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Design of temperature sensor using twisted photonic crystal fiber

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ABSTRACT

We proposed a novel temperature sensor based on dual core photonic crystal fiber (DCPCF) and applying different twisting on its cladding surface. The temperature dependent chloroform is applied as analyte. The sensitivity is calculated for different twist (10 rad/mm and 15 rad/mm).

Introduction

In theory of optical materials and its devices, the activity of optical medium involves to the different polarization. Recently birefringence effect introduced in PCF by breaking circular symmetry or introducing defects in cladding boundary since elliptic core fiber with irregular air holes [1] exhibits very high birefringence of an order of 10^{-2} wavelength from 1300 to 1600 nm, composing of central elliptical air hole with circumferential elliptical ring [2].

Cross section view of the proposed fiber

Fig. 1 depicts the structure and its field pattern. Silica acts as substrate and liquid is infiltrated at the center. By coupling length principle, the temperature sensitivity is obtained.

Result and analysis

The coupling length is equal to minimum light is easily transfer from one core to another one core of DEPCF. The coupling length [3] is calculated by $L_C = \frac{\lambda}{2|n_{RR} - n_{LR}|}$ and it is plotted in Fig. 2(a) which portrays that the particular wavelength say 1.55 µm, the coupling length of DEPCF is calculated as 4 mm, 3.9 mm and 3.85 mm for 20 °C, 22 °C and 24 °C respectively at twist rate of 15 rad/mm. According to the mode coupling theory, the transmittance [3] calculated by $T = \sin^2\left(\frac{\Delta n_{eff} \pi L}{\lambda}\right)$ and plotted in Fig. 2(b). The calculation shows the wavelength of the

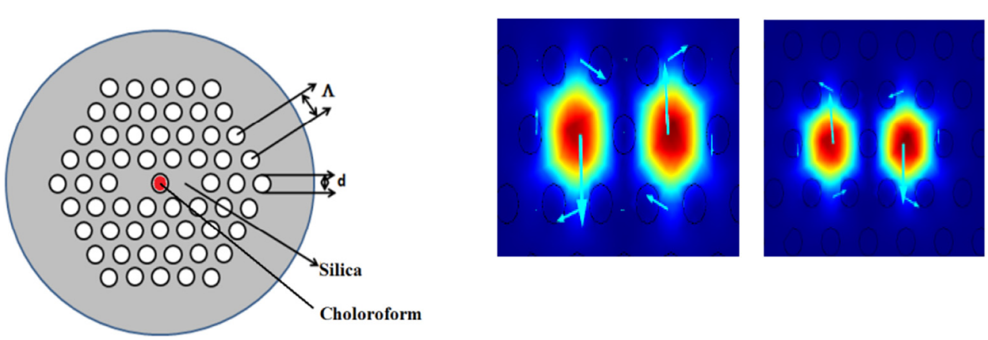

Fig.1. Cross sectional view of the proposed temperature sensor and its field distributions.

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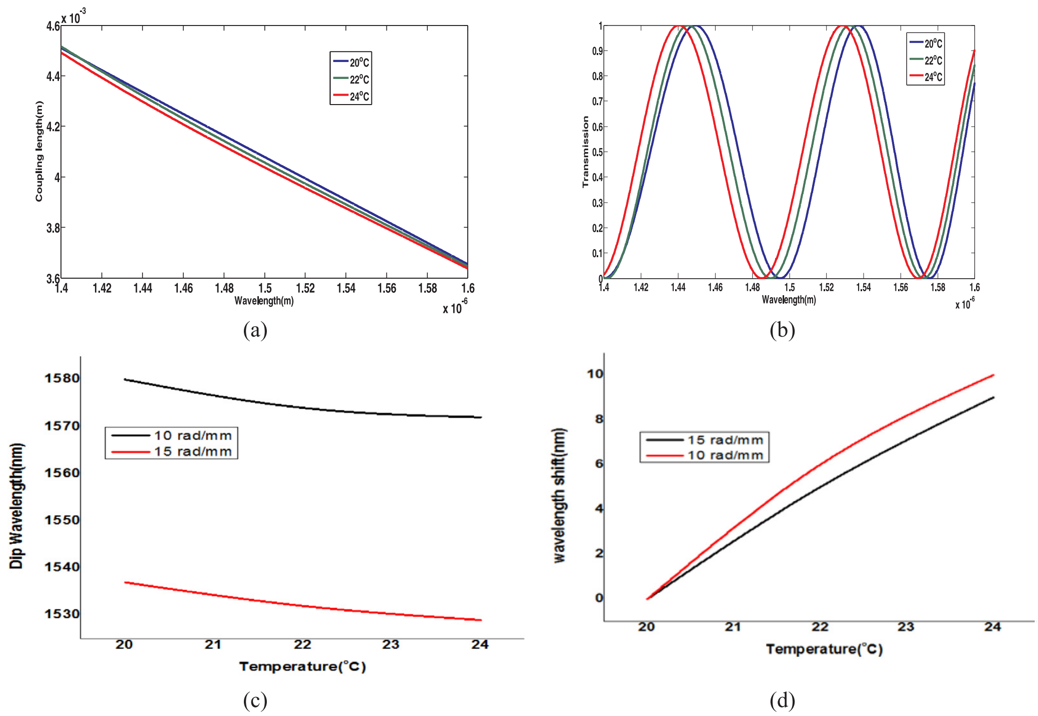

Fig.2. Coupling length, transmission, dip wavelength and wavelength shift of 20 °C, 22 °C, 24 °C at 15 rad/mm.

dip changes linearly with decreasing temperature from 20 °C to 24 °C as shown in Fig. 2(c). Further the sensitivity is expressed as $s = \frac{\Delta\lambda_p}{\Delta T}$. Where λ_p-peak wavelength, the total wavelength shift calculated as10 nm and 9 nm with respect to twist rate of 10 rad/mm and 15 rad/mm as shown in the Fig. 2(d). Finally, the proposed twisted DEPCF sensitivity of 2.5 nm/°C at length 1.24 cm and 2 nm/°C at length 0.9 cm for 10 rad/mm and 15 rad/mm respectively.

Conclusion

The article discussed the effect of variation temperature sensor while applying the twist. Those twists are permanently applied. For each radian of twisting, the temperature effect is monitored and sensitivity is calculated 2.5 nm/°C at length 1.24 cm and 2 nm/°C at length 0.9 cm for 10 rad/mm and 15 rad/mm.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.rinp.2018.08.005.

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