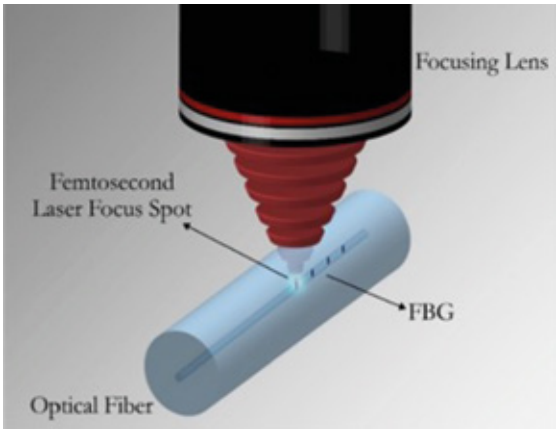
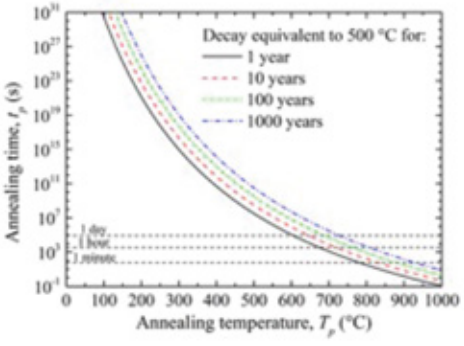
Resonant wavelength thermal stability of fiber Bragg gratings produced by femtosecond laser

Tiago Paixão[1], Luís Ferreira[2], Francisco Araújo[2], Paulo Antunes[1]

In the last years, fiber Bragg gratings (FBGs) have gain popularity within several areas of industry, mainly due to their inherent advantages, such as lightweight, flexibility, multiplexing capability, electric isolation and immunity to external electromagnetic fields. To work under harsh conditions, FBGs must have a stable response in terms of the reflective peak power, but most importantly in terms of their resonant central wavelength. In this work, we performed an extensive study on the thermal stability of FBGs inscribed by a femtosecond laser (FSL), proposing a novel approach to explain the FBGs' permanent refractive index decay under high temperatures, based on the study of their central resonant wavelength shift. The developed theoretical model can predict the refractive index decay over periods of up-to 1000 years, and allows to extrapolate the optimized FBGs' annealing conditions to guarantee long lifetimes. Furthermore, an experimental method was demonstrated, where the FBGs were submitted to continuous and stepped annealing regimes up-to a maximum temperature of 800 °C. The experimental results highlighted the potential of using FSL based FBGs in harsh environments, if proper pre-treatments are used to maximize FBGs thermal stability.





1 – Department of Physics & i3N, University of Aveiro
2 – HBK FiberSensing, S.A., Maia, Portugal

FIGURES 1
Schematic representation is presented of FBGs' inscription using the point-by-point method with the femtosecond laser.

FIGURE 2
Annealing conditions required to stabilize a FBG that would work at 500 °C, for a time span of up to 1000 years.