Analysis of Flat Top Comb-Filter based on Photonic crystal Fiber for DWDM

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Abstract— We have demonstration of optical comb filter based on the Sagnac loop interferometer of Photonic Crystal Fiber (PCFs). The effect of influence of high birefringence and effect of length of the two sections of the PCFs is analyzed as well as effect of polarization controller on the transmission function. This paper involves the construction of the flat top comb filter. These devices can be applicable for the dense wavelength division multiplexing (DWDM) applications.

1. Introduction

Optical waveguides was object of investigations in recent years for the promising prospect of optoelectronic THz devices [1]. Optical transmission bandwidth increment is one of the most important requirements for wavelength division multiplexing (WDM). The comb filter is the most important components for adding/dropping in optical communication. It is more advantageous of low loss, small size and better performance compared with conventional optical filter. Signal fidelity and tolerances is one of the important aspects, which can be obtained by a filter with flat-top pass bandwidth. Now a days, optical comb filter based on Sagnac loop is the area of interest for the multi-wavelength fiber lasers, high speed wavelength routing, optical pulse train generation, all-optical label swapping etc. However, Photonic crystal fiber (PCF) characteristics have been widely studied by different researchers. The coupling characteristics of dual-core PCF with asymmetric cores in the PCF are investigated [2]. A highly birefringent PCF can be obtained by employing arrays of sub wavelength air hole pairs in the fiber core, which are arranged in the conventional hexagonal lattice structure. The novel kind of PCFs based on fiber core with the arrays of circular air holes is investigated and its characteristics are widely discussed [3]. The modal characteristics of PCFs, with guiding cores consisting of one or seven missing air holes, are investigated with the finite element method (FEM) and compared to those of step-index fibers [4].

2. Theory

We introduce a generic design of PCF in which the air holes are arranged in a hexagonal lattice. Where is the hole pitch and diameter of the air hole. The fiber structure and it has high birefringence. The low index material is filled inside the air adjacent to the core, so that the low refractive index of holes is lower than that of pure silica. This PCF provides an effective index difference between the two orthogonal polarization modes. Due to the refractive index of the doped material the birefringence exist inside the PCFs.

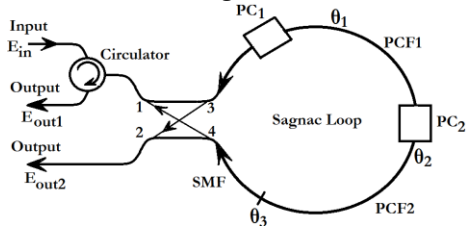

Fig 1: Schematic of the proposed flat-top comb filter.

The basic structure of proposed polarization independent all fiber filters is shown in the Fig. 1 [5]. The proposed device is based upon the Sagnac loop. The device is comprised of two polarization controllers (PCs), two sections of high birefringence photonic crystal fibers (PCFs), and simple 2×2 3-dB coupler. The input incident light is allowed to pass into Sagnac loop from the port 1 of the 3-dB coupler. Now, signal splits into clockwise and counter clockwise component by the 3-dB coupler. As the light waves travels through the PC1 and PC2, the polarization angle will rotate and the rotated polarization angles are θ_1 and $\theta_2$respectively. PCF2 is connected with the conventional single mode fiber (SMF) and it produces the polarization angle θ_3.

3. Result and discussion

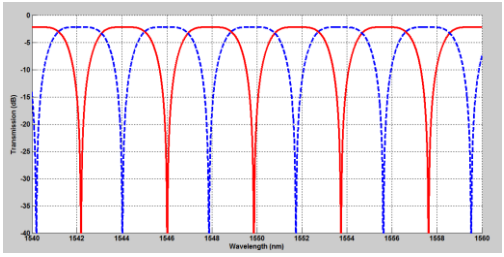

Fig 2: Wavelength switching operation with flat-top spectral response.

However, we can always obtain the flat-top comb filter by properly setting the PC and the lengths of PCFs. When the flat-top spectral response can be attained, the wavelength switching operation with the flat-top spectral response can be achieved as it is shown in Fig. 2. Figure 2 illustrate the output wavelength tunable comb flat-top spectra with parameter of $L_1 = 2L_2 = 0.8\text{m}$, $B = 1.5522 \times 10^3$ (solid line) and$L_1 = L_2 = 0.4\text{m}$, $B = 3.1 \times 10^3$ (dash line).

4. Conclusions

The analytical analysis of flat top comb filter based on the Sagnac loop interferometer is studied. We found the transmission band with sinusoid with similar PCFs. If the length of one fiber is twice of the other fiber, we can achieve flat top comb spectral response. Hence, by proper setting of the polarization state of PC, length of PCFs wavelength switchable comb filter can be easily obtained.

References

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