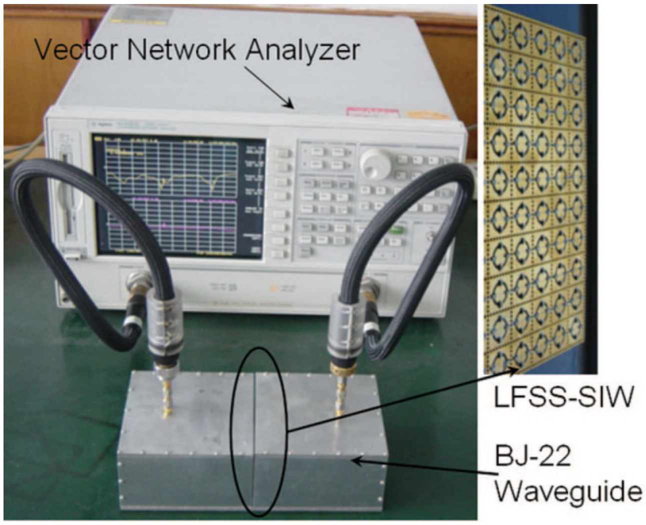

Figure 4 Photograph of the measurement setup for loaded FSS in SIW structure using BJ-22 waveguide. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

The measured and simulated results are presented in Figure 5, where a very good agreement between the two results is obtained. The measurement results indicate that the proposed LFSS-SIW has an insertion loss of 0.3 dB. This loss can be attributed to the dielectric and conductive losses in the FSS structure. And there is no other resonance frequency up to 15 GHz except 2.45 GHz. The minor discrepancies between the two results can mostly be attributed to errors occurred during the assembly of the LFSS-SIW. Nevertheless, this experiment verifies the accuracy of our simulations and predictions about the operation of LFSS-SIW introduced in the previous section.

5. CONCLUSION

A novel miniaturized bandpass loaded FSS using SIW technique is presented. The design has shown a pure resonance frequency response and stable transmission response at oblique TE incidence. The undesired coupling between loaded FSS unit cells is eliminated by using SIW cavity. And the size of the FSS is reduced over 90% when compared with analogous FSS by loading surface mount capacitors. Loaded FSS in SIW structure can be applied in designing multiband equipments, also different loadings can be considered, these will be the emphases of our next work.

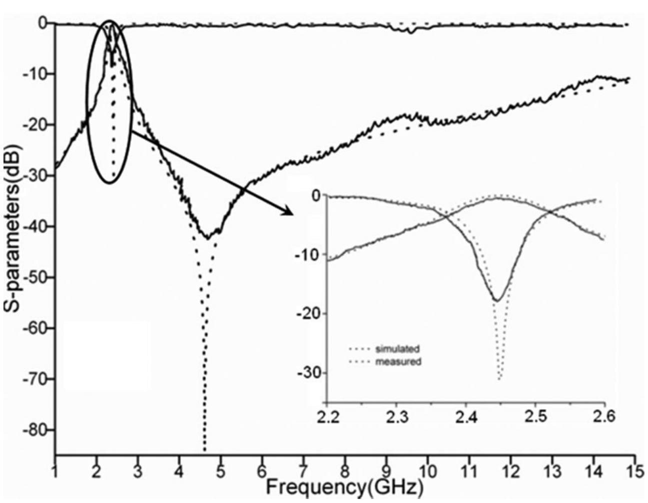

Figure 5 Measured and simulated responses of the loaded FSS in SIW structure showed in Figure 4

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TEMPERATURE SENSOR USING Hi-Bi ERBIUM-DOPED FIBER LOOP MIRROR

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ABSTRACT: *In this letter, a temperature sensor using a fiber loop mirror containing a piece of highly birefringent erbium doped fiber is presented. A Hi-Bi PANDA erbium-doped silica fiber was used and compared with the conventional Hi-Bi PANDA fiber. Different results for strain and temperature sensitivity were obtained. The temperature coefficient sensitivity was −2.22 nm/°C and significantly higher when compared with others conventional Hi-Bi fibers. Strain experiments were also performed.* © 2008 Wiley Periodicals, Inc. Microwave Opt Technol Lett 50: 3152–3154, 2008; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.23907

Key words: *fiber loop mirror; optical fiber sensor; highly birefringent fiber*

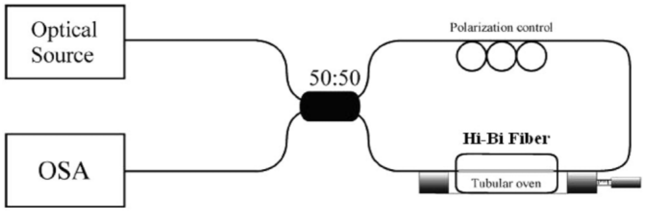

Figure 1 Schematic diagram of the system using the Hi-Bi FLM

1. INTRODUCTION

Highly birefringent fiber loop mirror (Hi-Bi FLM) is a device that can be used in optical fiber communications or as an optical fiber sensor [1]. The Hi-Bi FLM is formed by a 3-dB coupler connected with a polarization control and a section of highly birefringent fiber. The use of Hi-Bi brings some advantages over the traditional interferometer. One of them is the input polarization independence. Another one is the periodicity of the formed spectral filter, which depends only on the length of the Hi-Bi fiber and not on the total length of the FLM [1]. In optical sensing the FLM has been used in strain [2], temperature [3] and displacement sensing [4] measurements, as well as in spectral filter for Bragg grating demodulation [5].

In this work, the authors present a temperature sensor using the Hi-Bi PANDA erbium-doped silica fiber. The Hi-Bi FLM response was characterized in terms of temperature and also strain. The results were compared with the ones of the conventional PANDA fiber (both fibers have similar characteristics) [6].

2. EXPERIMENTAL RESULTS

The experimental setup consisted in an optical broadband source, a FLM, containing a piece of Hi-Bi fiber, a polarization controller, and an optical spectrum analyzer with a resolution of 0.05 nm, as shown in Figure 1. The optical source was an erbium-doped broadband source, with a central wavelength of 1550 nm and the spectral bandwidth of 200 nm. The Hi-Bi erbium-doped FLM is formed by a 3 dB optical coupler with low insertion loss, an optical polarization controller, and a length of 0.55 m of PANDA erbium-doped silica fiber (INO) with an attenuation of 4.6 dB/km at 1200 nm (data supported by manufacturer). A low-loss splice between the single-mode fiber (SMF 28), from the optical coupler and the Hi-Bi fiber was achieved (<1 dB). For strain characterization, the sensing head was attached to a translation stage with a resolution of 2 μm. All the measurements were performed with the coating around the fiber. For temperature characterization, the Hi-Bi fiber was placed in a metallic recipient in an oven, which allows a temperature reading to be set with an error smaller than 0.1°C. The output light was monitored using a commercial optical spectrum analyzer with a maximum resolution of 0.05 nm. In this experiment the birefringence (β) was calculated from the equation $\beta = \lambda/\Delta\lambda L$, where $\Delta\lambda$ is the wavelength spacing and L is the length of the Hi-Bi erbium-doped fiber piece. The birefringence value found was 1.59×10^{-4}. When compared with conventional PANDA fiber ($\beta = 3.3 \times 10^{-4}$) it was observed that the value is smaller for the same geometry [6]. The smaller birefringence in erbium doped Hi-Bi fiber can be responsible for the increase in the sensitivity. The difference between the two Hi Bi fibers is the doping in the core, and the authors believed that the erbium doping changes the birefringence properties of the core.

Figure 2 shows the spectral response of the Hi-Bi erbium-doped FLM when it is subjected to temperature. This Hi-Bi erbium-doped fiber showed negative temperature sensitivity (the arrow shows the left displacement of the spectrum) and when compared with others conventional Hi-Bi fibers presented the same behavior [6]. The parameter that controls the sensitivity of the sensing head is the birefringence. This effect is because of the birefringence decrease with the reduction of the stress effect obtained in the fabrication process of the erbium doped fiber and is dominant when compared with the thermal expansion where the response of the interferometer would increase.

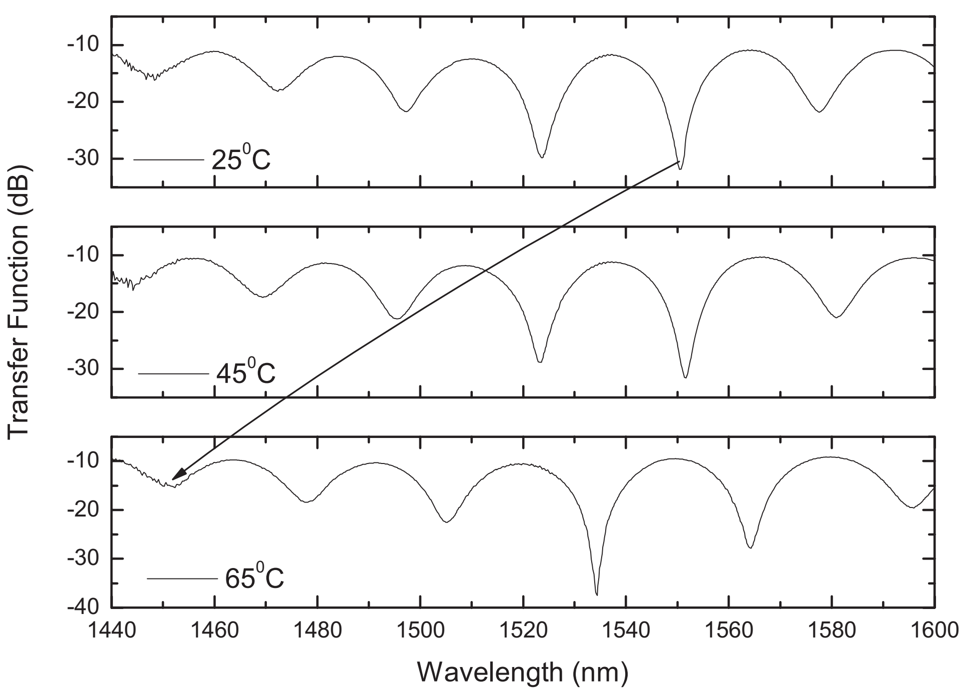

Figure 2 Spectral response of the Hi-Bi erbium-doped FLM when the temperature was applied

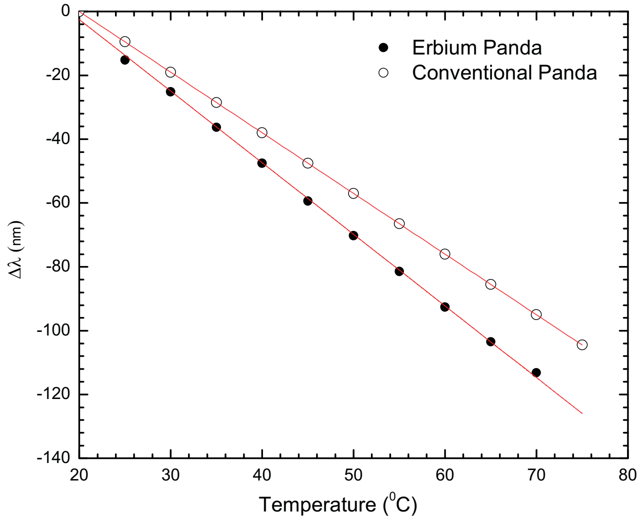

Figure 3 Temperature response of sensing head. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

Figure 3 presents a linear temperature response from 20 to 80°C for the Hi-Bi PANDA erbium-doped fiber, it is more sensitive to temperature than the conventional PANDA fiber with the same length, and its temperature coefficient is −2.22 nm/°C (this value is almost 17% smaller than the one of the conventional PANDA fiber). Using the maximum resolution of the OSA, it is possible to detect a variation of 0.02°C. The thermal difference between the two big holes with boron doped and core with the germanium doped, found in the conventional PANDA, is smaller than the thermal difference between the holes with boron doped and the core with germanium and erbium doped, found in Hi-Bi erbium-doped fiber. In this fiber there is an inner cladding co-doped with fluorine and phosphorus that makes it more sensitive to temperature than the conventional fiber. Figure 4 shows the linear fiber response when it was subjected to strain from 0 $\mu\varepsilon$ to 900 $\mu\varepsilon$. The strain coefficient is 30 pm/$\mu\varepsilon$, and it is less sensitive than conventional PANDA fiber. We believe that the fact of the coating being bigger ~3% than the conventional fiber and the possible difference in composition makes it stricter. Table 1 presents the values previously measured for the strain and temperature coefficients of the Hi-Bi PANDA fiber (PM-1550-HP) [6] and the measurement for the Hi-Bi PANDA erbium-doped fiber.

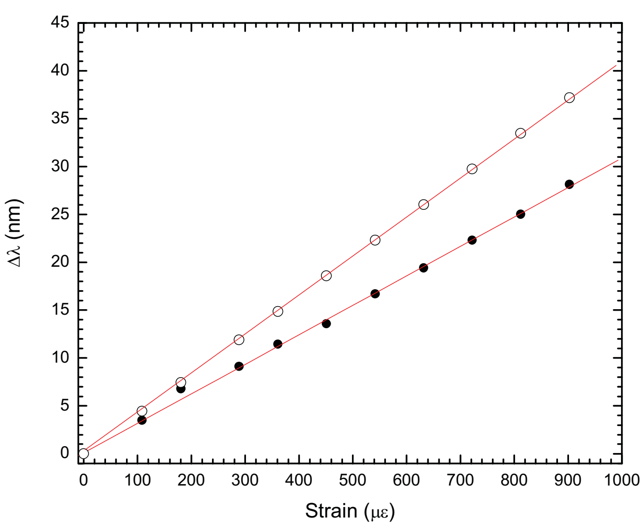

Figure 4 Strain response of sensing head. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com]

TABLE 1 Strain and Temperature Coefficients of Fibers

Type fiber	K_E (PM/ME)	κ_T (nm/°C)
PANDA fiber (PM-1550-HP)	41.2	−1.90
PANDA Erbium-doped fiber	30.0	−2.22

3. CONCLUSION

We demonstrated Hi-Bi erbium-doped FLM as temperatures sensors. This type of interferometric configuration is not itself a new concept; however, with the utilization of PANDA erbium-doped fiber it is more sensitive when compared with the conventional Hi-Bi fibers. This work also presented comparisons between the performance of FLM containing Hi-Bi erbium-doped fiber and a conventional Hi-Bi fiber when subjected to strain and temperature. The Hi-Bi erbium-doped fiber is presented as a potential solution for temperature sensors, having a sensitivity of 0.02°C.

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ANTENNA MINIATURIZATION WITH FERRITE–FERROELECTRIC COMPOSITES

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ABSTRACT: *A magneto-dielectric composite with nickel zinc ferrite and bismuth strontium titanate has been synthesized and characterized in terms of permeability and permittivity and used as substrates for antenna miniaturization. The objective was to achieve high- and equal permeability and permittivity for antenna miniaturization and impedance matching to free-space. Studies on antennas operating at 100 MHz indicate low-losses and a miniaturization factor of 7–10, in agreement with*