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Design and Simulation of Optical Fiber Bragg Grating Using Refractive Index and Temperature

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ABSTRACT : This paper presents the design & simulation of an Optical Fiber Bragg Grating (OFBG) for stress, strain measurement. The wavelength chosen for Optical Fiber Bragg Grating (FBG), so as to minimize the attenuation of the light signal in the communication link from Fiber Bragg Grating. In this Paper Grating mod Tool provide valuable help in optimizing the design Parameters and the spectrally response signal with independently shifting resonance at different refractive index and temperature value. The power reflectivity spectral and dispersion characteristics of the OFBG are analysed. In order to achieve wideband dispersion compensation with a low insertion loss, grating period, modulation index, different refractive index and OFBG parameter should be precisely optimised. The OFBG designs and simulation achieved in this study have resulted in different temperature and index difference of the fiber respectively with 1550nm central frequency.

Keyword: Optical Fiber Bragg Grating, Grating Mod Tool.

I. INTRODUCTION

Fiber Bragg Gratings are based on the principle of Bragg reflection. When light propagates through periodically alternating regions of higher and lower refractive index, it is partially reflected at each interface between those regions If the spacing between those regions is such that all the partial reflections add up in phase when the round trip of the light between two reflections is an integral number of wavelengths, the total reflection can grow nearly 100 %, even if the individual reflections are very small. Of course, that condition will hold only for specific wavelengths. For all other wavelengths, the out of phase reflections end up cancelling each other, resulting in high transmission. The condition for high reflection is known as Bragg condition. FBG consists of a periodic modulation of the index of refraction along the core of an optical fiber. FBG sensors are based on the fact that the Bragg wavelength changes with change in the pitch of the grating and the change in the refractive index. Thus, any physical parameter (like temperature, stress, strain) which causes change in the above mentioned parameters can be sensed using a FBG, by measuring the shift in the Bragg wavelength or the change in reflection coefficient of a particular wavelength. A FBG consists of a periodic modulation of the index of refraction along the core of an optical fiber.

FBGs are created by exposition of a photosensitive fiber to an intensity pattern of UV light. In its basic form, the resulting grating reflects selectively the light guided by the optical fiber at the bragg wavelength $\lambda = 2n\Lambda$, where n and Λ are the effective index of refraction of the fiber and the pitch of the grating in the fiber respectively as shown in Fig. 1.

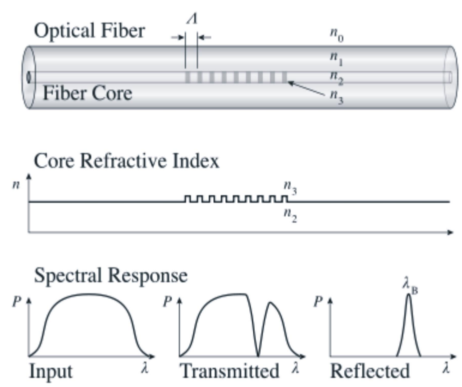

Fig. 1. Bragg grating in optical fiber.

II. THEORY

In this paper we perform a simulation of fiber Bragg grating with different temperature parameter and different refractive index of fiber. The simulated fiber gratings with different refractive index of fiber and varying temperature were analyzed and designed by calculating length of grating , modulation depth, grating period, Such simulations are based on solving Bragg condition equations that describe the changing bragg wavelength with changing effective index of refraction of the fiber and length of grating.

The Bragg grating wavelength equation describe by $\lambda = 2n\Lambda$, where n and Λ are the effective index of the fiber and the pitch of the grating in the fiber respectively.

Using Simulation, The Fiber bragg grating have created as shown in Fig. 2.

Fig. 2. Fiber bragg grating using simultion.

Characteristics of OFBG

The grating layout utility is used to speed up the time needed to produce this type of Optical fiber bragg grating for the particular rising temperature and different delta value to set the index. Set the layout option to fiber, the grating type to volume index and the modulation depth to 0.0012 in order to specify that we wish to create an index modulated fiber structure. Then, set the width and height to 5.25 Λ*m*, and geometry related parameters. Using the rising temperature and Different delta value to set the index (*n*) gets different form of test of spectrum response with central wavelength 1550nm in simulation as shown in table:

Rising temperature	***For different simulation test, the different delta value to set the index (n)***
6.6700*10Λ-7	Δn = 0.0005
6.6800*10Λ-7	Δn = 0.0002
6.6900*10Λ-7	Δn = 0.0005
6.7000*10Λ-7	Δn = 0.0005
6.7100*10Λ-7	Δn = 0.0003

Simulation Parameter :

Parameter	***Setting***
Index modulation	0.0012
Central wavelength	1550
Refractive index of fiber core	1.456
Refractive index of fiber cladding	1.458
Length of grating	1mm
Length of period of N	10,000 period
Grating period/Grating Length	Appro. 0.534μm

III. SIMULATON RESULT

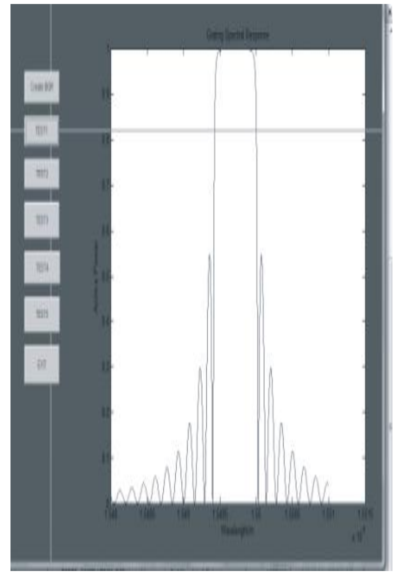

Fig.3 (*a*). Simulation result for test 1 between Wavelength and Reflectivity power.

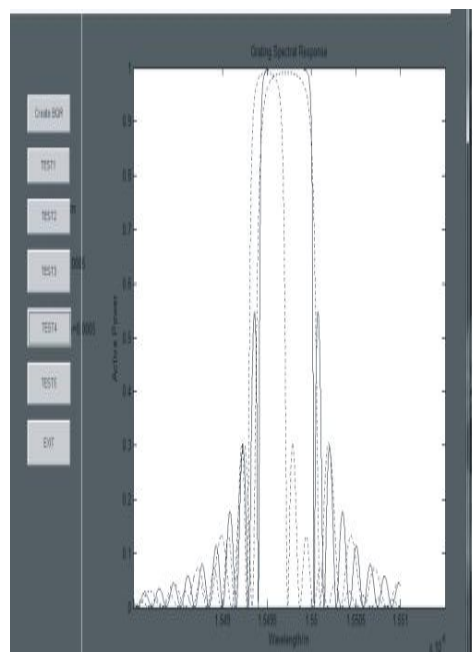

Fig.3 (*b*). Simulation result for test 4 between Wavelength and Reflectivity power.

Table 1. Dependence of reflectivity on grating length and index difference

FBG	Δn:0.0005	Δn:0.0002	Δn:0.0005	Δn:0.0005
	Λ=0.0012	Λ=0.0012	Λ=0.0012	Λ=0.0012
L mm	R	R	R	R
1	94.65%	93.76%	98.51%	96.43%

IV. CONCLUSION

The results of fiber Bragg grating simulation shows that spectral properties of grating depends the most on grating length, *L*, and refractive index change Δn.

This simulation method shows fundamental dependences between the grating dimensions and its properties. This is the basic method for making a grating proposal. This paper presents the optimization of length of an optical fiber grating for maximum reflectivity and minimum side lobe strength. The performance of fiber Bragg grating mainly depends on grating length and change in refractive index. Change in refractive index plays a crucial role in side lobe strength; it increases with increase in change in refractive index. It is mainly due to abrupt change in refractive index at the two edges of the grating. The wavelength 1550nm chosen for analysis is from the third window to minimize the attenuation. The reflection power with grating lengths and change in refractive index were analyzed from optical fiber grating index.

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