SMARTFIBER: Miniaturized sensor technology for smart composite structures

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I. Introduction

Composite materials are being increasingly employed in industry. Their superior design flexibility and fatigue performance make them attractive replacements for traditional materials. In order to increase safety, and explore the limits of these new materials, sensors could be embedded. Optical fiber Bragg gratings (FBG) are ideal for this purpose. However, the manual procedure of embedding the brittle fibers, results in high process times, risks of fiber breakage and limited placement accuracy. Additionally, the fiber entry point is extremely fragile. The EU-project, SMARTFIBER, aims to overcome these and other issues, in order to increase the uptake of optical fiber sensing technology in industrial environments.

II. FBG technology

FBGs are microscopic mirrors inside optical fibers. When broadband light is launched into the fiber, only a small part is back-reflected (Fig. 1). Due to strain sensitivity of the FBG, the reflected wavelength will vary with strain.

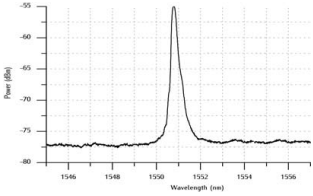

Figure 1. Reflection spectrum from an FBG.

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Traditional fibers have diameters of 125μm ($\approx$ the thickness of a human hair). This is still an order of magnitude larger than the average reinforcement fiber (6μm) (Fig. 2).

Figure 2. An optical fiber embedded in composite material.

SMARTFIBER will reduce the diameter of the FBGs below 60μm, decreasing the distortion of the composite. Research will be done to determine the necessary properties for the coating to minimize spectrum distortion, while maximizing adhesion between the optical fiber and the composite material.

III. Miniaturized read-out unit

The read-out unit will be miniaturized in order to be embedded inside the composite. Research will be performed to optimize the shape of the unit to avoid loss of strength. Wireless communication and power transmission will be included.

Placement of the fibers and read-out unit will be automated using automated fiber placement.

IV. Conclusion

SMARTFIBER will enable fully automated embedding and miniaturisation of FBGs and read-out unit. The near future will focus on optimizing the read-out unit's geometry to limit the influence on composite strength.