Design and analysis the parameters of FBG based sensors using OptiGrating

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ABSTRACT

As we know these days Fiber Bragg Grating is the most commercially used techniques for developing high accuracy sensors and these FBG based sensor works very efficiently for tracking the fault detection through any parameters like pressure, temperature, strain, vibration, etc of any system. In this paper author consider some parameters of FBG and analyze those parameters with the help of simulation through OptiGrating 4.2 version. In this paper our focus is to simulate the scanning parameter and scattering parameter.

Keywords:-Fiber Bragg Grating, Optigrating, FBG Sensor

1. INTRODUCTION

The Fiber Bragg Grating (FBG) is a periodic refractive index modulation of the fiber.Useful components in telecommunication and sensing system[1]. Fiber Bragg gratings are used two types of grating firstly short period grating and another long period grating.Short period grating are also refer as fiber Bragg grating because the phenomena equivalent to Bragg reflection and Bragg deflection crystal. When the light beam is incident in the core because of index contrast a part of beam reflected from this interface ,the beam goes out and that it reflected from the real interface similarly all other layer, there would be reflection.When all these reflections are added up in phase that they can have a very strong reflection and this will have at a particular reflection [2].

2. THEORY OF FBG

In fiberBragg grating a wave is incident at a periodicity Λcontinuous that divided by 2 for high reflective region andΛ/2 for low reflective region.High refractive index $n_0+\Lambda n_0$and for low refractive index is $n_0 -\Lambda n_0$. If all the wave reflection are added up in phase and they have a phase shift of 2π and integral multiple of 2π then have a strong reflection[3]. The wavelength for fiber which the incident light is reflected with maximum efficiency is called the Bragg wavelength.In optical fiber condition is given by

$\beta 1 - \beta 2 = \Delta\beta = 2\pi/\Lambda$ ……..1

Where β_1 and $\beta_2$are propogation constant and Λ is grating period.

$$\beta 2 = -\beta 1 = \beta \dots\dots\dots\dots\dots\dots\dots\dots 1.1$$

Therefore phase matching condition ,

$$\beta - (-\beta) = \frac{2\pi}{\Lambda} \text{…….....} 1.2$$

$$2\beta = \Delta\beta = \frac{2\pi}{\Lambda} \dots\dots\dots\dots\dots\dots\dots\dots 1.3$$

Since Δβ is large ,

$$\beta = \frac{2\pi}{\lambda neff} \dots\dots\dots\dots\text{……..} 1.4$$

.

Where n_{eff} is a effective refractive index of fiber

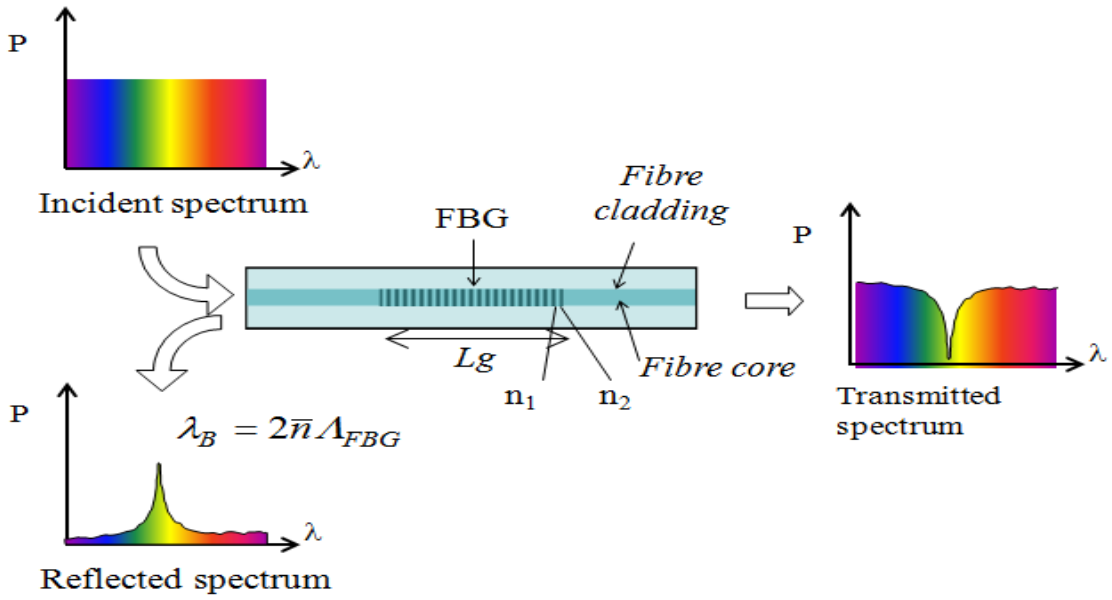


Fig 1 Basic structure of fiber Bragg grating [4]

Now the equation becomes,

$$2\left(\frac{2\pi}{\lambda neff}\right) = \frac{2\pi}{\Lambda} \dots\dots\dots\dots\dots\dots\dots 2$$

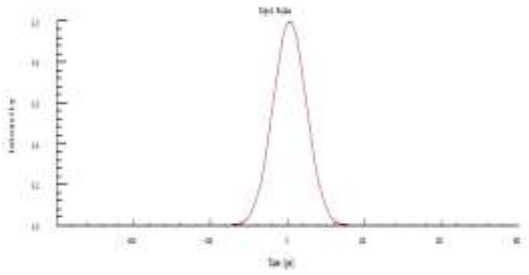
3. PARAMETERS OF FBG

Parameters which we consider in this paper for simulation and analysis are the average indexing, Grating length and some adjustable parameters like length, index modulation, or height, order, tilt angle, index modulation.

Parameters	**Symbols**	**Values**
Bragg wavelength	λ_B	*1.55μm*
Core width	*L*	*4.15μm*
Effective refractive index	n_{eff}	*1.47*
Grating manager	*L,H,P*	*4000,0.002,450*

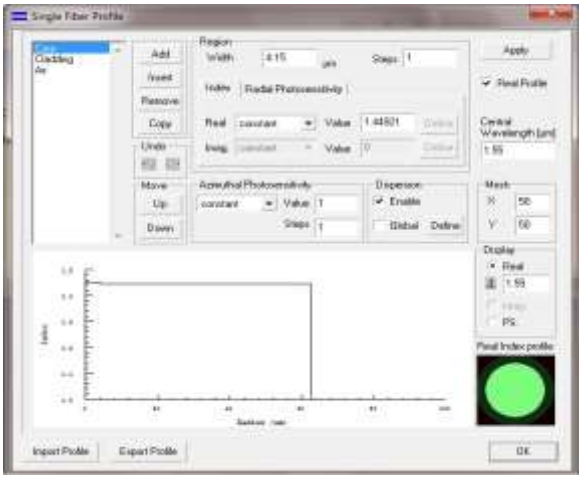
4. RESULTS AND ANALYSIS

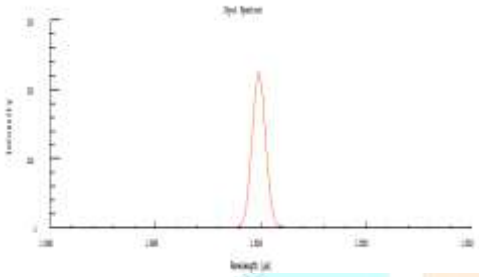
1.INPUT



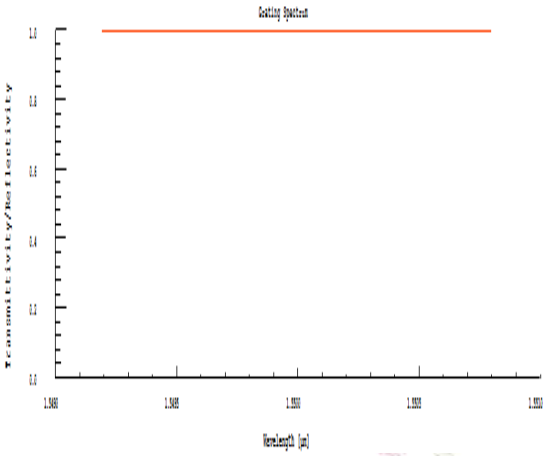
SPECTRUM

2.INPUT

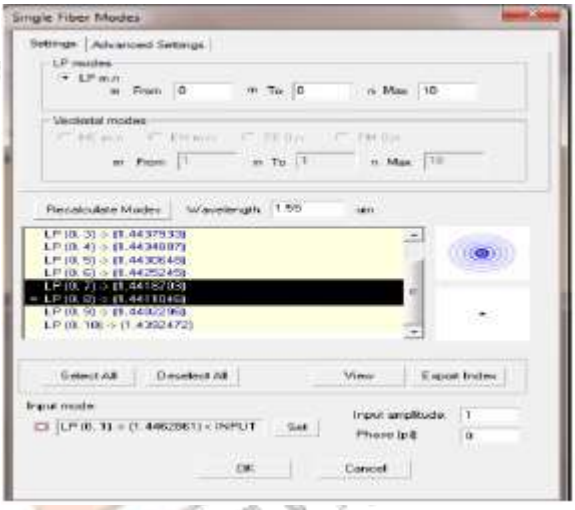




3.GRATING SPECTRUM



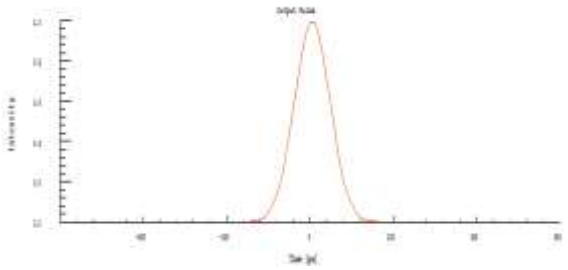
5.SINGLE MODE FIBER(CLADDING)



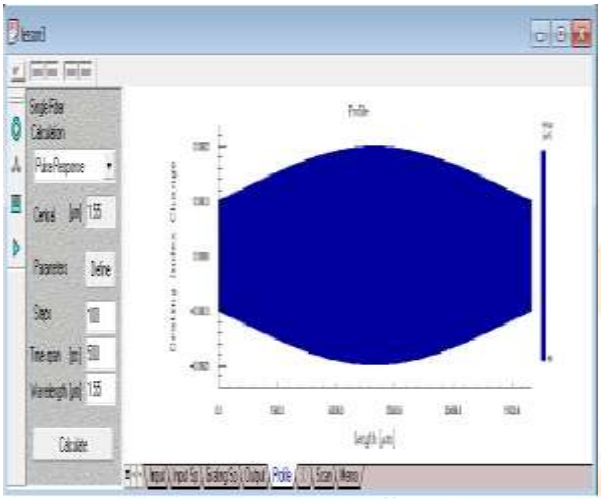
6.GRATING MANAGER

4. SINGLE MODE FIBER(CORE)

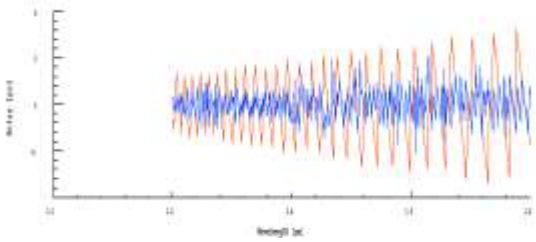
7.OUTPUT



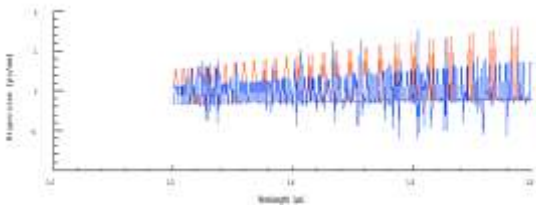
8.PROFILE



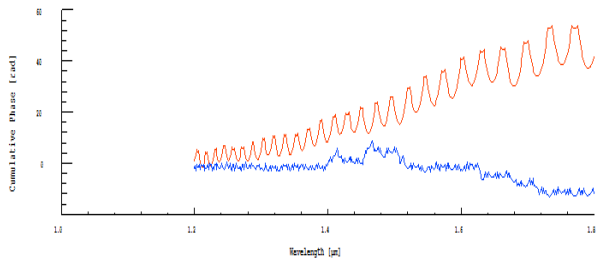
9.DELAY



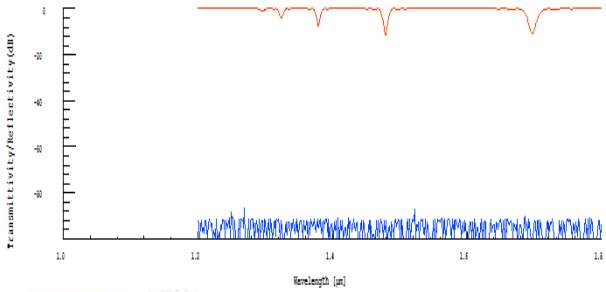
10. DISPERSION



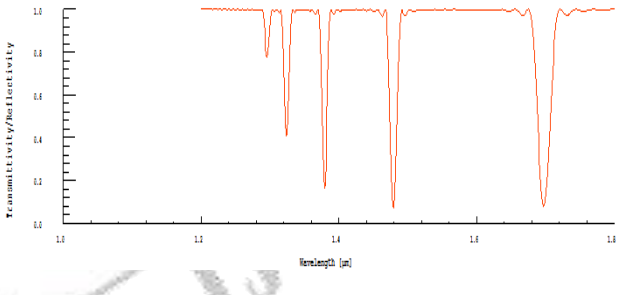
11.PHASE



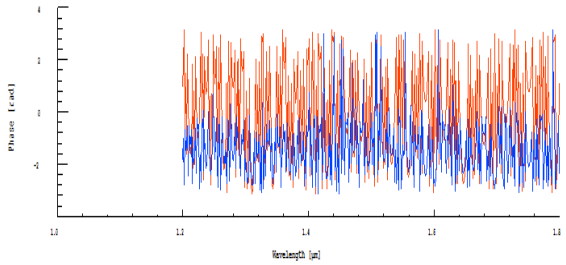
12.POWER



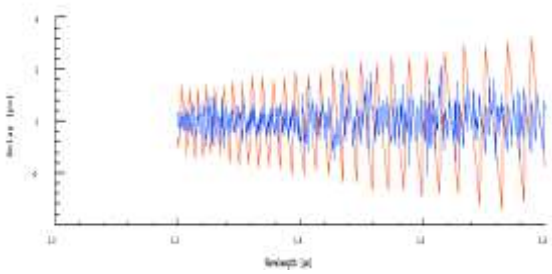
13.PROPOGATION POWER



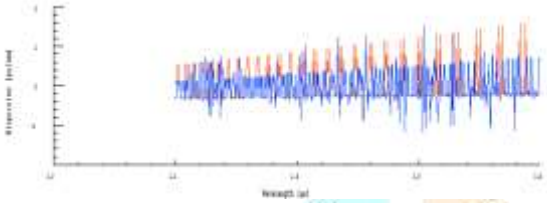
14.PULSE RESPONSE INPUT SPECTRUM



15.PULSE RESPONSE GRATING SPECTRUM

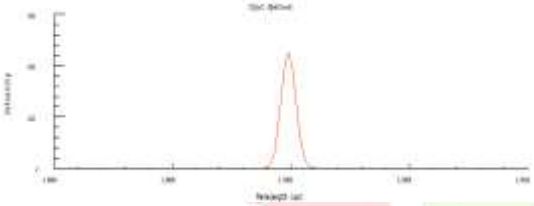


16.PULSE RESPONSE OUTPUT

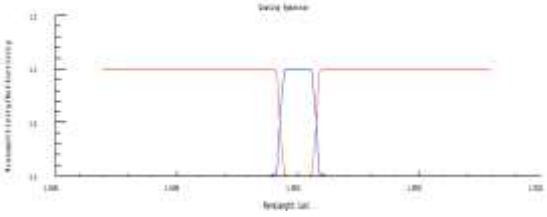


17.CALCULATE INPUT

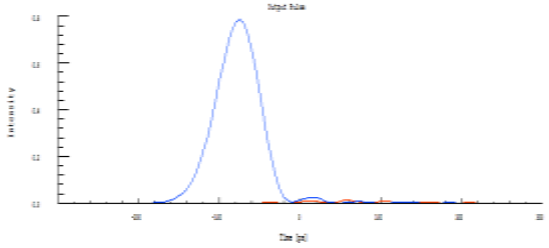
18.CALCULATE INPUT SPECTRUM



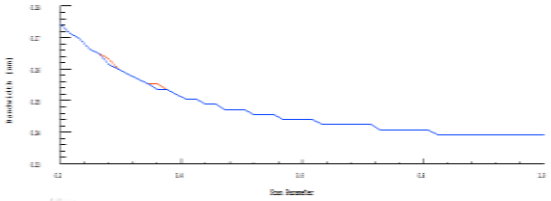
19. CALCULATE GRATING SPECTRUM



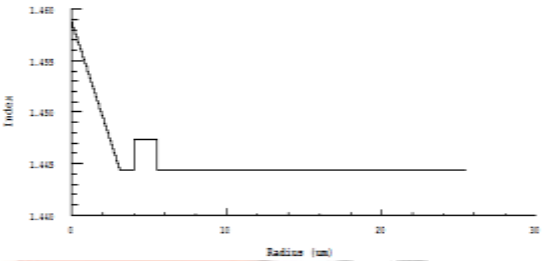
20.CALCULATE OUTPUT



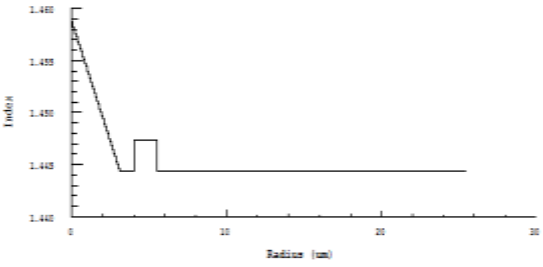
21.CALCULATE SCAN



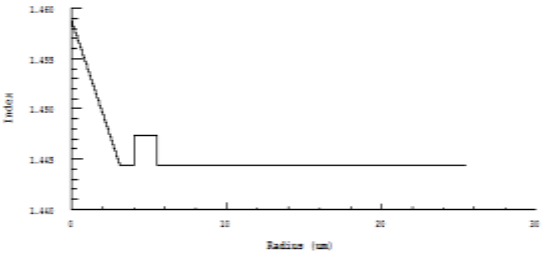
22.SINGLE FIBER



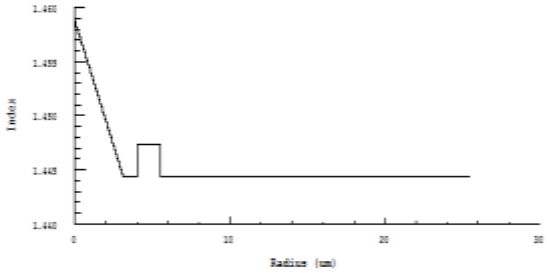
23.SINGLE MODE FIBER(r_0)



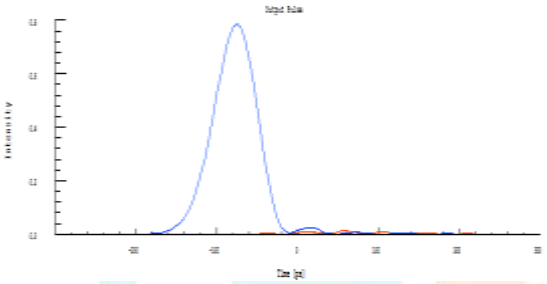
24.SINGLE MODE FIBER(r_1)



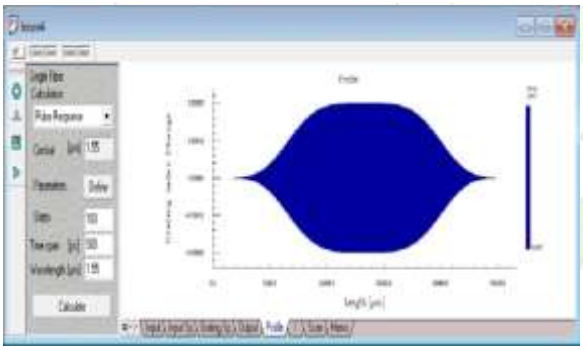
25.SINGLE MODE FIBER(r_3)



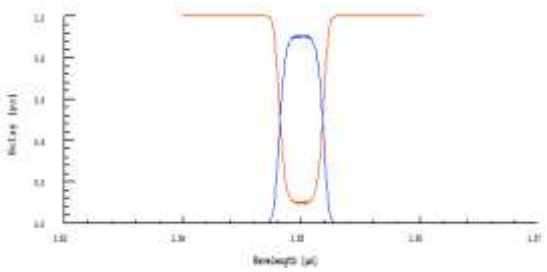
26.OUTPUT



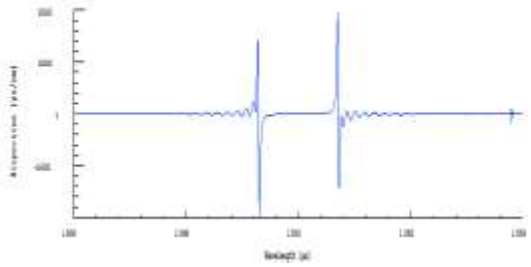
27.PROFILE



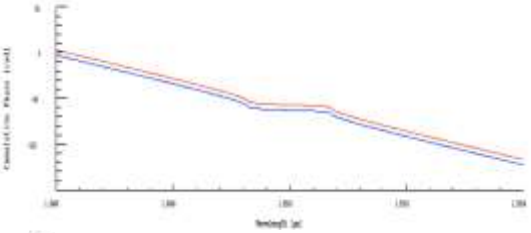
28.SPECTRUM DELAY



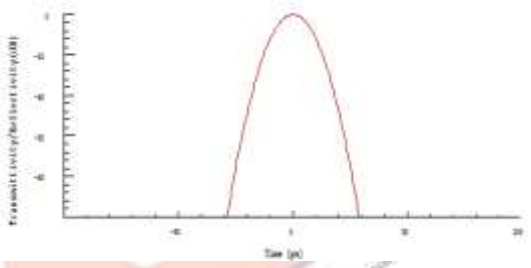
29.SPECTRUM DISPERSION



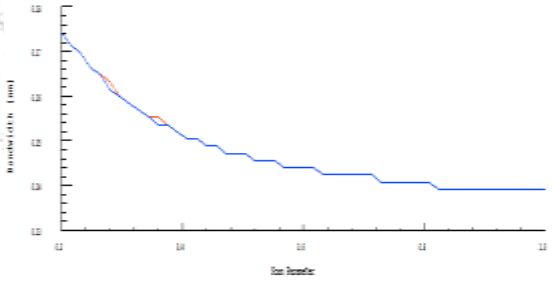
30.SPECTRUM PHASE



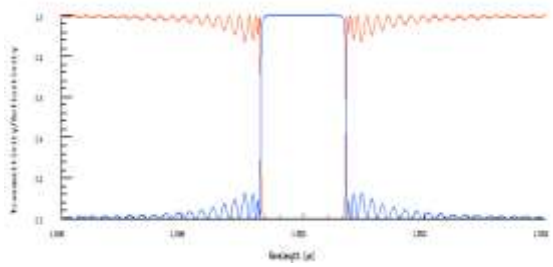
31.SPECTRUM POWER



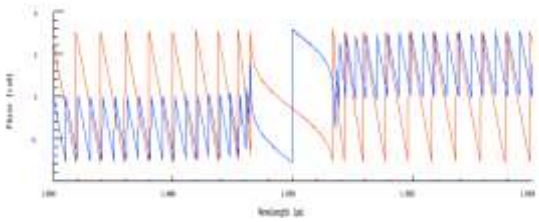
32.SPECTRUM SCAN



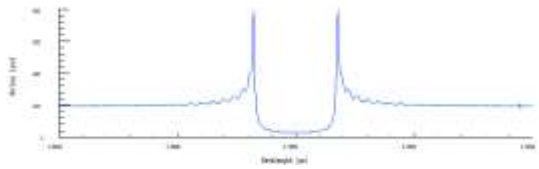
33.PULSE RESPONSE INPUT



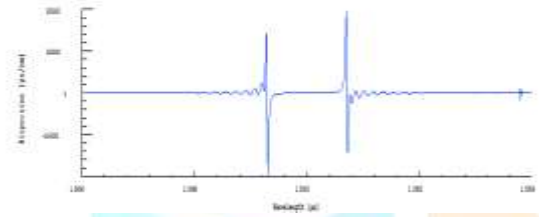
34.PULSE RESPONSE INPUT SPECTRUM



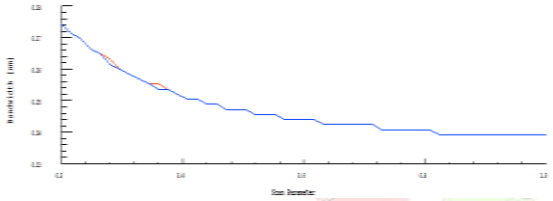
35.PULSE RESPONSE GRATING SPECTRUM



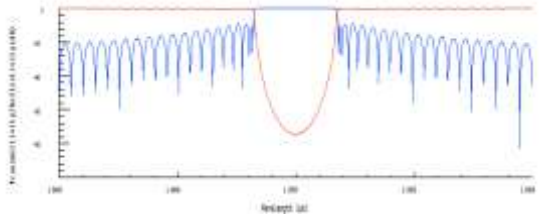
36.PULSE RESPONSE OUTPUT



37.PULSE RESPONSE SCAN



38.PROPOGATION POWER



From the above FBG results, it can be easily analyze that the selected parameters can be used for different applications and this is done with the help of simulation technique by optigrating software, The following grating options chosen by authors which is as follows

1.Average Index-- linear ,uniform, from file, or user defined function.

2.Grating The selection of grating is based on Chirp—sine ,rectangular from file, or user defined function.

3.period chirp—Quadratic linear sqare root, cubic root, from file or user defined function.

4.Adjustable paramerters—length, index modulation, or height, order, tilt angle, index modulation.

5.CONCLUSION

Fiber Bragg Grating having reflectivity increases that increase in grating length and index modulation.FBG having bandwidth is narrower for longer grating length and wider for index modulation. When increase in grating period, Bragg wavelength shift from central wavelength . This change having in wavelength shift can be used for strain and temperature sensors. From all the above results it is very clearly analyze that the considering parameters shows the characteristics of FBG parameters which isvery helpful for vibration, Temperature, Strain, Stress , medical sensors etc.

6.REFERENCES

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[3] Deba Kumar Mahanta,''Design of Uniform Fiber Bragg grating using Transfer matrix method'', International Journa of Computational Engineering Research (IJCER) Vol.3 , 2013.

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