Design of Mode Filter using Asymmetric Loop Bragg Fiber

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1. Introduction

The study of circular waveguides in recent years have received substantial attention as it offers very high transmission bandwidth as well as improved propagation characteristics as compared to other waveguides. A waveguide with non-circular loop has a special attention because it can be used in integrated optics and optoelectronics devices [1].

An optical fiber involves various mechanisms for guiding light such as total internal reflection, photonic band gap formation, antiresonant reflection mechanism etc.[2]. Propagation of light in optical fiber through high refractive index core is to satisfy total internal reflection. So in that case it is not possible to make the fiber hollow or of low refractive index core to minimize photon propagation loss. A non-circular low refractive index core Bragg fiber can solve this problem, so it is has been designed which has an alternating cladding of high-low refractive index as shown in Figure 1.

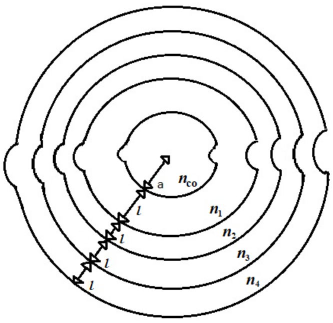

Figure 1: Non-circular Bragg fiber with four cladding layers [3].

Bragg fiber utilizes photonic band gape guidance mechanism for light propagation. The propagation constant β is an important parameter which decides whether light is to be guided or evanescent in any medium. The propagation constant β of any medium with refractive index n can be expressed as, $\beta = kn\cos\theta$, where k is vacuum wave constant and θ is incident angle of light to the axis of core. For light to be guided, propagation constant must be $\beta < kn$. If $\beta > kn$, θ becomes imaginary and light evanescent [4]. This Bragg fiber has been studied by finite difference method and transfer matrix method for modal analysis which are compared in Table 1.

2. Results and discussion

In this section, transfer matrix method was applied to compute different degenerate modes of non-circular Bragg fiber [5] and modal dispersion characteristics are plotted which reflects clearly mode filtering by controlling the cladding thickness l. Equation (1) and (2) are mathematical relations that are used to plot modal dispersion characteristics.

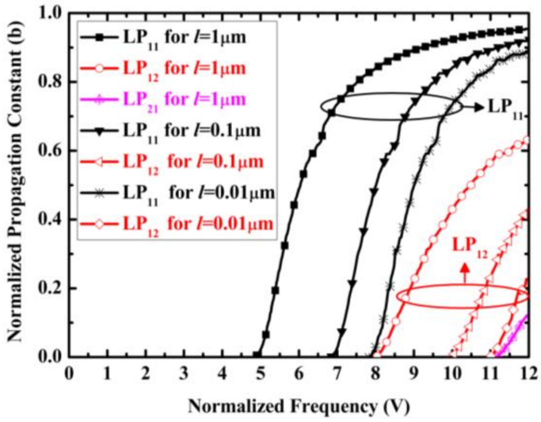

Figure 2: Comparison of modal dispersion characteristic for different cladding thickness (l) of Bragg fiber.

$$V = k\,l(n_2^2 - n_{co}^2)^{1/2} = k\,l[2n(\Delta n + \Delta n')]^{1/2} \quad (1)$$

$$b = \frac{\beta^2 - n_{co}^2 k^2}{k^2(n_2^2 - n_{co}^2)} \approx \frac{\beta - n_{co}k}{k(\Delta n - \Delta n')} \quad (2)$$

where, $\Delta n = n_2 - n_1$ and $\Delta n' = n_2 - n_{co}$

Table 1. Comparison of TMM & FDTD results for various normalized frequencies

Mode	Normalized cut-off frequencies for various modes in asymmetric Bragg fiber					
	b=1.00µm		b=0.10µm		b=0.010µm	
	TMM	FDTD	TMM	FDTD	TMM	FDTD
LP_{11}	4.85	4.67	6.57	6.32	7.92	7.80
LP_{12}	8.00	7.93	10.0	9.67	11.3	11.0
LP_{21}	11.20	10.85	-	-	-	-

3. Conclusions

Cladding thickness (l) and number of cladding are key parameters of a Bragg fiber to control number of modes and propagation losses. So by proper designing of cladding thickness we can get a single mode Bragg fiber with efficient coupling and minimum propagation loss.

References

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