Simple Micro-interferometers based on Twin-core Fiber

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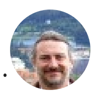
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Workshop on Specialty Optical Fibers and their Applications

Simple micro-interferometers based on twin-core fiber

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Abstract: Two interferometers were proposed with different types of twin core fiber. Both are characterized in temperature and the topology based on photonic crystal fiber presents higher sensitivity.
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1. Introduction

Twin-core fibers, also known as dual-core or two-core fibers, were first proposed as strain sensors in 1981 [1]. They were demonstrated as temperature sensors in 1983 [2]. With the advent of Photonic Crystal Fibers (PCF), several twin core fibers were developed such as twin-core fibers with air cladding [3] and twin-core photonic bandgap fibers [4]. Hybrid twin core fibers where light is guided by total internal reflection in one core and by bandgap guidance in the other were also proposed for wavelength-selective coupling [5]. More recently, another type of microstructured twin-core fiber was developed: the suspended twin-core fiber. In a suspended core fiber the core appears to be suspended in large air holes by thin glass bridges [6].

In this work, it is compared a twin-core PCF (TC-PCF) with a conventional twin-core fiber. A small section of these fiber types was spliced in the top of standard single mode fiber creating a reflecting micro-interferometer. Both sensors were subjected to temperature variation and present different sensitivities.

2. Experimental results

An erbium-doped broadband source with a bandwidth of 100 nm and a central wavelength of 1550 nm was used to illuminate both sensing heads. The light is back-reflected through an optical circulator and collected by an optical spectrum analyzer (OSA) with a maximum resolution of 0.01 nm. The characteristics of the TC-PCF are: a core diameter (3.1μm) and a cladding diameter and the of Ø=126μm, the pitch Λ=1.8 μm, the hole dimensions are 0.6μm and the distance between the two cores is 3.7μm. See Fig. 1. Relatively to the conventional twin-core fiber (TCF) the core diameter is 3μm with a distance separation of 6μm. The length of each sensing head is 0.7 and 1.1 mm for TC-PCF and TCF, respectively. Fig. 2 presents the optical spectrum obtained by the OSA and the temperature response of the two sensing heads based on the twin-core fiber topologies. The observed visibilities are low which is somehow expected due to the asymmetry created in the region of the splice.

Concerning temperature sensitivity, both sensing heads present different results, namely, $1.98 \times 10^{-8}\,K^{-1}$ and $1.53\times10^{-8}\ K^{-1}$, for TC-PCF and TCF, respectively. Usually, the PCF structure has lower sensitivity to temperature when compared with standard single mode fiber, where the doping of the core plays an important role in the temperature response. However, for the configuration proposed in this work, the temperature behavior is different – which can be explained through the following equation: $\Delta n = \lambda^2/\Delta\lambda L$, where λ is the wavelength of operation, $\Delta\lambda$ is the wavelength spacing between two consecutive peaks and L corresponds to the PCF length. The parameter Δn is the difference between the effective indices of the two cores.

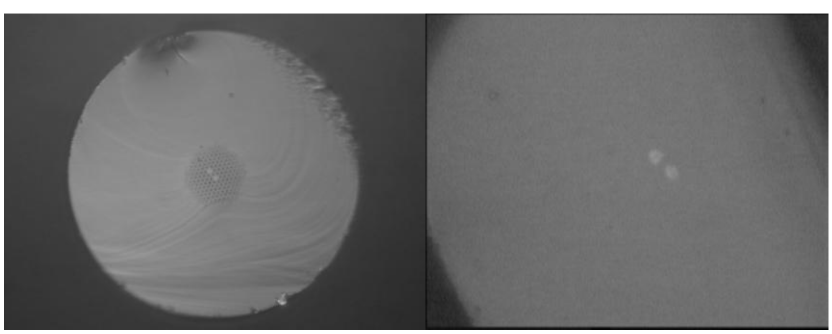

Fig. 1. Photograph of the two different twin-core fibers.

In this case, the thermal expansion of the two cores (TCF) is similar, thus, the dominant effect is the effective refractive index. Since the doping between the cores of the TCF is similar, the thermo-optic effect is low when compared with the TC-PCF. As for the TC-PCF, the thermo-optic effect has two contributions: one is from the geometry of the cladding and the other is from the air, which is low when compared with the silica core.

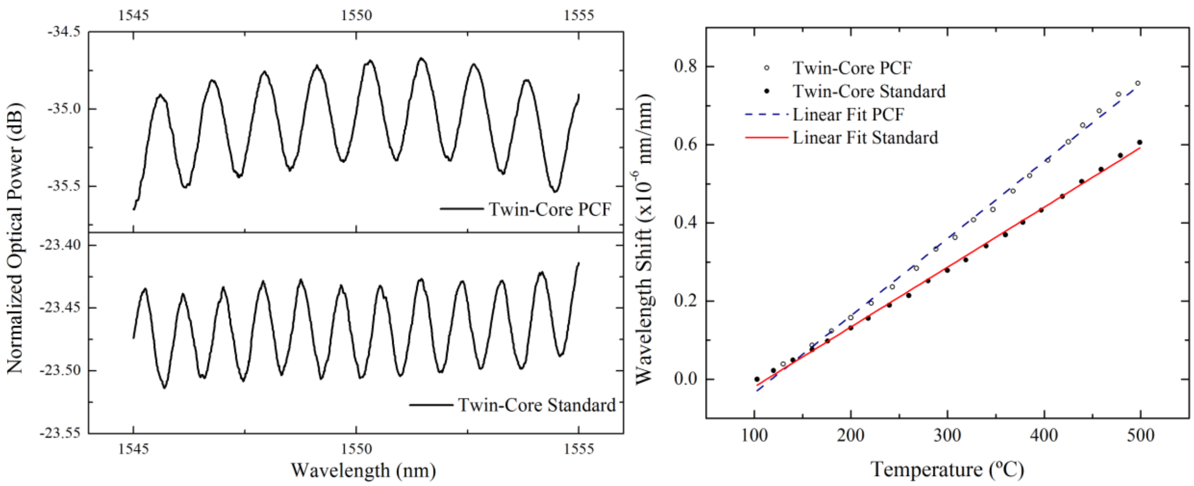

Fig. 2. Spectral response and temperature response of the two sensing head based on twin-core fiber.

3. Conclusions

In summary, two simple micro-interferometers were demonstrated with different twin core fibers. Both were characterized in temperature and the topology based on photonic crystal fiber presented more sensitivity when compared with conventional twin core fiber. The temperature sensitivities obtained were 1.98×10^{-8} K^{-1} (TC-PCF) and 1.53×10^{-8} K^{-1} (TCF).

Acknowledgments

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