Project description for MSc thesis proposal

Analysis of tilted FBG spectrum affected by birefringence

The high specific strength and stiffness of thermoset composite materials has allowed them to slowly supplant traditional materials in numerous technological fields such as aerospace and aeronautics, automotive, naval, wind turbines, and railways. The composite manufacturing process is a crucial step to obtain the best mechanical performance from the structure, especially with increasing of the material thickness. Then, the investigation of the material state during the composite curing becomes the key to avoid possible defects which would induce premature failure of the structure.

For this purpose, the same concepts of Structural Health Monitoring (SHM), for a composite structure, can be considered extended also in the case of manufacturing processes. In the last decades, Fibre Bragg Grating (FBG) sensor was considered one of the best promises for embedded real-time monitoring of composite structures, as it proved capable of meeting the embedding and monitoring requirements. Nowadays, a new kind of Bragg grating sensor, called weakly Tilted FBG (TFBG), is studying for the same aim as its special super-imposed Bragg grating structure bestows further measuring abilities to the sensor maintaining the embedding benefits of FBG. However, due to transverse loads, the embedding of the FBG sensor could result in a geometrical change of its shape and induce strain/stress state that cause birefringence effects in the optical dielectric material of the waveguide and, consequently, a variation in the FBG spectrum. Recent researches shown that, generally, the birefringence causes the splitting of the reflected/transmitted peak in the FBG spectrum into two or more peaks. Nevertheless, although the reflected spectrum of TFBG is similar to that of the FBG sensor, the TFBG transmitted spectrum is more complex and composed by numerous peaks which are fundamental for the sensing scopes. In literature, the effect of birefringence due to transverse loads on the transmission spectrum of TFBG sensor has not yet been sufficiently addressed.

Based on the descriptions above, here are proposed list of tasks in this master's thesis project:

1. Literature review. In this phase the objectives are to acquire knowledge about the TFBG sensor and its analytical models. Moreover, the candidate should collect some information on the effect of transverse loads on FBG/TFBG sensors and embedding fibre optic sensors in composites.
2. Creating a model for birefringence effects on the transmitted spectra of TFBGs. Initially, we wish to develop a model able to simulate the TFBG transmitted spectra in unperturbed state, which takes into account the optical parameters of the Bragg grating structure.
3. Successively, the model should be able to consider (at least) uniform transverse strain distribution values as input, and simulates the transmitted spectra of TFBG as the output. In literature this topic has not been addressed yet, and few researches were conducted.
4. Experimental testing with loading setup for uniform load on TFBG sensor and comparison of the numerical and experimental results.
5. Writing thesis and journal/conference paper.

Estimated time: 9 months.

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