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PWE Approach to MSOF for Beam Splitting Application

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Abstract:- **Simulation studies of electric field splitting application using microstructure fiber with employing plane wave expansion method. The distribution in micro structured optical fiber (MSOF) using plane wave expansion (PWE) technique for beam splitting application is reported in this paper. Here MSOF is realized by 5x5 air holes on silicon substrate with defect at centre. PWE method is employed to envisage a number of spectrally distinct output beams with respect to single input beam. Simulation result revealed that electric field mode of propagation varies arbitrarily with respect to radius of air hoes at lattice constant of 500 nm, for example proposed MOSF allows 1,2, 3,4,5,6 and 7 number of modes of propagation for radius of air holes , 110 nm ,120 nm, 210 nm. 150 nm, 162 nm, 165 nm and 230 nm respectively. Finally simulation is also carried out for output power from MSOF and present result explores that the power emerging from micro structure fiber depends in both structure parameter and configuration along with nature of material.**

Keyword : ***MSOF,PWE, beam splitter***

INTRODUCTION

Recently various optical devices are being frequently deployed in to carry out different applications in the field of optical technology. Out of several devices, beam splitter is a special type of optical device that splits a beam of light into two however the splitting beam will be more than two depending on the nature of material as well as devices for an example dichroic optical coating devices splits different output beams, where metal coating device splits of two instead of many. As far as literature survey on beam splitter is concerned a lot of works have been carried out [1,2,3,4].In reference[1],authors discusses the beam splitter application by Mach-Zehnder interferometer where in [2] broadband beam splitter plate is made by BKF material. Similarly, refer [3] realizes polarization beam splitter. Aside this, recently a beam splitter application is discussed using photonic crystal structure by employing difference in time domain method [4].We in this paper explores beam microstructures fiber is shown in figure 1,

Fig. 1 Schematic diagram of microstructure showing multiple output beams

Figure 1 represents the microstructure fiber allows multiple beams with respect to single input beam. Here we have considered silicon as background materials and 5 x 5 holes are etched on square lattice optical fiber. In this case output signal depends on power emerging from air holes; for example if light will be transmitted through single hole only then it is treated as single beam splitter device. Similarly if light will be coming out from two holes then it will be treated as two beams splitter. Also one can consider multiple output beams using the same principle. As far as our research is concerned, here we have shown the same for single beam splitter to seven beam splitter. These beam splitting is realized with respect to different values of both lattice spacing and air holes, which is discussed in section 3.

This paper is organized as following: section 2 gives mathematical approach to PWE method, where results and discussion are made in section 3 and conclusions are draw in spectrums.

II. MATHEMATICAL TREATMENT

The electric field distribution in microstructure optical fiber is computed using, Helmholtz equation, which is given by [5]

— — (1)

The solution of eqn is expressed as

(2)

Where is the periodic function with periodicity of lattice.
The wave functions are represented in terms of Bloch wave and expanded in to Fourier series over lattice vector, which is expressed as

(3)

Here E'kr(Gr) are Eigen vectors to be found during the Eigen problem solution. Gx and Gy are called Fourier coefficients for harmonics. Using above equations, we solved Eigen value problem and compute the field distribution in the microstructure optical fiber.
From above field distribution, the peak electric field corresponding to each diagram is computed and then power for each peak is found by the following expression

(4)

Where ' ' is velocity of light, is permittivity of free space , is the refractive index modulation, 'A' is the area of the square lattice, is the peak electric field.

IV.SIMULATION RESULT AND DISCUSSION

To realize beam splitter, here we have considered 5x5 air holes on silicon substrate at lattice constant of 500 nm. In this case we try to envisage number of spectral beams with respect to single beam. So to realize the same, here the radius of air holes is varied at lattice constant of 500 nm. The reason for varying the radius of air holes is that splitting ratio (output: input) changes with changing the radius of air holes. To obtain so , we use the plane wave expansion to find out electric field distribution by employed equation (1-3). The simulation for radius 110 nm and 230 nm are shown in figure 2(a) and 2(b) respectively.

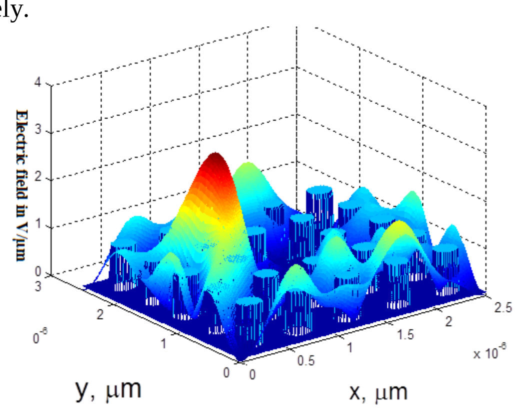

Fig. 2(a) Electric filed distribution in MSOF at r=100 nm and a= 500 nm

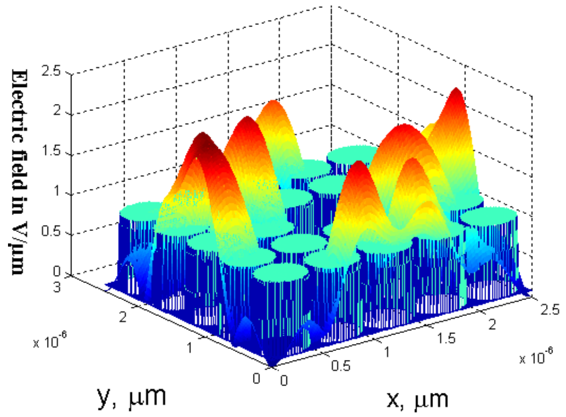

Fig. 2(b) Electric filed distribution in MSOF at r=230 nm and a= 500 nm

Fig2(a) and 2(b) represent the electric field distribution in microstructure optical fiber showing number of peaks of 1 and 7 respectively. Similarly simulation for other radius are done and not shown here. In these figures (Figure 2a and b) it is seen that electric field distribution is taken by z-axis where length and breadth of fiber taken by x and y axis respectively. In this figure red colour is considered as peak electric field .Using above concept from fig 2(a) it is observed that one peak electric field corresponding to (500nm,110nm)of (a,r) is 3.216 V/ . Similarly from fig 2(b) there are seven peaks are observed. Each electric field has definite electric field intensity. These fields are represented as output beams. This indicates that 7 output beams having different peak value is coming out from the fiber with respect to single input. Similarly using same concept and from other simulation results it is found that the number of peak electric field is 2,3,4,5,and 6 for the combination (500nm,120nm),(500nm,210nm),(500nm,150nm),(500nm,162nm)and (500nm,165nm)of (a,r) respectively. After calculating the peak electric field ,we move to compute the output power of the beam using equation (4).It is found that for combination of lattice and radius of (500nm and 110nm) gives single output having power of 261 mW. Using figure 2(b) it is also seen that 500 nm of lattice spacing and 230 nm of radius gives 7 output beams having power of 124 mW ,115 mW,106 mW,103 mW,103 mW,93 mW and 82 mW respectively. Similarly from other simulation (not shown in figure) result, it is inferred that 500 nm of lattice spacing and 165 nm of radius gives 6 output beams having power of 184 mW ,133 mW,122mW,112mW,93mW,84mW respectively and 500 nm of lattice spacing and 162 nm of radius gives 5 output beams having power of 145 mW ,138 mW,136 mW,101 mW,83 mW respectively and 500 nm of lattice spacing and 150 nm of radius gives 4 output beams having power of 178 mW ,150 mW,128 mW,83 mW respectively and 500 nm of lattice spacing and 210 nm of radius gives 3 output beams having power of 211 mW ,95 mW,92 mW respectively and 500 nm of lattice spacing and 120 nm of radius gives 2 output beams having power of 206 mW ,134 mW respectively.

V. CONCLUSION

Beam splitting application using microstructure optical fiber is thoroughly discussed in this paper. The simulation for electric filed distribution in same optical fiber is carried by employing plane wave expansion method. The output power emerging from MSOF is also computed corresponding to each radius and lattice spacing. Finally, simulation result divulged that both electric field and output power varies randomly with radius of air holes. and lattice spacing of structure.

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