Sensitivity to deformation of an FBG sensor

The Fiber Bragg Grating sensor (FBG) allows to measure the deformation because it produces a wavelength response proportional to the variation of its grating pitch Λ induced by the deformation itself.

The wavelength λ_B reflected by a Bragg grating is in fact expressed by the relation

$$\lambda_B = 2n_{eff}\,\Lambda$$

where n_{eff} is the effective refraction index of the grating.

A variation L of the grating length induces then a variation of Λ and then of λ.

The deformation ε can therefore be calculated as:

$$\epsilon = \frac{\Delta L}{L} = \frac{\Delta \Lambda}{\Lambda} = \frac{\Delta \lambda_B}{(1 - p_e)\lambda_B}$$

where p_e is a coefficient accounting the elasto-optic effects on the refraction index of the sensor and is

$$p_e \approx 0{,}22$$

It follows that the deformation causing a variation of 1 pm in the wavelength reflected by a sensor with, for example, λ_B = 1530.5 nm, is 0,837 $\mu\varepsilon$.

The measurement sensitivity in wavelength, expressed in pm/$\mu\varepsilon$ is then about

$$s_\lambda = 1{,}19 \text{ pm}/\mu\varepsilon$$