Nanowires in Optical Fibers

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The main objective of this work is to explore nanowires based on suspended-core optical fibers for the development of new optical devices with nanometric dimensions. As for applications, the intention is to produce optical sensors for the detection of environmental parameters such as temperature, refractive index or gas sensing.

Nanowires in optical fiber can be produced using several chemical or physical techniques. The nanowire is made by stretching a heated fiber, forming a structure comprising a narrow filament. Only in 2003 was it possible to reach sub-micrometric dimensions through the optimization of technological equipment [1]. This fabrication provides longer, more uniform and robust nanowires with transversal dimensions between 100 and 600 nm. Due to residual surface roughness associated with the high homogeneity that nanowires in optical fibers exhibit, optical losses are low, allowing the use of nanowires in a wide range of new applications for communications, sensors, lasers, biology, and chemistry. The nanowires exhibit excellent optical and mechanical properties, including a substantial evanescent field, high nonlinearity, strong confinement and low loss coupling between optical fibers. The nanowires are manufactured in an adiabatic way, preserving the original dimensions of the optical fiber at the entrance and at the exit, allowing easy splices with other optical devices [2].

However, nanowires need some external protection. One possible solution is to protect them in silica tubes or manufacturing them inside a suspended-core fiber (Fig. 1). The suspended core fibers appeared in 2001 and are a particular class of fibers where the microstructured core with small diameter (~1 micrometer) is surrounded by large alveoli, and is fixed to the cladding by very thin membranes of silica, so the observation of the fiber cross section gives the idea that the core is suspended [3]. Recently, it was possible to design suspended twin or multi-core fibers. These fibers have special physical properties, such as high birefringence and intermodal interference making them very interesting to manufacture fiber optic interferometers.

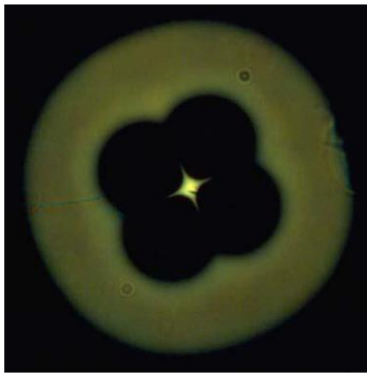

Fig. 1 - Example of a suspended-core optical fibre

References:

[1] L. M. Tong, *et al*, *Subwavelength-diameter silica wires for low-loss optical wave guiding*, Nature 426, 816–819 (2003).

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[3] T. M. Monro, *et al*, *Sensing with microstructured optical fibers*, Meas. Sci. Technol., 12, 854–858, (2001).