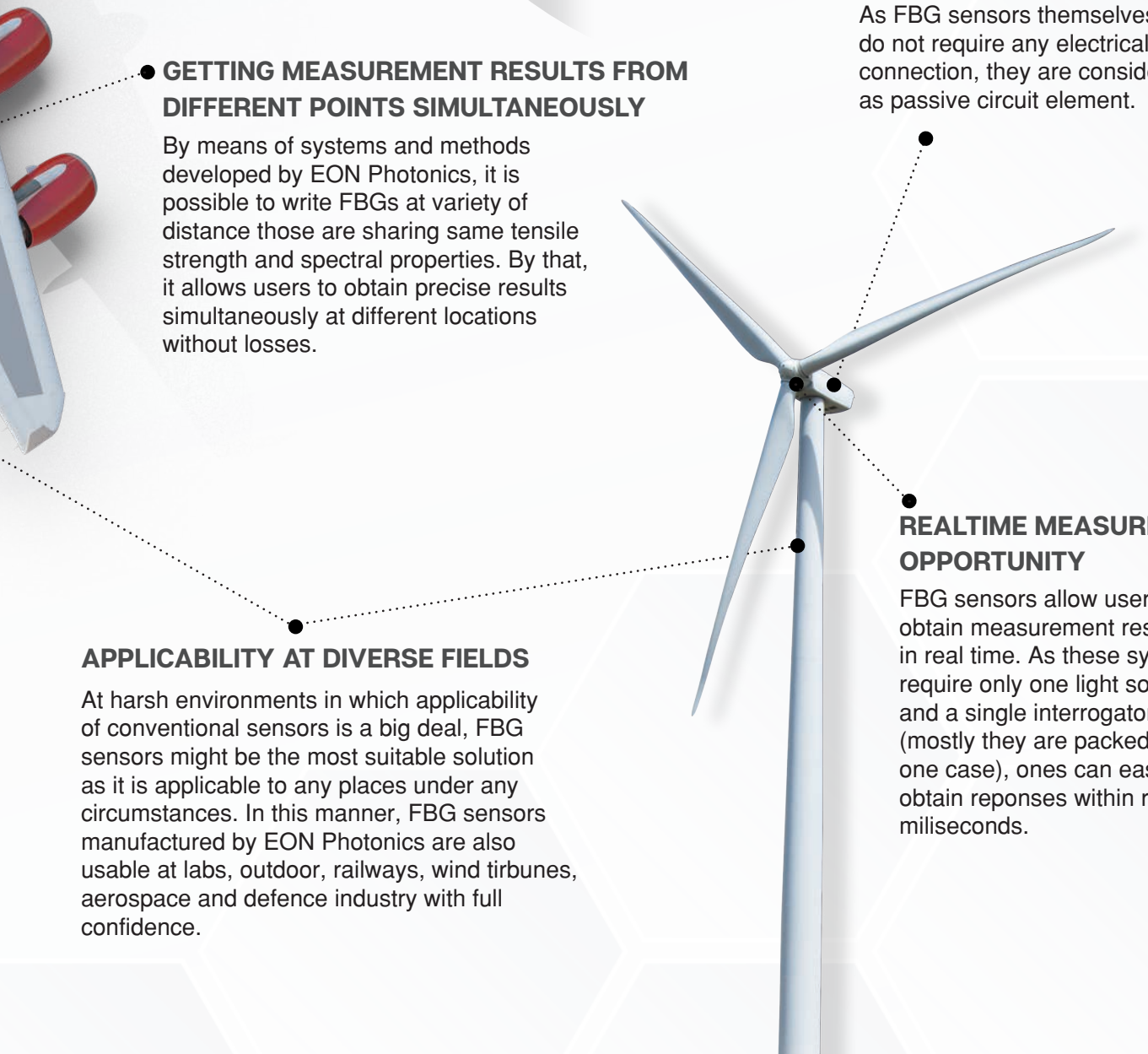


PASSIVE CIRCUIT ELEMENT

As FBG sensors themselves do not require any electrical connection, they are considered as passive circuit element.

GETTING MEASUREMENT RESULTS FROM DIFFERENT POINTS SIMULTANEOUSLY

By means of systems and methods developed by EON Photonics, it is possible to write FBGs at variety of distance those are sharing same tensile strength and spectral properties. By that, it allows users to obtain precise results simultaneously at different locations without losses.



REALTIME MEASURING OPPORTUNITY

FBG sensors allow users to obtain measurement results in real time. As these systems require only one light source and a single interrogator (mostly they are packed at one case), ones can easily obtain reponses within range of miliseconds.

APPLICABILITY AT DIVERSE FIELDS

At harsh environments in which applicability of conventional sensors is a big deal, FBG sensors might be the most suitable solution as it is applicable to any places under any circumstances. In this manner, FBG sensors manufactured by EON Photonics are also usable at labs, outdoor, railways, wind tirbunes, aerospace and defence industry with full confidence.

FIELDS OF APPLICATION

STRUCTURES

It provides cost effective solutions when applied to large scale structures such as Oil Platforms, Bridges, Mines, Dams, Tunnels.

- Strain assessment
- Load distribution analysis
- Thermal mapping

ENERGY

FBGs can be safely used in various energy fields such as Wind Turbines, Oil Wells, Pipelines, Nuclear Reactors and Generators. The reason is that FBGs are immune to electromagnetic fields and high radio frequency consisting fields.

- Strain assessment
- Load distribution analysis
- Liquid level detection
- Thermal mapping

WIND TURBINES

It provides the structural health monitoring of the propellers, instant control and observation of the operating status.

- Makes stress assessment instantly.
- Provides opportunity to observe the load distribution in the propellers.
- Provides real-time analysis of the propeller design stage.
- Determines the plastic deformations in the propeller due to temperature and strain.

TRANSPORTATION

It is used for structural health monitoring in highways, bridges and tunnels to determine when maintenance is compulsory. Fields of use;

- It is used to monitor the strain and fatigue behavior of steel ropes on bridges.
- It is used in the determination of the deformation due to expansion and contraction of the rails.
- In addition to structural health monitoring, FBGs work as integrated with signalization systems in order to ensure a safe journey and prevent any possible accidents.

NAVIGATE

FBG sensors in submarines and ships used for structural health, load and fatigue behavior monitoring at specific points in the structure.

• It provides instant measurement of strain and temperature changes that occurring on the surfaces of ships and submarines.
• Conventional sensors may collect unreliable datas in areas which are under high pressure high magnetic field or consisting of radio frequencies FBG sensors can be safely used in such fields due to its immunity to such affects
• It provides opportunity of thermal mapping.

LABORATORY TESTS AND MEASUREMENTS

FBG sensors can be used in laboratory environments safely where various physical parameters are measured, espically in the mechanical testing stage for the following purposes.

• FBGs used for materials as well as manufactured products life tests
• It is used in fatigue behavior and load analysis tests,
• It is used in tensile and compression tests for expansion and contraction analysis of materials and for detecting and measuring deformations on the surface of the material.

SAFETY AND SECURITY

It uses around the police station and at the border lines by placing them on the security wires.

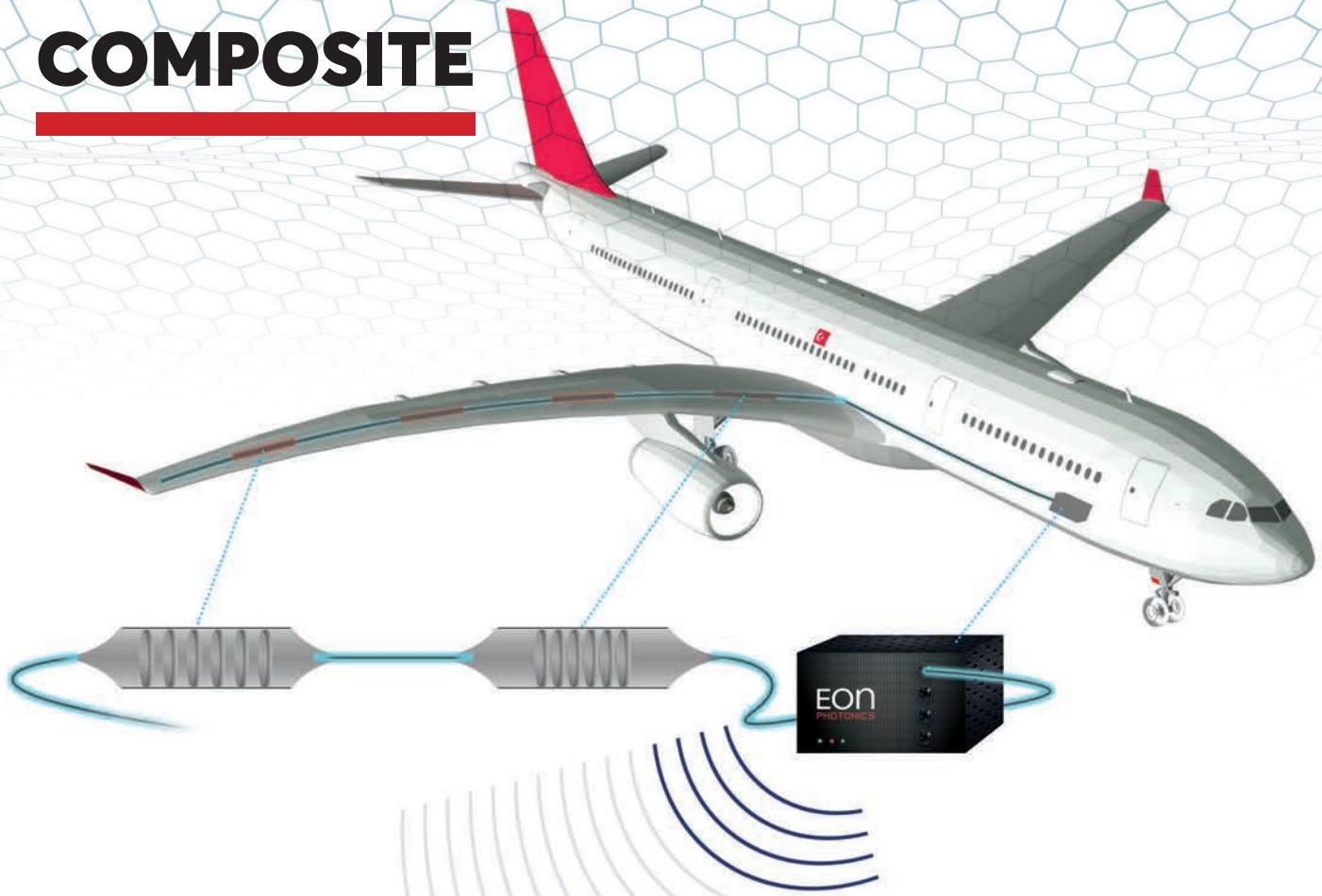
• It is used around the police station and at the border lines by placing them on the security wires.
• It is used inside of the cosmic rooms in order to improve the level of security.
• It is used safely in the presence of signal mixer like jammer.

MEDICAL

Medical robotic arm, patient status tracking devices

• FBG sensors are used as patient status tracking devices by embedding them into objects such like patient clothes, beds and chairs in order to inform the doctor about the patient's condition.
• It is used for tracking the vital functions of the patient in MR devices those are having a great level of magnetic field.
• They are usable as force sensors to adjust the holding tension in robotic hands.

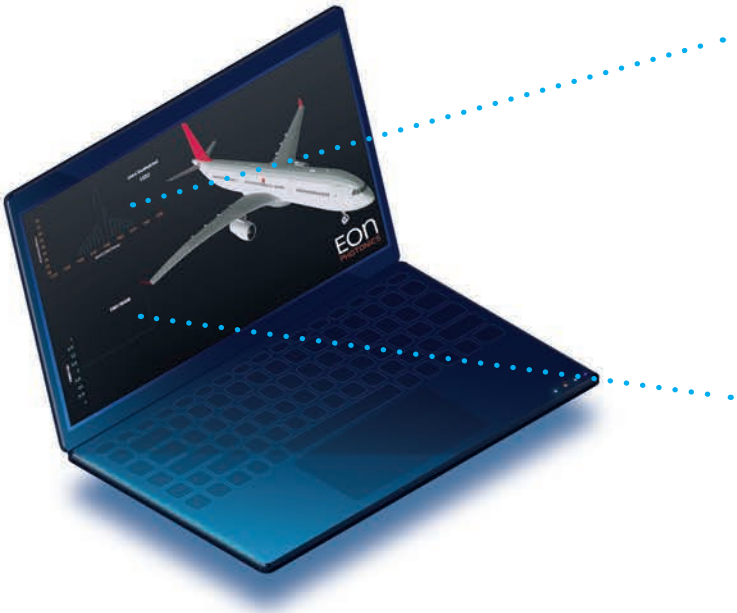
COMPOSITE

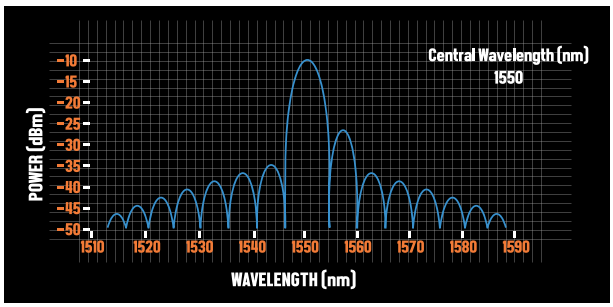


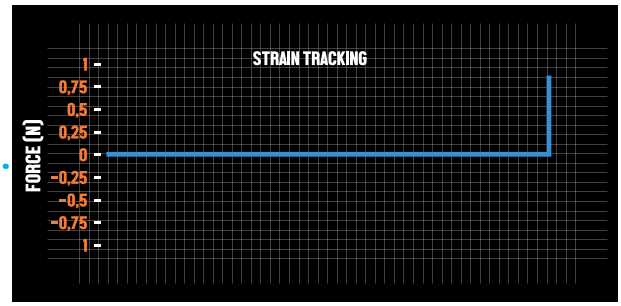
In literature, composite is defined as composition of two or more constituent materials which in turn results a material having greater properties as compares to base materials. FBG sensors started to be used in composite materials with the developing technology because of it's unique properties which allows ones to monitor the inner events among the layers of the composite material. So that FBG sensors can be easily embedded into composite materials such as Carbon Fiber Reinforced Polymer (CFRP) and Glass Fiber Reinforced Polymer (GFRP). When FBG sensors embedded into the composite laminated, ones will be eligible to observe temporary and permanent changes as well as deformations within the composite material.

Especially in avionic and space applications, embeding FBGs into composite materials allows ones to have a proper structral health monitoring and testing system. Eventually, using FBG sensors in such fields allows to monitor the material integrity, deformation, health status and by that unnecessary maintenance, waste of time and money will be prevented.

Use of avionic application areas:







TECHNICAL SPECIFICATIONS

Strain Sensor Technical Properties	
Technical Properties	Parameter
Sensitivity	1 pm / με
FBG Length	0.7 mm - 14mm
Fiber Length	Customizable
Strain Measurement Range	±2500 με
Recoat	Acrylate or Polyimide
Central Wavelength	C-L Band (1515-1585 nm)
Operating Temperature	-55°.....+80°C Acrylate / -55°.....+275°C Polyimide
Connector Type	FC/APC

Temperature Sensor Technical Properties	
Technical Properties	Parameter
Sensitivity	10 pm / °C
FBG Length	0.7 mm - 14mm
Fiber Length	Customizable
Recoat	Polyimide
Central Wavelength	C-L Band (1515-1585 nm)
Temperature Measurement Range	-55°.....+275°C
Connector Type	FC/APC

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