CS_2-Filled Solid-Core Photonic Crystal Fiber for Temperature Sensing Based on Photonic Bandgap Effect

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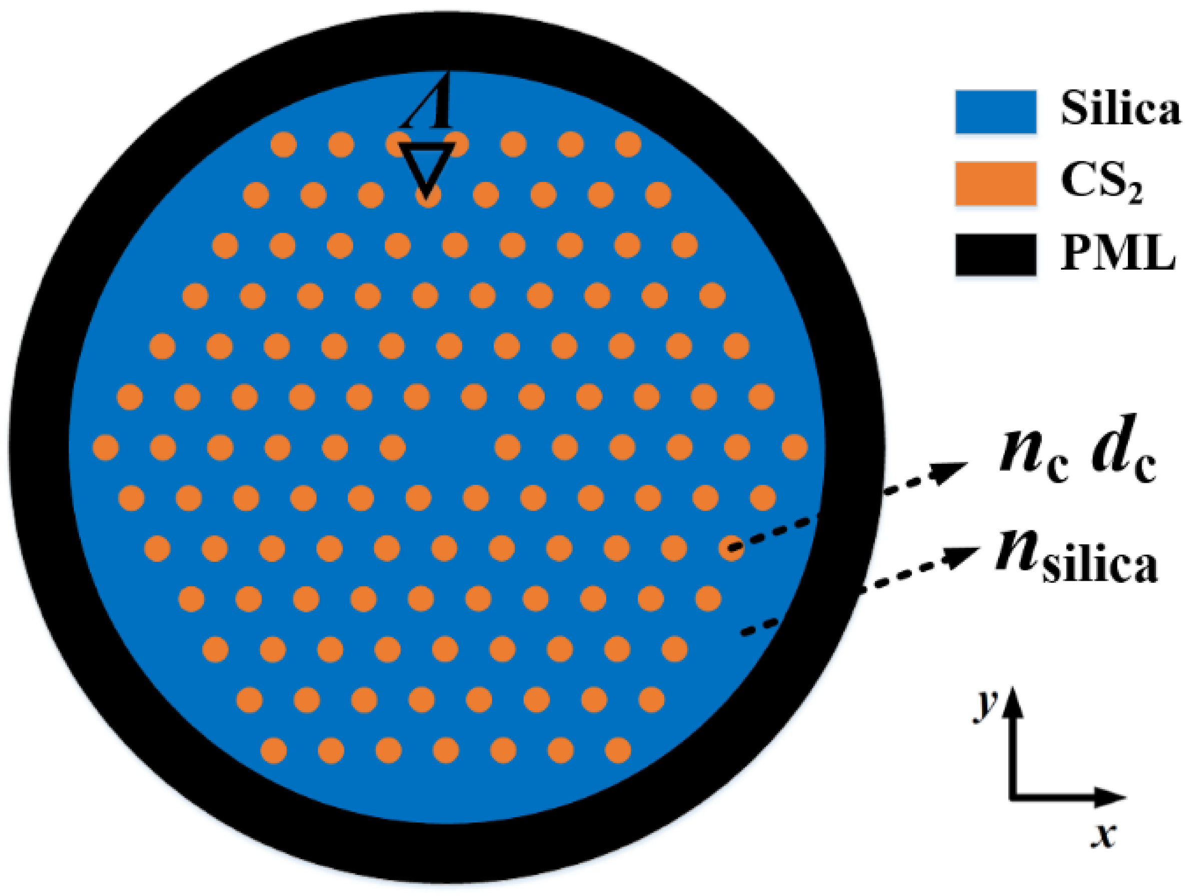
Introduction

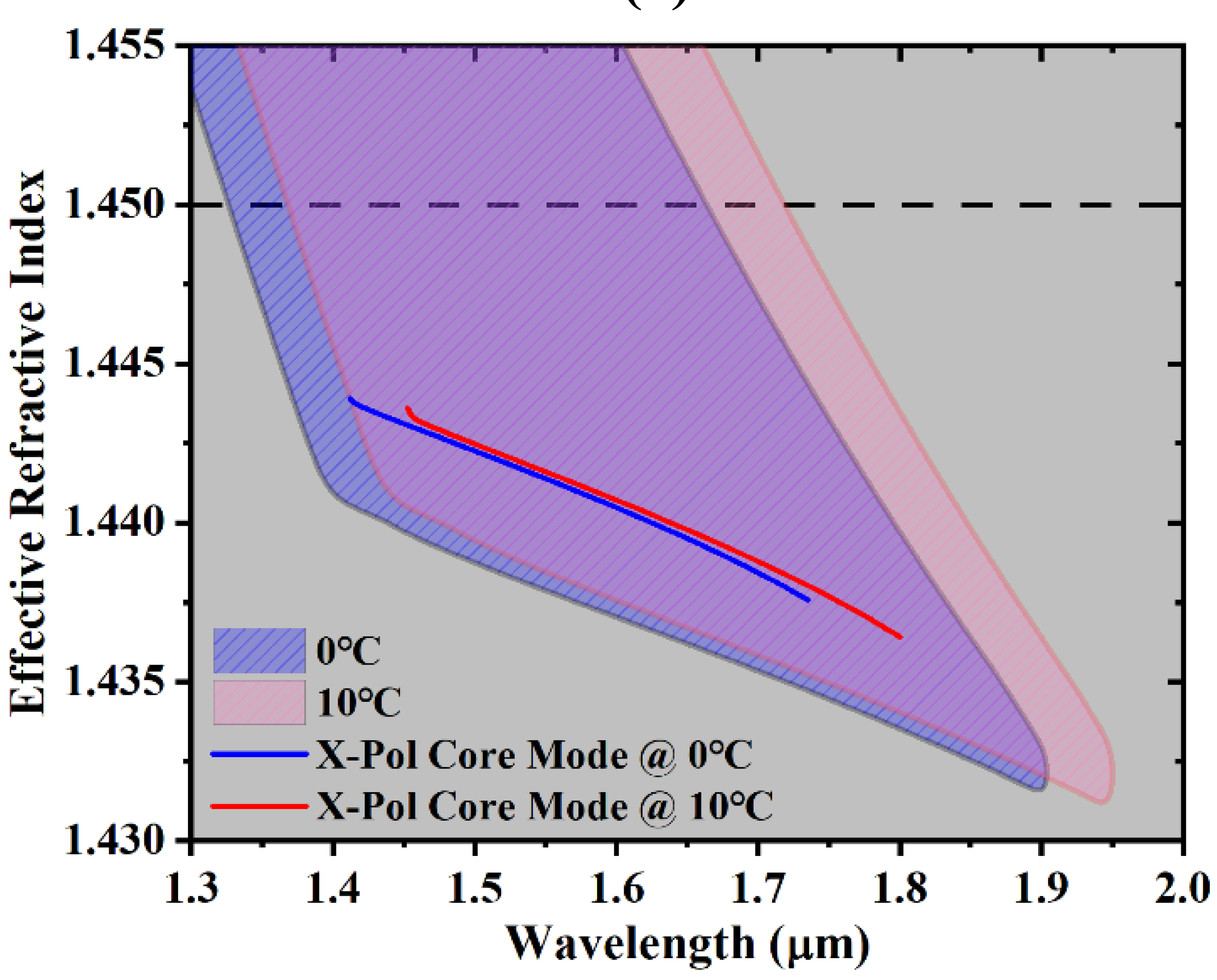
Photonic crystal fibers (PCFs) have important application in sensing due to their excellent optical characteristics, including adjustable dispersion, high birefringence, endless single-mode transmission, etc. Until now, many efforts are made in the PCF sensors, such as gas sensor, refractive index sensor, temperature sensor, pressure sensor, and so on.

We proposed a solid-core PCF filled with CS_2 for temperature sensing based on photonic bandgap (PBG) effect. The change of temperature can change the refractive index of CS_2, which further results in the shift of PBG. The simulation results show that the average sensitivity can achieve 4.60 nm/℃ and the linearity R^2 is 0.999 in the range of -50 to 40 ℃.

Fiber design and simulation results

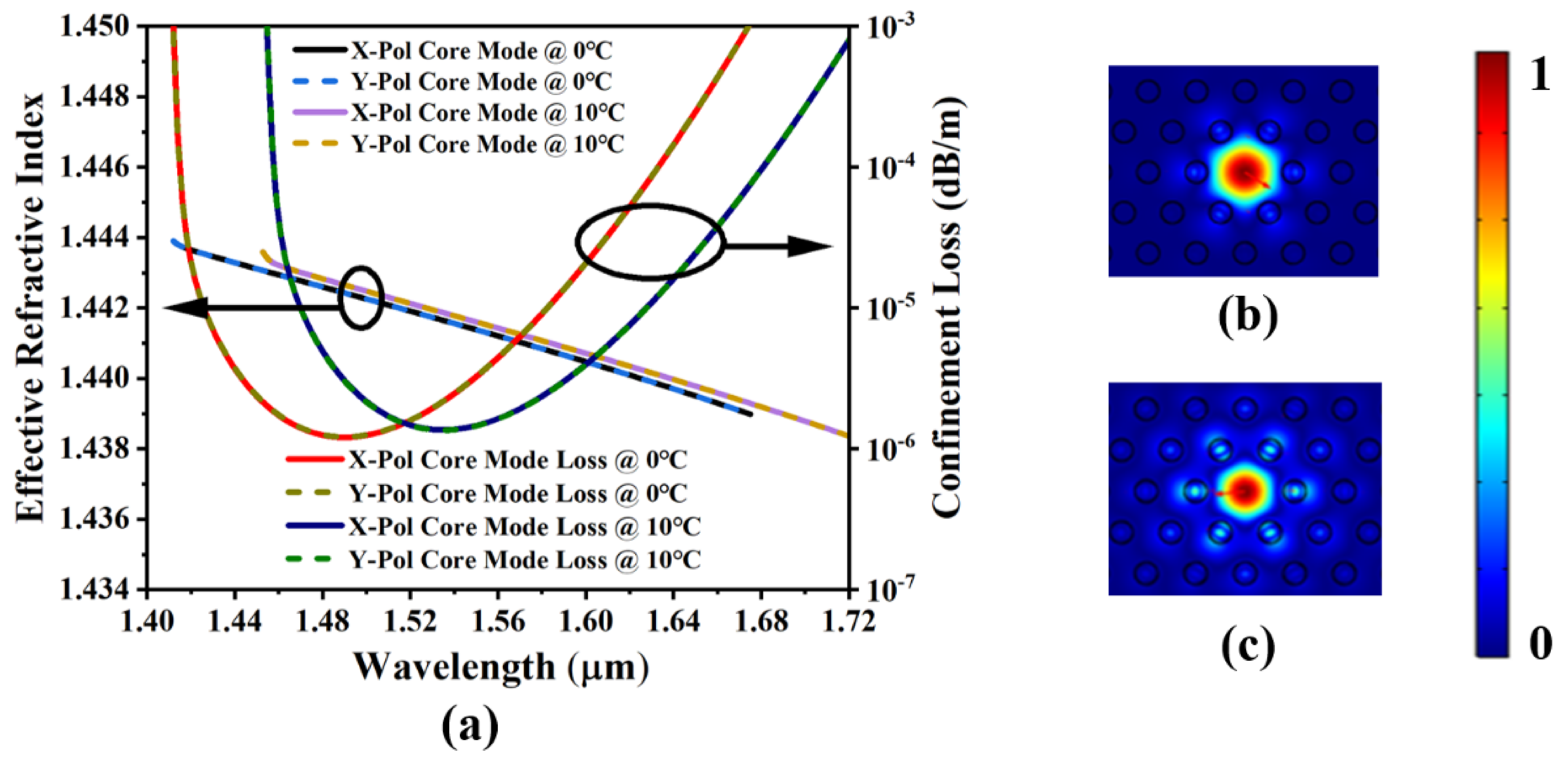


(a)

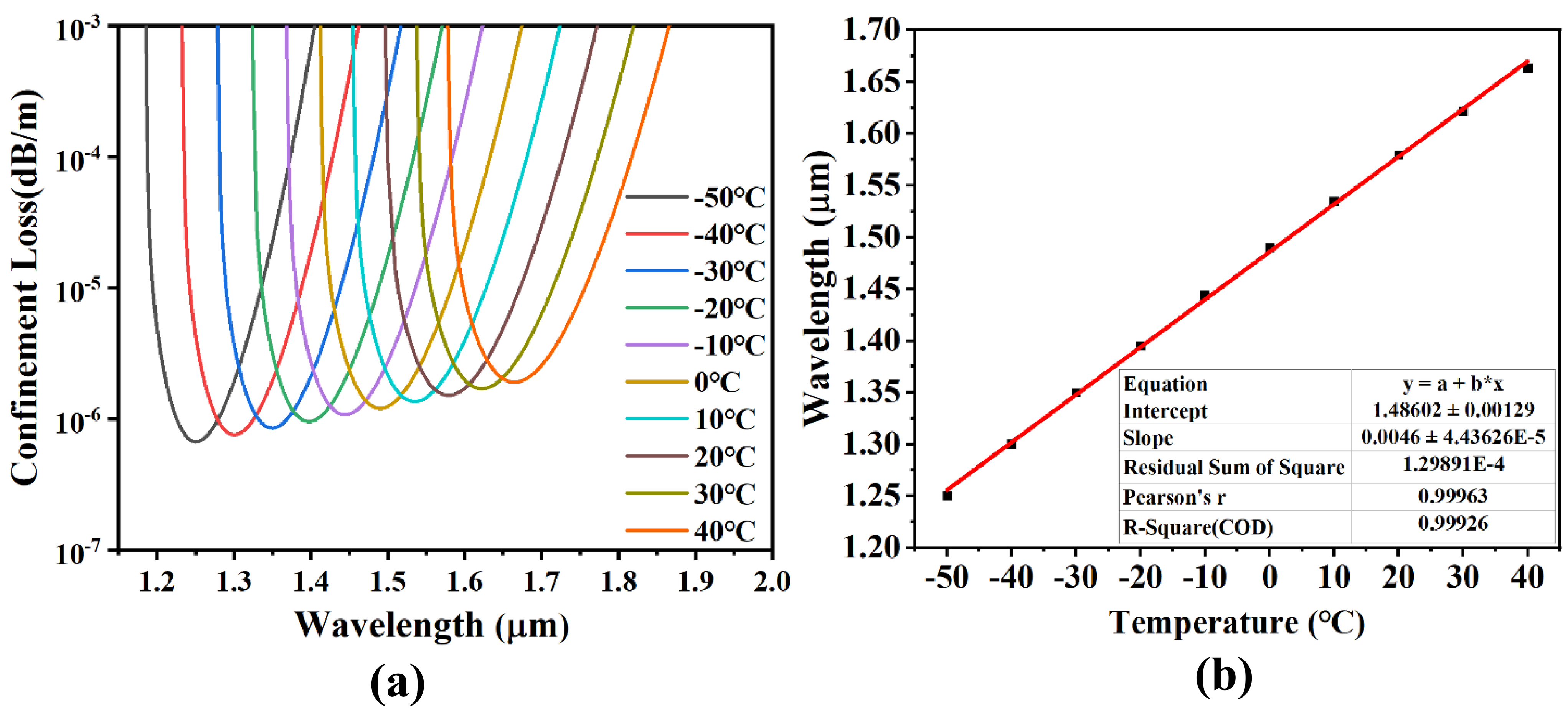


(b)

(a) The cross-sectional structure of the designed CS_2-filled solid-core PCF. (b) the bandgaps of the fiber at the temperature of 0°C and 10°C



(a) The dispersion curves of the *x*-pol and *y*-pol core modes and the confinement loss spectra of the *x*-pol and y-pol core modes when the temperature is set as 0 ℃ and 10°C. (b) and (c) show the mode field distributions of the *x*-pol core modes calculated at wavelengths 1.49 and 1.656 μm, respectively.



(a) The confinement loss spectra of the x-pol core mode of the CS_2-filled solid-core PCF when the temperature changes from -50 to 40 ℃. (b) The corresponding wavelength variation in the lowest confinement loss wavelength and linear fitting results.

The linear fitting equation is y=0.0046x+1.48602. The corresponding average sensitivity of the proposed sensor is 4.60 nm/℃, and R^2=0.999 when the temperature changes from -50 to 40 ℃.

Conclusion

In summary, we propose a simple structure CS_2-filled solid-core PCF for temperature sensing based on the PBG effect. The average sensitivity and R^2 of the proposed sensor can reach 4.60 nm/℃ and 0.999 in the wide temperature range of -50 to 40 ℃, respectively.

Acknowledgements

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