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PREFACE

Dear colleagues,

On behalf of Chairman Organizing Committee of the 6th National Radar Seminar and International Conference on Radar, Antenna, Microwave, Electronic and Telecommunications (ICRAMET) 2012, I would like to thank all the participants for their participation during the 6th National Radar Seminar and the first International Conference on Radar, Antenna, Microwave, Electronic and Telecommunications (ICRAMET) 2012 that hold in Bali on April 23-24, 2012.

The 6th National Radar Seminar and the first International Conference on Radar, Antenna, Microwave, Electronic and Telecommunications (ICRAMET) 2012 is an annual event organized by Research Center for Electronics and Telecommunications (PPET-LIPI), School of Electronics and Informatics (STEI-ITB), Indonesian Radar Association (AsRI), International Research Centre for Telecommunications and Radar-Indonesia (IRCTR-I), and IEEE MTT/AP-S Indonesian Chapter. This seminar is a forum for socialization and discussion among researchers, observer, top scientists, and users of Radar. It is expected that solutions, technologies, and policies in Radar can be produced in this Seminar.

I would like to specifically express my gratitude to the chairman of Indonesian Institute of Sciences (LIPI) Prof Dr. Lukman Hakim,Keynote speakers : Prof. Leo P. Ligthart of TU Delft, Prof. R. Prasad from Aalborg University of Denmark, Dr. Atmaji Wisesa as a representative of the Indonesian Industries and Kolonel Hetharia as the chief commander of the Indonesian Airforce Radar Workshop .

This proceeding consists of 41 scientific papers. Some of these papers presented as oral presentation, and the rest will be presented as poster presentation during the two-days seminar on 23-24 April 2012. I truly hope that this seminar will be able to provide an interesting session and serve as an excellent forum for a live technical discussion.

Last but not least, this seminar would not be possible without the contribution of the Speakers, the Authors, the Advisory Committee, and the member of the Organizing Committee.Therefore, I would like to take this opportunity to express my sincere appreciation to all ofthem for execution of the the 6th National Radar Seminar and the first International Conference on Radar, Antenna, Microwave, Electronic and Telecommunications (ICRAMET) 2012.

Chairman OrganizingCommittee

Dr. Mashury Wahab

CONTENTS

Proceeding of The 6th National Radar Seminar And The first International Conference
On Radar, Antenna, Microwave, Electronics And Telecommunications (ICRAMET) 2012
Bali, April 23-24, 2012

The Characteristic of Uniform Fibre Bragg Gratings in The Two Layer of Refractive Index n1 and n2

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Abstract— **The subject of this work is to observe the The Characteristics of Uniform Fibre Bragg Gratings in the Two Layer of Refractive index n1 and n2 in C-band region by using the transfer matrix method. Couple mode theory for Bragg gratings was used to describe the characteristics of uniform fibre Bragg grating to the light wave propagating through fibre. Here, reflection, transmission, delay and dispersions characteristics of uniform fiber Bragg gratings were demonstrated and the simulation will be limited to single-mode silica-based fibre operating at a central wavelength of 1550 nm. By simulating the characteristics of fibre Bragg gratings in the two layer of refractive index, we are expect better understanding about the characteristics of fibre Bragg grating for further application in telecommunication, lasers and sensor field. With calculate the reflection, transmission, delay and dispersion properties, we will analyse the characteristics of fibre Bragg gratings in the two layer of refractive index, they are n1 and n2.**

Keywords-component; fibre Bragg gratings, refractive index, Couple mode theory

I. INTRODUCTION

A fibre Bragg grating is a periodic perturbation of the refractive index along the fibre length, which is formed by exposure of the core to an intense optical interference pattern. Fibre gratings are key components in the optics market, as illustrated by their wide use in wavelength stabilized lasers, fibre lasers, fibre amplifiers, Raman amplifiers, phase conjugators, wavelength converters, passive optical networks, wavelength division multiplexers and demultiplexers, add/drop multiplexers, dispersion compensators and gain equalizers. Furthermore, the sensitivity of Bragg gratings to the external environment allows them to be used as sensors.

II. THEORY

A grating is a device that periodically modifies the phase or the intensity of a lightwave reflected on, or transmitted through, it. In the last few years, many groups worldwide realized, by UV laser writing, high quality gratings in the core of photosensitive optical fibres. During irradiation, a refractive index modulation (index grating) is formed with the same spatial periodicity, Λ, as the writing interference pattern. This refractive index grating acts as a distributed (Bragg) reflector that couples the forward propagating to the backward propagating (λ_{Bragg}) light beam. The wavelength for which the incident light is reflected with maximum efficiency, λ_{Bragg}, is called the Bragg resonance wavelength. The equation relating the grating spatial periodicity and the Bragg wavelength depends on the effective index of the transmitting medium, n_{eff}, and is given by

$$\lambda_{Bragg} = \frac{2.n_{eff}.\Lambda}{M}$$

The period can be adjusted to obtain Bragg resonance from the visible to the infrared. N is an integer indicating the order of the grating period.

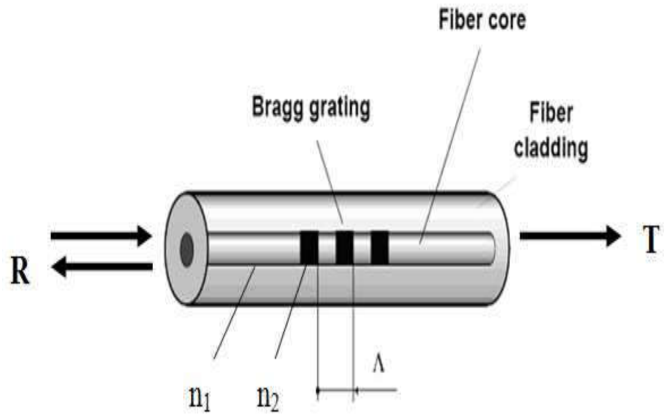


Figure 1 Uniform fibre Bragg gratings

Figure 1 schematically shows the grating functionality where is the period of the Bragg gratings.

The photosensitivity refers to a permanent modification of the refractive index following a specific light exposure. This effect enables an index grating to be written in an optical fibre. The amount of the saturated refractive index change and the initial change rate of this index are the two parameters characterizing the photosensitivity. Although all the details of this process are not completely understood, the origin of photosensitivity is related to defects associated with oxygen deficiencies in the chemical structure of germanium-doped silica optical fibre. This phenomenon provides a new approach for studying the properties of defects in glasses and also a practical method for writing permanent gratings in glass fibres. These gratings are useful for the fabrication of fibre based devices for optical telecommunications and optical sensing applications.

III. METHOD

The periodic variation of the refractive index with an input wave will lead to the formation of a backward reflected component. The aim of coupled mode theory is to study the the coupling between these two (the forward and the backward propagating) waves. In general we may write the forward and backward propagating waves as in equation :

$$\vec{E}_t(r,\theta,z,t)=\sum_{\nu m}\left[A_{\nu m}(z)e^{j\beta_{m}z}+B_{\nu m}(z)e^{-j\beta_{m}z}\right]\vec{b}_{\nu mt}(r,\theta)e^{-j\omega t}$$

Note that we are considering the coupling between two waves that are propagating in opposite directions and therefore the change in sign in the exponential (due to the fact that A and B have opposite propagation directions). We are interested in the evolution along the propagation direction of the field amplitudes $A(z)$ and $B(z)$. With the boundary conditions $A(0)=A_0$ and $B(L)=0$ these equations may be solved analytically [7] and give us:

$$A(z)=A_0\frac{\overline{\kappa}e^{-j\delta z}}{\delta\sinh\gamma_B L-j\gamma_B\cosh\gamma_B L}\sinh\left[\gamma_B(z-L)\right]$$

$$B(z)=A_0\frac{\overline{\kappa}e^{j\delta z}}{-\delta\sinh\gamma_B L+j\gamma_B\cosh SL}\left\{\delta\sinh\left[\gamma_B(z-L)\right]+j\gamma_B\cosh\left[\gamma_B(z-L)\right]\right\}$$

Based on equation above and initial parameter as follows: $L=30\mu m$ (grating length and propagation distance z), $\lambda=1550\ nm$ (input wavelength), $\lambda_B=1550\ nm$ (Bragg wavelength), $n_{eff}=1.45$ (mode effective index), $\kappa=0.03$ $1/\mu m$ (coupling coefficient). Figure 2 Note that the field amplitude decrease exponentially inside the grating. Here the decrease is due to coupling to the reflected wave and not to the material. The decreasing of transmission and reflection field intensities have relatively equal rate but different value. Where the transmission field intensity was higher then the reflection.

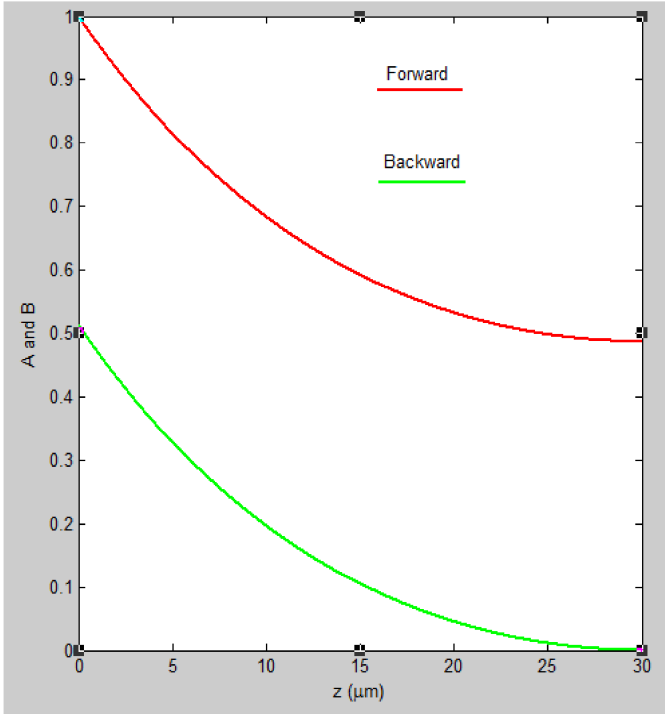
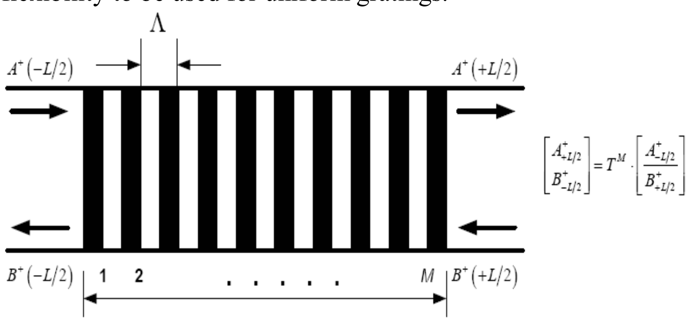


Figure 2 Forward and backward field intensities inside the grating at $\lambda=\lambda_B$=1550 nm, with $\kappa=0.03$ $1/\mu m$ and $L=30$ μm .

The principle behind the transfer matrix method is to subdivide the grating structure into multiple uniform sections. Each of these sections is then described by a transfer matrix that “transfers” the input field into the output field, and then identify each section using a 2-by-2 matrix. The information contained in each matrix is specific to the section. The individual matrices are then successively multiplied along the length of the grating to describe the behaviour of the entire grating. The greatest advantage of this technique lies in its flexibility to be used for uniform gratings.



Uniform grating

Figure 3 Illustration of grating simulation using the transfer matrix method

IV. RESULT AND DISCUSSIONS

By simulating the characteristics of fibre Bragg grating in the two layer of refractive index, we are expect better understanding about the characteristics of fibre Bragg grating for further application in telecommunication, lasers and sensors field.

The initial parameter for simulating characteristics of fibre Bragg grating in two layer refractive index are: λ_B = 1550 nm (Bragg wavelength), λ = 1500 nm – 1600 nm (wavelength range), $c = 2.99793 \times 10^8$ m/s (light velocity), M = 240 (number of elementary cells), $h = 25 \times 10^{-9}$, n_1 = 1.44 (index of first layer), n_2 = 1.47 (index of second layer), d_1 = 0.7 μm (length of first layer), d_2 = 0.35 μm (length of second layer). L = 1.05 μm (elementary cell period length).

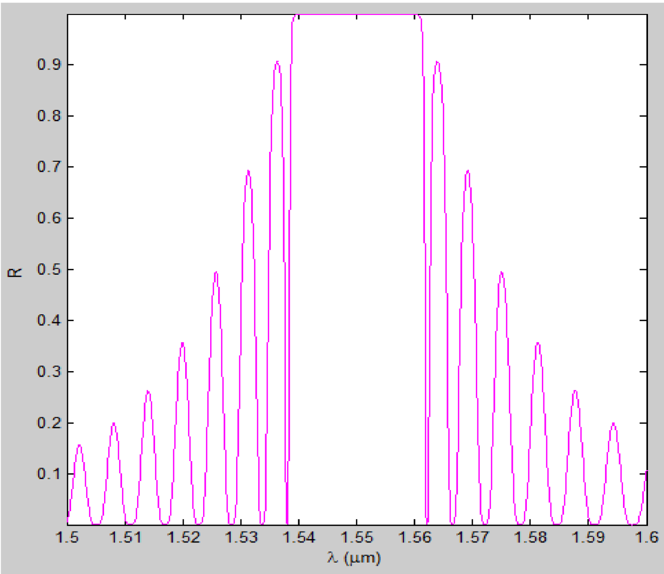


Figure 4 Reflection spectrum of fibre Bragg grating in the two layer refractive index = 1.44 and = 1.47 at = 1550 nm

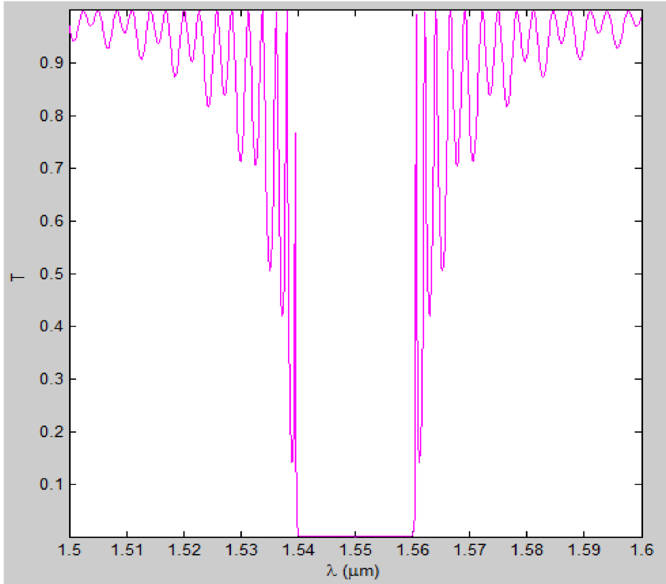


Figure 5 Transmission spectrum of fibre Bragg grating in the two layer refractive index = 1.44 and = 1.47 at = 1550 nm

Figure 4 shows the total reflectivity VS wavelength along the grating length. Here we can found a region around the Bragg wavelength where the power is totally reflected, althought with side lobe around this area. This is very interesting phenomena because it is means that we can produce perfect bandpass filter by reducing the side lobe. We shall return to explain about the technique to reducing the side lobe later on.

Figure 5 was strengthen the characteristic of fibre Bragg gratings, where in the same region which the power is totally reflected, there are no power transmission. It is means that fibre Bragg grating give us an opportunity to produce two natural filters all at once, they are bandpass filter as a result of reflection power cause of Bragg grating and bandstop filter as it's output.

Now, we will observe the others characteristic of fibre Bragg grating by simulated it using less number of elementary cells M especially for M = 120. Here, we will show the comparison of reflection and transmission spectrum with M = 240, M = 180 120 and M = 120 as follows:

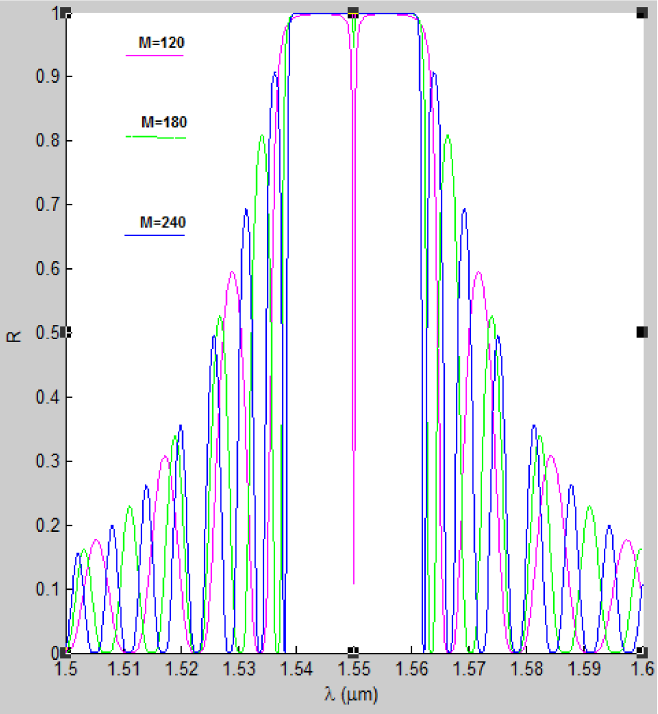


Figure 6 Comparison of reflection spectrum for $M = 240$, $M = 180$, and $M = 120$

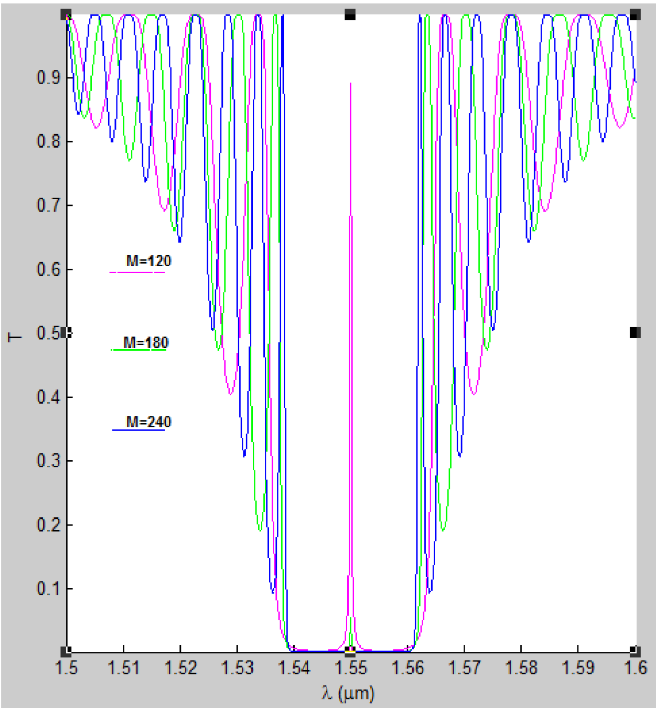
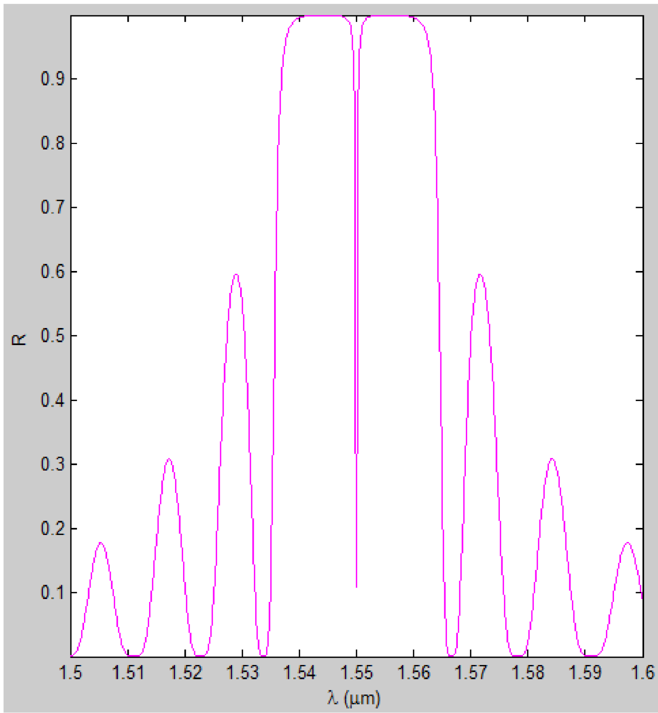


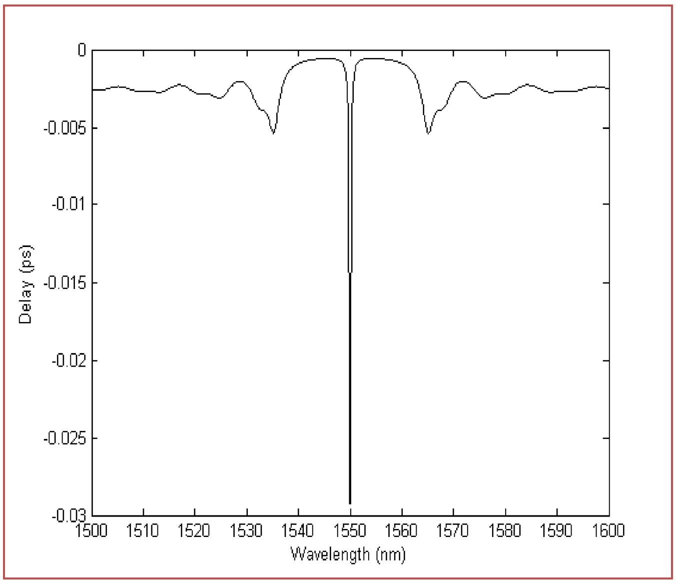
Figure 7 Comparison of transmission spectrum for $M = 240$, $M = 180$, and $M = 120$.

One of the most exciting opportunities offered by fibre Bragg gratings is the possibility to perfectly light ideally without any losses. This in turn implies the possibility of creating not only perfect mirrors but also optical cavities with extremely high finesse or waveguides with extremely small sizes. In figure 6 and 7 we are show the reflectivity of fibre Bragg gratings that has a defect formed by an enlarged high-index layer, placed at the center of the grating. Note the black solid curve: this corresponds to the case in which the thickness has doubled (also called defect). A narrow transmission peak has opened up right at the center of the fibre Bragg gratings. The cavity is formed by the central defect and the mirrors are formed by the gratings lying to the right and to the left of the defect. Note that due to the fact that light propagates somewhat inside the grating, even in conditions of perfect reflection, these mirrors are often referred to as “distributed” mirrors. The defect at the central grating above just because less number elementary cells using in the simulation.

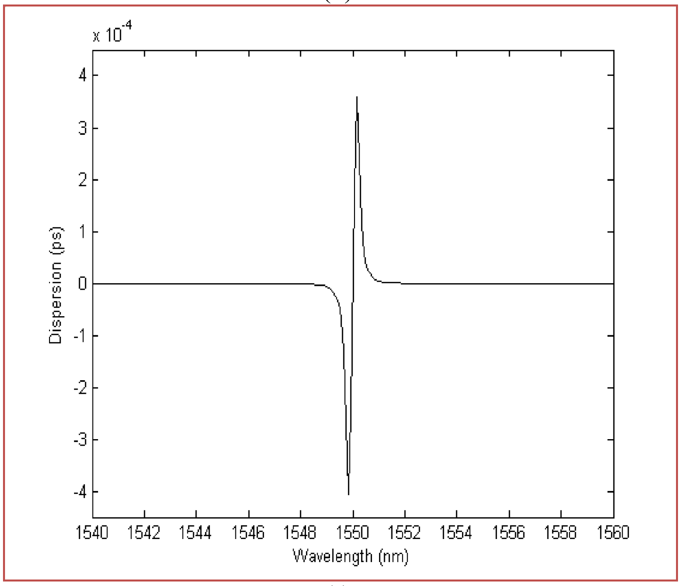
We can analyse the delay and dispersion of fibre Bragg gratings reflection spectrum based on the simulation result as follows:



(a)



(b)



(c)

Figure 9 Delay (b) and dispersion (c) of fibre Bragg gratings reflection spectrum with a central electron-like defect formed by an enlarged high-index layer (a).

Here, we can say that the delay shows about how fast the decreasing or increasing reflection signal have been change along the grating length. So, the delay is representation of velocity of the lightwave propagating in the fibre Bragg grating. Minus value of delay is cause of the decreasing of reflection power spectrum and on the contrary. As we know the dispersion explain about the rate of change of the group delay with wavelength, as can be seen in the figure 9 (c) that the dispersion of two channel separated by a narrow transmission cavity cause of defect in the central of the grating have relatively same rate but different value. The dispersion value of the left channel of the cavity has minus value because the intent decreasing of field intensity until it reach the minimum reflection cause by defect. And then it is will increase again until reach maximum reflection in the right side channel of the cavity, cause by this phenomena the the right side channel of the cavity has relatively positive value of dispersion.

The delay and dispersion response shows discontinuity placed at the midpoint of gratings. It is has relatively equal response with Mach-Zehnder response. This discontinuity response cause by enlarged high-index n_2. The enlarged high-index n_2 may be induced via environmental effects (temperature or strain), it's means that fibre Bragg gratings can be sensors.

V. Conclusion

The characteristics of fiber Bragg grating based on the simulation using two layers refractive index are:

- Total reflection area is form around the Bragg wavelength with sidelobes for number of elementary cell $M = 240$.
- For M = 120, the defect will be happen in the center of the gratings although no defect in the structure of the grating, but for M = 180, the defect will happen in the half center of the gratings.
- In defect Bragg grating the calculation may produce passive components if we choose proper γ_B values to suppress unproper coupling numbers.
- By choosing γ_B values greater than zero the active optical devices may be created.
- By choosing γ_B values less than zero the Bragg grating becomes very lossy.

References

[1] Bush, K, S Lolkes, RB. Wehrspohn, H. Foll, 2004, Photonic Crystals: Advanced in Design, Fabrication, and Characterization, Wiley-VCH Verlag GmbH & co. KgaA.

[2] Faccio, Daniele, Introduction to photonic crystals, Chania, 2006

[3] Joannopaulos, John D., Steven G. Johnson, Joshua N. Win, Robert D. Meade, , Photonic Crystals : Molding the Flow of light second edition, Princeton University Press 2008

[4] Boudrioua, Azzedina, 2009, Photonic Waveguides, John Wiley & Sons.inc

[5] Skorobogatiy, Maksim, Jianke Yang, Fundamental of Photonic Crystal Guiding, Cambridge University press, 2009.

[6] Sukhoivanov, Igor A, Igor V Gurvey, Photonic Crystals Physiscs and Practical Modelling, Springer, 2009

[7] Qadriyah, The Characteristics of Fibre Bragg Grating in C-band Region by Using Transfer Matrix Method, University Al Azhar indoesia, 2008

[8] Abhijit Chaudhari. "Optical filters in Wavelength Divisio Multiplexing".

[9] Jones W.B., "Introduction to Optical Fiber Communication Systems", HARCOURT BRACE JOVANOVIC INC., Florida (USA), pp. 70 – 122