A Broadband Polarization Beam Splitter Based on Compressed Hexagonal Structure and Liquid Crystal-Filled Dual-Core Photonic Crystal Fiber

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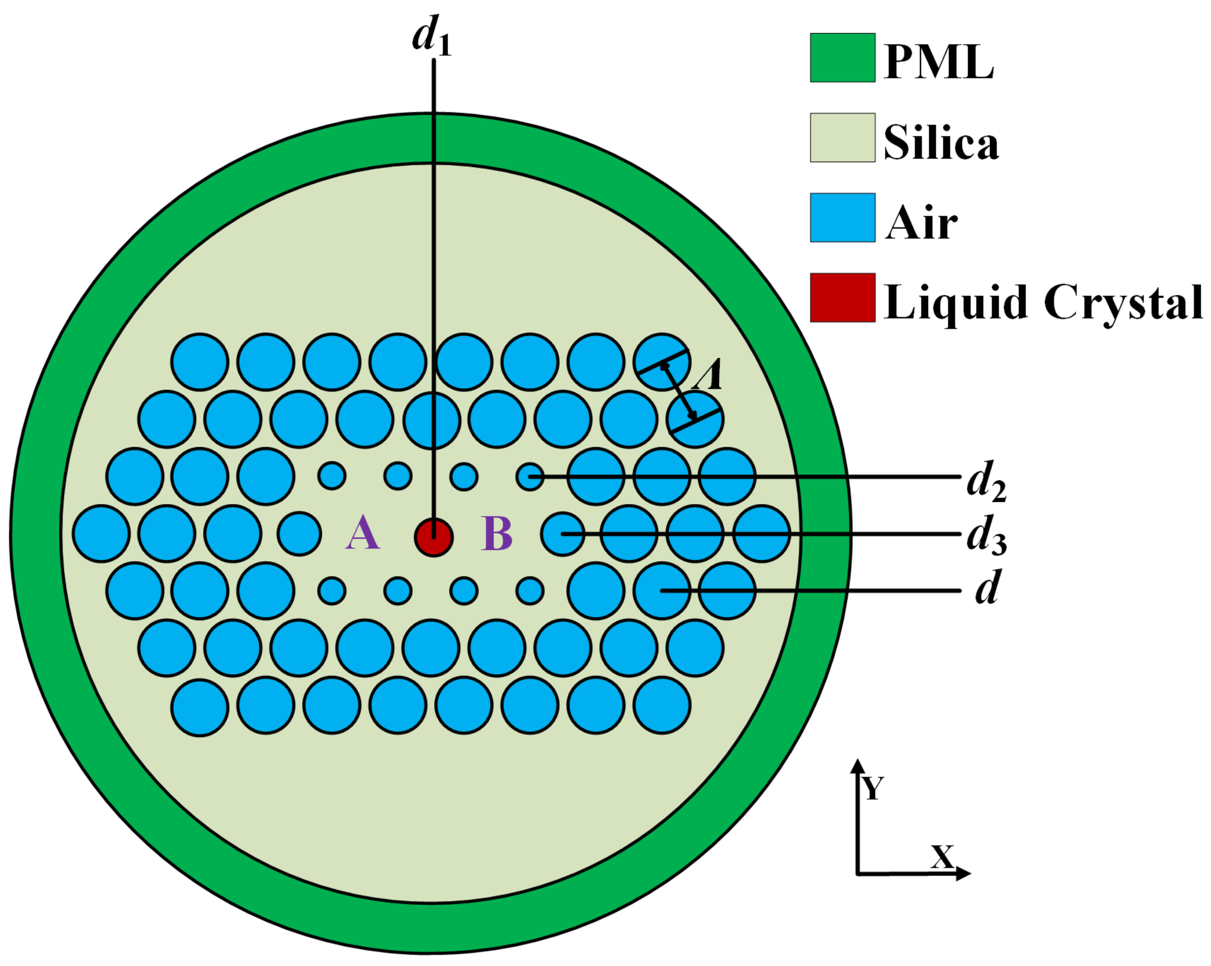
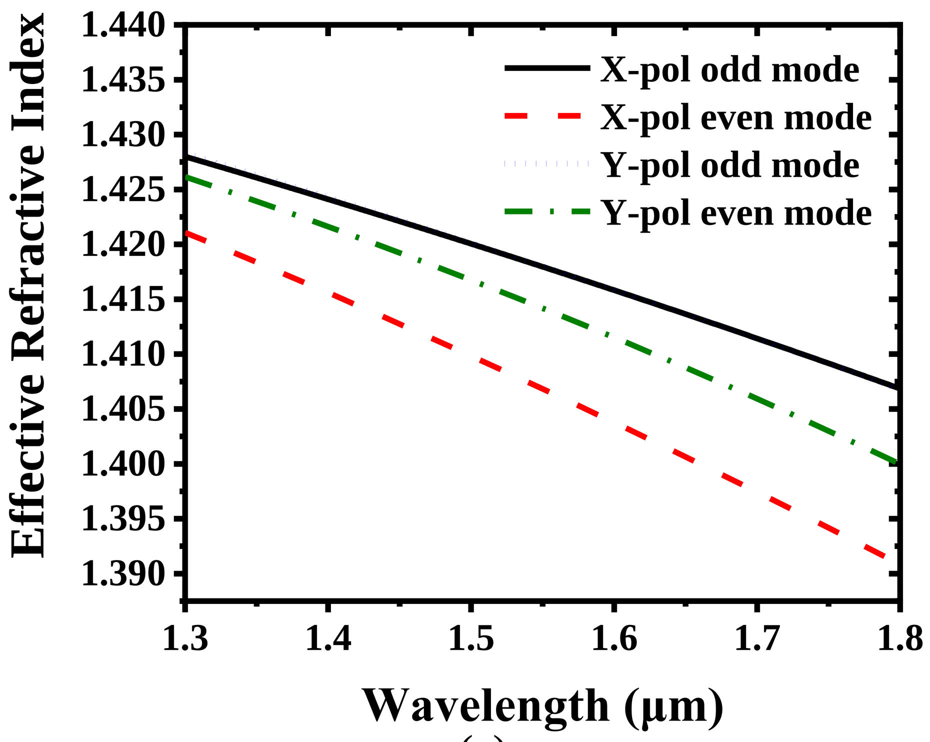
Introduction

Polarization beam splitter (PBS) is an important passive optical device in optical communication system, which is mainly used to separate light beams with different polarization directions. Photonic crystal fiber (PCF) has been widely used in the field of the PBS because of its flexible structure, high birefringence, endless single-mode transmission, etc.

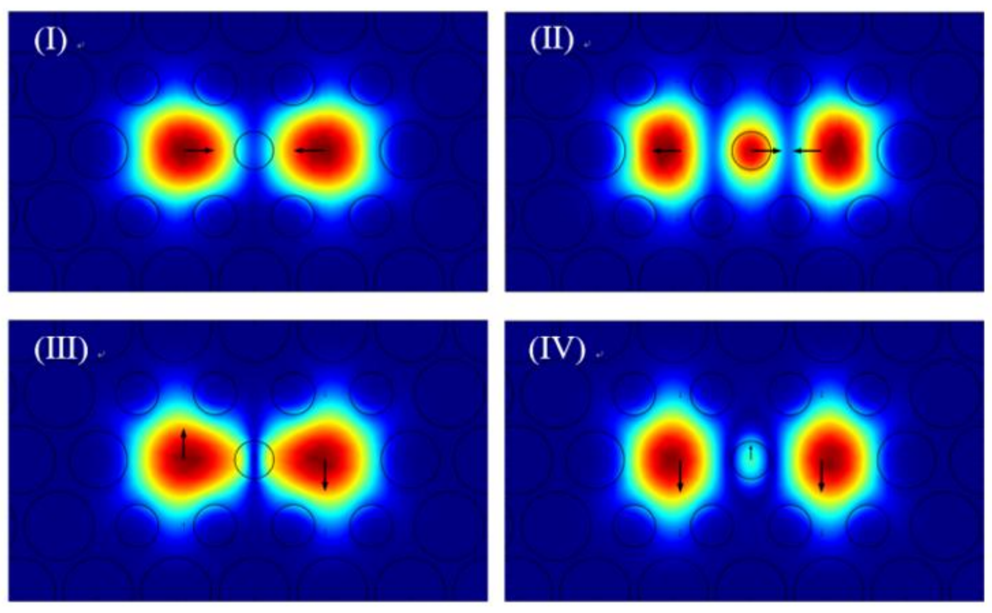
Therefore, we propose a broadband PBS based on compressed hexagonal structure and liquid crystal-filled dual-core PCF. Its air holes are arranged in a compressed hexagonal structure, and central hole is filled with nematic liquid crystal (NLC), which greatly improves the birefringence. In addition, the numerical results are analyzed by finite element method (FEM). The simulation results show that the splitting length of the PBS is 109.5 μm, and the bandwidth for the *ER* of 20 dB is about 280 nm, covering S, C, L and U communication bands.



Design of the PBS and simulation results



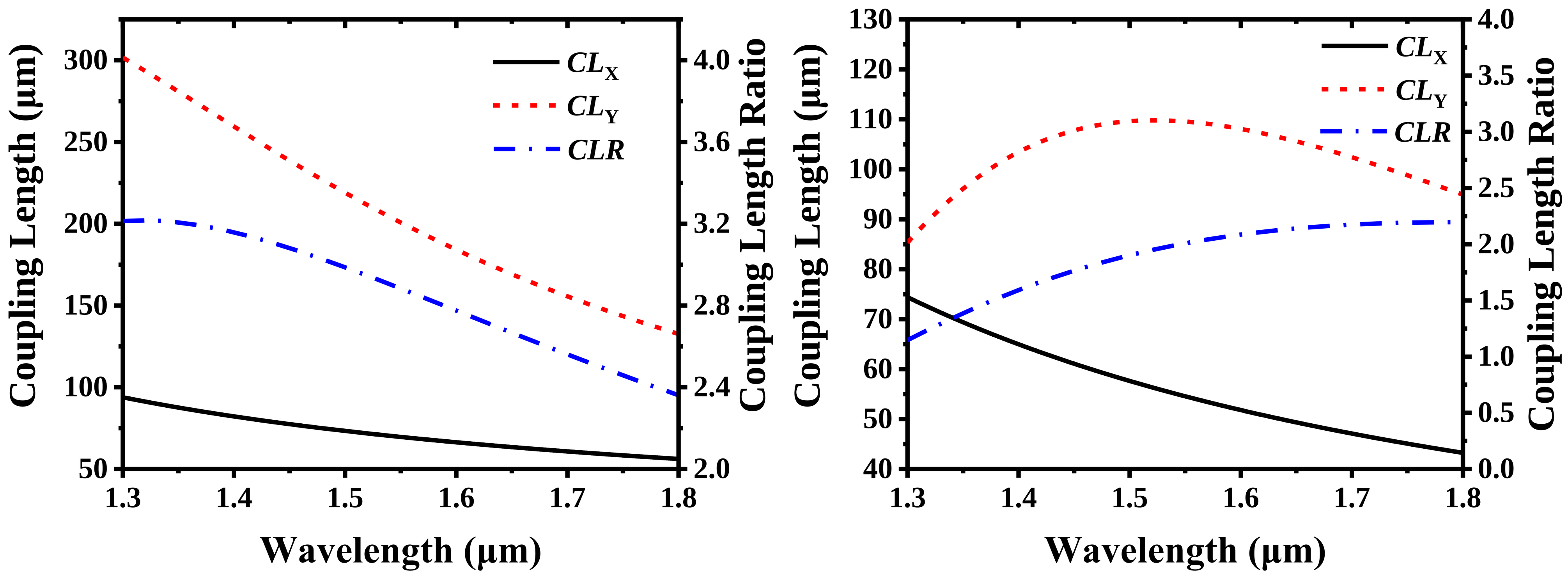
(a)



(b)

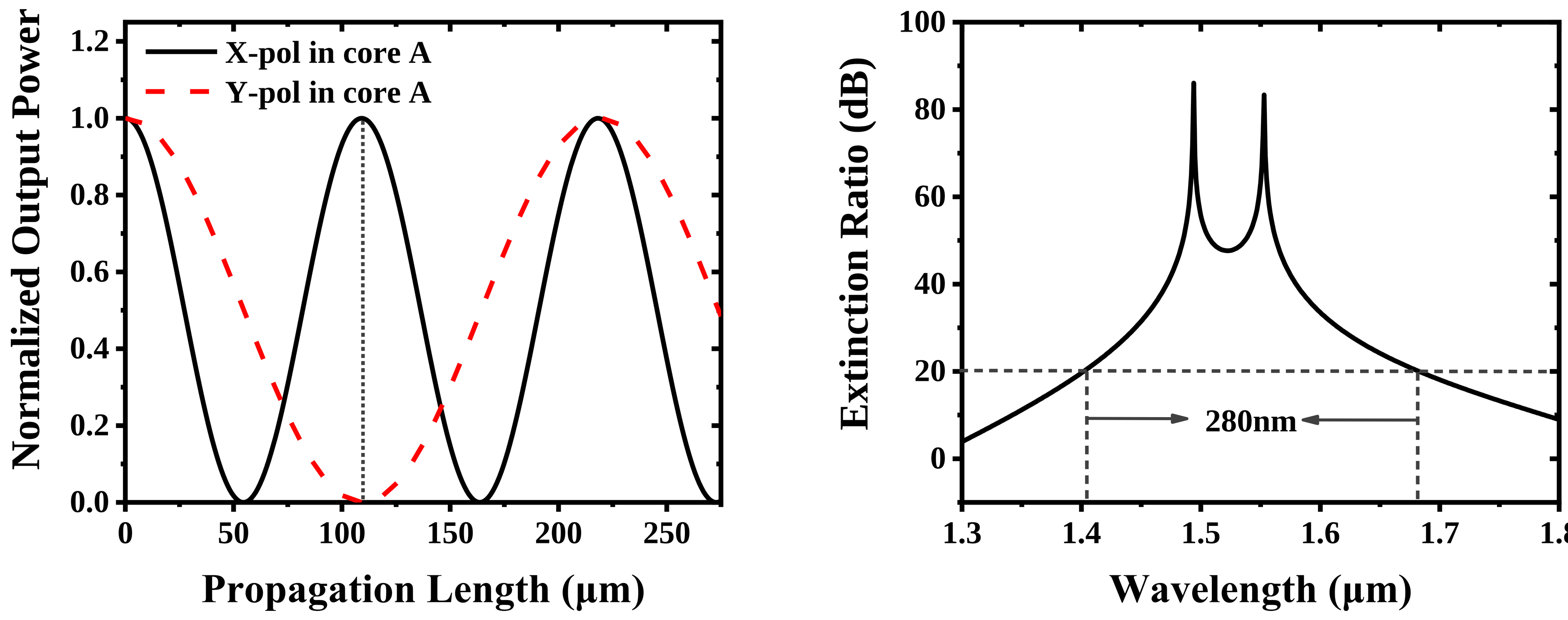
(a) The cross section of the proposed broadband PBS based on compressed structure and liquid crystal-filled dual-core PCF. (b) The mode field distributions of the (I) X-pol odd mode (II) X-pol even mode (III) Y-pol odd mode (IV) Y-pol even mode.

In order to get the shortest PBS, a set of optimal parameters is found: d = 1.8 μm, d_1 = 1.0 μm, d_2 = 1.1 μm, d_3 = 1.5 μm, Λ = 2.0 μm.



(a) (b)

CL of the X-pol mode (CL_X), Y- pol mode (CL_Y) and *CLR* of the proposed PBS with the (a) original parameters and (b) optimal parameters.



(a) (b)

(a) Relationships between the normalized output power of the X-pol and Y-pol in core A and propagation length of the proposed PBS at the wavelength of 1.55 μm. (b) The dependence of the *ER* on wavelength.

When the propagation length is 109.5 μm, the two polarized beams are completely separated into the two cores. With the wavelength increasing from 1.3 to 1.8 μm, the *ER* reaches the peak value of 86 dB and the second maximum value of 83 dB at the wavelength of 1.494 μm and 1.553 μm, respectively. In addition, the *ER* maintains greater than 20 dB from wavelength 1.402 to 1.682 μm.

Conclusion

In summary, a broadband PBS based on the compressed hexagonal structure and liquid crystal-filled dual-core PCF is proposed. The length of the proposed PBS is 109.5 μm, and its corresponding bandwidth is 280 nm, which covers the S, C, L, and U communication bands.

Acknowledgements

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