

Fiber-Optic Sensors for Structural Health and Biomedical Monitoring

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The last decade observed a continuous development of optical sensors based on fiber-optic components. Fiber-optic sensors, offering attractive features of minimal weight, high sensitivity and reliability, immunity to EM fields and high temperature resistance, together with low manufacturing and maintenance cost, successfully penetrate the markets of biomedical applications, security systems, structural health monitoring and many others, outperforming their electronic competitors.

The idea of constituting the demo centre on fiber-optic sensors results directly from the advantages and versatility of fiber-optic sensors and variety of potential application fields. The proposed **one-day hands-on trainings will address the major topics of manufacturing and practical application of various fiber-optic sensors** with a specific focus on biomedical and structural health monitoring applications, reflecting the unique competences of the team in these fields. Defined in such a way – the demo centre operates within the **TP2 Glass and Polymer Specialty Fibres and Fibre Devices platform**, addressing the domains of **metrology and sensors**.

The scope of the trainings covers fundamentals of fiber-optic sensors manufacturing - focused mainly on Fiber Bragg Grating (FBG) sensors, physical effects and major measuring equipment used in fiber-optic sensing systems, selected aspects of integrating the sensors with composite materials (smart composites) as well demonstration of selected practical applications. The training scope includes also hands-on experience of the systems equipped with discrete (FBG, fiber bends) or distributed sensors (OFDR, OTDR) dedicated to monitoring physical deformations of various objects of civil engineering (e.g. masts, railway crossings) as well as selected parameters of the patient (heart rate, respiratory rate) under remote medical care.

The training will comprise several hands-on sessions:

- **Hands-on training on fiber Bragg grating (FBG) manufacturing and testing** – a session showing the process of grating inscription in optical fibers, including in-situ spectral monitoring of gratings growth as well as methods of estimation of their basic functional parameters.

- **Hands-on-training on FBG characterization** – a session showing the methods of characterization of FBGs as strain and temperature sensors, including measurements of the spectral response and determination of the strain and temperature sensitivities.
- **Hands-on training on thermal processing of specialty optical fibers** (including highly birefringent polarization-maintaining as well microstructured fibers) – a session demonstrating the process of splicing of specialty optical fibers and manufacturing the selected fiber-optic components (tapers, couplers etc.).
- **Hands-on training on measurement techniques and methods** – a session demonstrating the fundamentals of sensor/monitoring system design and operation. The systems of concern comprise either a single fiber-optic sensor or multiple sensors and an appropriate interrogation system. Systems based on distributed sensors will also be demonstrated, with the use of OFDR or OBR measuring techniques.
- **Hands-on training on lamination processes of fiber-optic sensors** – a session showing the process of lamination of optical fibers in a composite material, which enables forming of *smart composite* with sensing properties.
- **Fundamentals of optical signal processing and analysis** – a session explaining the relationships between a change of optical signals in fiber optic sensor and the value of the measured physical quantity.

Maximum group size counts 4 persons, all having direct and unlimited access to the laboratory and measuring equipment.

The team has a documented expertise in the field of development and manufacturing of various types of fiber Bragg gratings (also for commercial entities), as well as their comprehensive characterization with the use of various measurement techniques (in the time and frequency domain). Furthermore, the team has successfully developed several demonstrators (TRL 5-7) of fiber-optic sensor systems, including a system for monitoring of cardiac activity and respiration rate of a patient undergoing an MRI examination (the demonstrator won the First Runner Up Prize at SPIE 2018 Photonics Innovation Village); stress and strain monitoring system for aviation applications; a system for monitoring the deformation of a sailing yacht mast; a demonstrator of an interferometric fiber-optic gyroscope system.

The team members conducted also a series of training courses including the training on fiber-optic technologies for 600+ employees of CORNING CABLE SYSTEMS POLSKA Sp. z o.o., the training for Bitner Sp. z o.o. employees in the field of fiber-optic technology with hands-on experiments (including splicers, OTDRs, OBRs, Optical Spectrum Analyzers, Dispersion and Loss Analyzer), and many others.

The training-related materials and documents will be prepared according to the client's requirements.

The first course should be ready to offer effective on March 2022

Apart from the regular scheduled training activities we would be happy to offer visits to the training center also for informal users, however under condition of announcing these well before the session and mutual agreement on the date and scope of the training (which has to be defined at least one month prior to the visit). We offer high degree of flexibility in tailoring the training offer with respect to users' needs & demands.