Fiber bragg gratings (fbg)
REVIEW OF OFC

1. OFC IS THE METHOD OF TRANSMITTING INFORMATION FROM ONE PLACE TO ANOTHER BY SENDING PULSES THROUGH OPTIC FIBRES

2. LIGHT FORMS THE CARRIER WAVE THAT IS MODULATED TO CARRY INFORMATION

MAIN BENEFITS OF FIBRES ARE:

- LOW LOSS
- HIGH DATA CARRYING CAPACITY
- NO CROSSTALK
- SIMPLE, FLEXIBLE, LOW COST
INTRODUCTION

Fiber Grating

- Fiber grating is made by periodically changing the refraction index in the glass core of the fiber. The refraction changes are made by exposing the fiber to the UV-light with a fixed pattern.
Structure of fiber Bragg grating

- Consists of a cladding and core
- Core have refractive index $n_2$
- Cladding have refractive index $n_1$ and that of air is $n_0$
- $n_3$ is the induced refractive index.
History of FBG

• First fiber grating: Hill, 1978 at CRC

• First holographically written Bragg grating: Meltz, 1989.

• First devices era 1990-1996:

• Kashyap, Russell, Reekje, Malo, Poumellec; Ar ion 244 nm.

• Albert, Dyer, Herman; excimer 198
THEORY OF FBG

- Based on principle of bragg reflection

- The bragg reflection condition is given by:

\[ \lambda_B = \frac{2n_{\text{eff}} \Lambda}{\lambda} \]

- where; \( \lambda_B \) = Bragg Wavelength; \( n_{\text{eff}} \) = Effective Refractive Index; \( \Lambda \) = Perturbation Period.

- A uniform grating can be represented by a sinusoidal modulation of the refractive index of the fiber core given by:

\[ n(z) = n_{\text{core}} + \Delta n [1 + \cos(2\pi z / \Lambda + \phi(z))] \]
Fiber Grating Basics

- When the grating period is half of the input light wavelength, this wavelength signal will be reflected coherently to make a large reflection.
  - The Bragg Condition

\[ \lambda_r = 2n_{\text{eff}} \Lambda \]
\lambda_2 = \lambda_B
Spectral response

\[ \lambda_B = 2 \cdot n_{\text{eff}} \cdot \Lambda \]

where:
- \( n_{\text{eff}} \): effective refractive index of the fiber core
- \( \Lambda \): grating period

Spectral Response

- Input
- Transmitted
- Reflected
Types of fiber Bragg gratings

Due to the change in the induced index change there are several types of grating:

1. Uniform grating
2. Apodized grating
3. Chirped grating
Uniform FBG

Here the grating is uniform throughout the core.

This is the simplest type of Bragg grating.

The refractive index change profile along the fibre axis is uniform.

Apodized FBG

• Click to edit the outline text format
  • Second Outline Level
  • Third Outline Level
  • Fourth Outline Level
  • Fifth Outline Level
  • Sixth Outline Level

• Here the refractive index of the grating approaches to zero at the end of grating.

• That is there is a variation of intensity of induced refractive index change.

• The maximum index change of the grating is at the end of the grating.
Chirped FBG

• There is a linear variation in the grating period called chirp.

• Here the reflected wavelength changes with grating period.
- Click to edit the outline at
  - Second Outline Level
  - Third Outline Level
  - Fourth Outline Level
    - Fifth Outline Level
FABRICATION OF FBG

There are mainly two methods of fabrication:
1. Transverse Holographic Method.
2. Phase Mask Method
HOLOGRAPHIC METHOD

- Uses 244 nm
Phase mask method
APPLICATIONS OF FBG

- Telecommunication-Filters.
- Wavelength Division Multiplexing (WDM) systems
- pump laser
- gain flattening filters
- highly selective filters
- chromatic dispersion compensators
- Sensors-Simultaneous measurement of strain and temperature.
FABRY-PEROT FILTER

- It consists of two FBGs with a cavity between them.
- It passes only particular frequencies for which the cavity is at resonance.
- The spacing between these frequencies is called as free spectral range.
- The bandwidth of the filter depends on the reflectivity.
- Constructive and destructive interference takes place inside the cavity.
Fabry perot filter

Figure: Fabry-Perot filter
ADVANTAGES OF FP FILTER

• Bandwidth above 100MHz.
• Easy to manufacture.
• Low insertion loss.
Sensor for simultaneous measurement of strain and temperature

• Bragg wavelength is sensitive to both temperature and strain.

• Two gratings G1 and G2 with closely related bragg wavelength is written in a fiber with distance nearly 1cm.

• This fiber is embedded in a silica glass tube.

• The grating of shorter wave length G1 is fixed in the inner wall of the tube.
FBG SENSOR

Figure: FBG Sensor
Application Sectors of FBG Sensors –

Temperature and vibration in electrical generators

NASA
Kayser-Threde

Aerospace structures

Airbus

Siemens Gas Turbine W 501

Temperature and vibration in energy and aircraft turbines

Wind turbine rotor blades

Enercon/Jenoptik

Railway interfaces – to contact lines and rails

Siemens

MTU Aero Engines

Rock-bolts in coal mining

GESO Jena, GFZ Potsdam

Super-conductive magnets

MPI Plasma Physics

Hydrogen monitoring

ESA / Kayser-Threde
ADVANTAGES OF FBG

- Flexibility.
- Low insertion loss.
- Low cost.
- Low transmission loss.
- Electrically inert.
- Peak reflectivity in OFBG can be as high as 99%
- Resolution of 0.05 nm has been achieved.
Devolping applications.....

- Aerospace Applications
- Bragg Grating Sensors in Marine Applications
- Civil Engineering Structural Monitoring
- Distributed strain sensors, small, robust
- Medical Applications
- Nuclear Power Industry
- Power Transmission Lines
CONCLUSION

- FBGs have revolutionized the communication industry by providing high performance, more reliable telecommunication links.

- They reflect a very narrow band of frequency, but can be designed to have more complex responses.

- They can sense parameters which vary the pitch or refractive index of grating.


QUESTIONS