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Analysis of Birefringence and Confinement Loss in Hybrid Photonic Crystal Fiber

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Abstract: **In this paper, the hybrid design of square lattice having elliptical air holes with alternate rings having orientation of 45º and 135º has been proposed and studied with pure silica as substrate and elliptical air holes as cladding material. Here an attempt is made to extensively study the effect of different geometrical parameters based upon different elliptical ratios and orientation towards achieving best possible results by comparing the output graph in sequential manner. In this thesis birefringence and confinement loss are exhibited by square-lattice and hexagonal geometry of the PCFs based on pure silica. Two independent methods are developed to model a set of related hexagonal and square PCF structure and observed at L – band. Different orientation of angels is taken as 45º, 90º and 135º and it is calculated for hexagonal and square geometry.**

Keywords: **Photonic crystal fiber (PCF), Birefringence, confinement loss, Matlab.**

I. INTRODUCTION

The PCFs i.e. Photonic Crystal Fiber is formulated by a single matter like silica glass & a set of air channels that are of microscopic size along the boundary of its length. Optical fiber is now present optimum technology in the field of communication to sensing with its important features like EM noise reduction, less operational power.

Micro structured fibers called Photonic crystal fibers (PCFs) is undergoing various advancements and reached up to an efficient class of fiber for above applications. The distinct angles for refraction in the two polarizing constituents are presented having the optical axes going by the surface & also going in a perpendicular direction to plane of incidence. This is why the angle of refraction is not same for polarization.

A. Birefringence:

The ray of light coming parallel as ‘s’ polarization view a different index of refraction than the light which is perpendicular as ‘p’ & so it gets refracted on a different angle. The optical characteristics of a matter that have an index of refraction which rely on the propagation & polarization of light is termed as Birefringence.[1] The materials that are optically anisotropic are termed as birefringent. Birefringence is also expressed as the utmost difference in the index of refraction that is presented by the material.

Birefringence is the method that leads to the doubly refraction when a ray of light is incident on a birefringent material gets splinted by polarization in two different rays that takes a bit different paths than each other. This phenomenon was explained by RamsesBarth Olin a Danish scientist. He observed [2] calcite, the crystal possess the strongest birefringence.

II. THEORY AND EXPLAINATION OF DESIGN

Simulation Used MATLAB and SIMULINK:

MATLAB is basically a logical environment where user is able to execute complicated programs even by putting very little commands. Initially it was formulated over FORTRAN but there were regular enhancements over it. The most recent version is on C language. With a focus on programming on numerical, programs of various tasks in routine are eliminated & it permits to focus on experiments to encourage the tasks. Outcomes from the programs are visualized in a 2D or 3D

plane & also it has few tools to provide solution ensuring the desired outcomes. Even a user is able to programs his own m files. These all files are in readable txt format which can be written, manipulated & printed with an ease. These structures of Matlab are open & permits programmers to write their own files specified on a set off. There are certain sets designed by experts which are invaded into as tool boxes of Matlab. Thus with a basic installation you will be able to search for a lot of tool boxes.

A. Hexagonal lattice:

Out of the five 2-D lattice forms, hexagonal or equilateral triangular lattices are one of them.

An equilateral triangle is generated by linking three adjoining points. In the picture, four formulations of triangles are common to the most. In every set, directions have an angle difference of 45°, & in the angles of two distinct sets it is 45°, 90° & 135°. For each horizontal lattice having rows in horizontal directions, one of every three direction is horizontal & for the hexagonal lattice having rows in vertical direction one of every three rows is as well vertical.

B. Square lattice:

In terms of mathematics, square lattice is considered as a form of lattice in a 2-D Euclidean space. It is a 2-D form of integer lattice that is represented by Z2. There are 5 forms of 2-D lattices of which this is one of them which is sorted by the symmetrical groups. The fixed no. of rings taken for three ellipticity ratios.

C. Hybrid Lattice:

A view that is row oriented is taken of matrices that possess some flexibility in basic & matrix presentation like we incorporate a matrix BKZ- reduced if rows of matrix formulate BKZ-reduced base [13]. For complete grounding of lattices, look for [3,4] though for our wish will provide: for a provided criteria B = $\{b_1,\ldots\ldots,b_a\}$ of R_{na} lattice that is explained to be formulated of set points.

There are several bases will produce the similar group of lattice points, intellectually is a base B is presented by a matrix with rows {b1,bn} where the rows are exactly there of UB for any U∈G[Ln(Z)] which produces such points. Though it seems to be convenient to provide us more ease with presentation of matrices on bases where one can be taken into account for isomorphic lattices too.

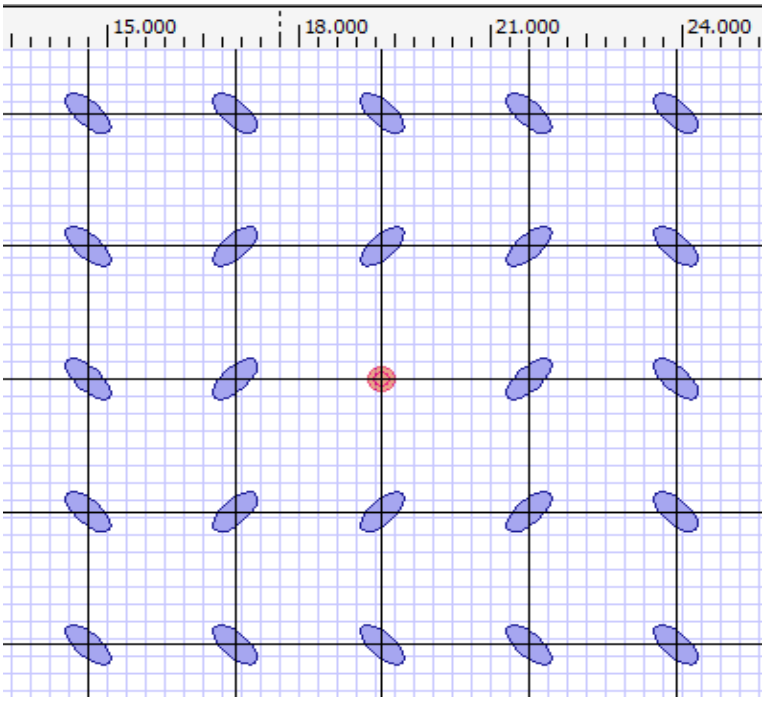

Fig1:- Hybrid lattice structure

The graph as presented is for hybrid lattice: The hybrid graph is produced by simulation that is considered by following factors: The Alternative rings of layout will be having orientation of 45° & 135°. Operating wavelength = 1.62 micrometer.

III. RESULTS AND SIMULATION

To formulate a contrast in between structure of square lattice & hexagonal lattice in a hybrid design is in reference to losses & bi-ref. As per theory there will be a rise in bi-ref & deduction in losses in a square, hybrid & hexagonal structures respectively. We need to execute 3 designs separately & implement the computation of calculated confined loss & birefringence.

As per the simulation outcomes, a graph is formulated in wavelength & birefringence. The input ranges in between range of wavelength on X axis that is 10-20 & at Y axis is birefringence that is 1-7.

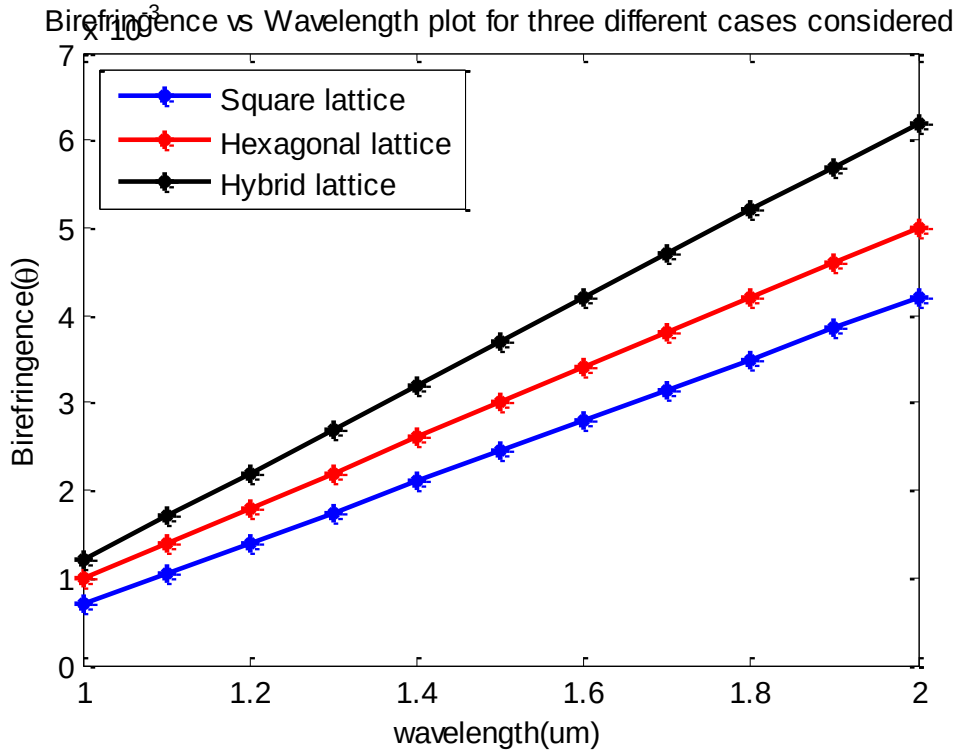

Fig 2:- wavelength v/s birefringence

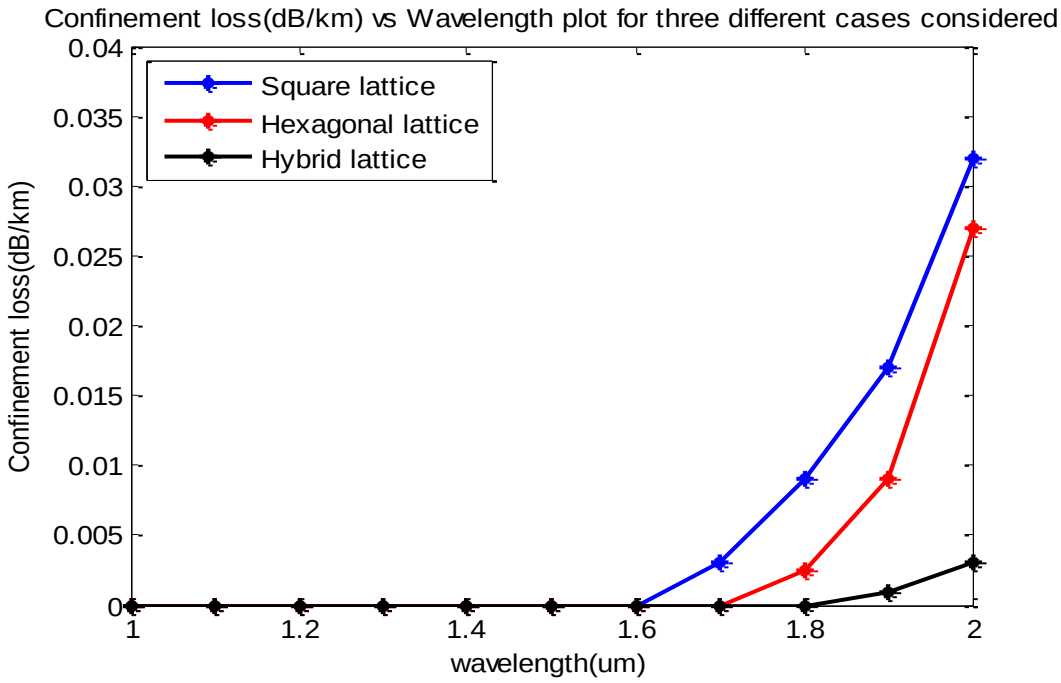

Fig 3:- wavelength v/s confinement loss

This is a resultant graph for confinement loss by putting all the given conditions in contrast on basis of orientation with the ellipticity proportion for all structure.

Table 1 :- Birefringence and confinement loss comparison

Comparative table $\Lambda = 2.3, \lambda = 1.62\mu m$			
Property / **Lattice**	**Hybrid Lattice**	**Hexagonal lattice**	**Square Lattice**
Birefringence	0.004235	0.003578	0.002872
Confinement loss (dB/km)	Very low (approx. $10^{\wedge -9}$)	Very low	0.001

IV. CONCLUSION & FUTURE SCOPE

The Hybrid Hexagonal Square Lattice PCF which is comprised of elliptical air holes that are put in contrast & explained for the confinement loss & birefringence characteristics which is designed as mentioned in figure 2 & figure 3 modal birefringence of a hybrid hexagonal square lattice PCF with elliptical air holes is examined in L-band at 1.62μm wavelength to be equal to 4.2x10-3. The confinement loss of hybrid lattice is nearly ten raise to the power minus seven which is very very low compared to other lattice structures. Thus the suggested Hybrid Lattice PCF having elliptical air holes can be implied at greater birefringence. One can use L-C-band combinations over traditional L-band and can demonstrate for ground-based methods as well as radio occultation scenarios.

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REFERENCES

[1] Soeun Kim, Yong Soo Lee, Chul-Sik Kee, Chung Ghiu Lee:"Hybrid Lattice Photonic Crystal Fiber" :18th European Conference on Network and Optical Communications & 8th Conference on Optical Cabling and Infrastructure - NOC/OC&I 2013 ISBN: 978-1-4673-5822-4, July 10-12, 2013, Graz, Austria

[2] Fei Liua, Hongyan Gaob, Yani ZhangC, Qiang Xud: "Optical Birefringence and Polarization Dependent Loss of Elliptical-hole Rectangular Lattice Photonic Crystal Fibers Based on Polymer": International Conference on Electronics and Optoelectronics volume 4 (ICEOE 2011) IEEE

[3] Harish Singh Kanyal, Abhishek Katariya, Ajay Kumar Bairwa : "Design and Comparison of CA-PCF and EA-PCF for Dispersion Property ": International Conference on Communication Systems and Network Technologies 2012978-0-7695-4692-6/12 © 2012 IEEE DOI 10.1109/CSNT.2012.145

[4] M. R. Khatun and M. S. Islam :"Propagation Properties and Stress Sensitivity of Square and Hexagonal Photonic Crystal Fiber ": Proceedings of 14th International Conference on Computer and Information Technology (ICCIT 2011) 22-24 December, 2011, Dhaka, Bangladesh

[5] Ritu Sharma, Vijay Janyani, Anuradha Sharma : "Design of Elliptical Air Hole PCF with Hybrid Square Lattice for High Birefringence and a Lower Zero Dispersion Wavelength":International Journal of Computer Science & Emerging Technologies (E-ISSN: 2044-6004) 238 Volume 2, Issue 2, April 2011

[6] Peng Song*, Yanrong Tong, Xinlian Chen :"A Novel High Birefringence Photonic Crystal Fiber with Squeezed Elliptical Holes" : 2010 3rdInternational Conference on Biomedical Engineering and Informatics (BMEI 2010)

[7] Sanjaykumar C Gowre, Sudipta Mahapatra and Uday N.K.:"Analysis of birefringence in modified photonic crystal": World Journal of Science and Technology 2011, 1(8): 84-88 ISSN: 2231 – 2587

[8] P. J. Roberts, D. P. Williams, H. Sabert, B. J. Mangan1, D. M. Bird, T. A. Birks, J. C. Knight and P. St. J. Russell: "Design of low-loss and highly birefringent hollow-core photonic crystal fiber"7 August 2006 / Vol. 14, No. 16 / OPTICS EXPRESS 7329

[9] Jayprakash Vijay, Md. Sabir:"Design of highly birefringent square lattice photonic crystal fiber with flattened dispersion and low confinement loss" : International Journal of Advanced Electrical and Electronics Engineering, (IJAEEE) ISSN (Print): 2278-8948, Volume-2, Issue-1, 2013

[10] Ashok Kajla, Surbhi Gupta: "Evaluation of Confinement Loss of Different Photonic Crystal Fibers on the Basis of Varying the Size and Shape of Holes" : International Journal of Engineering Research & Technology (IJERT)Vol. 3 Issue 2, February 2014IJERTIJERT ISSN: 2278-0181

[11] Weidlich, A. and Wilkie, A., "*Realistic Rendering of Birefringency in Uniaxial crystals"*, ACM 0730-0301, Transactions on Graphics, 20TBD (2008).

[12] Syms, R. and Cozens, J., "*Optical Guided Waves and Device"*, (McGraw–Hill Book Company, USA, 1993).

[13] Baldwin, C. G.,"*An Introduction to Nonlinear Optics"*, (Plenum Press, USA, 1975).

[14] Chike–Obi, B., "*Introduction to the Physics of Sound and Ligh"t,* (Heinemann Educational Books, USA, 1991).