

# Bragg Gratings in Microstructured Polymer Optical Fibers

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## Introduction

Fiber optic sensors offer attractive characteristics that make them very suitable and, in some cases, the only viable sensing solution. Some of the key attributes of fiber sensors are:

- Immunity to electromagnetic interference
- Excellent resolution and range
- Passive operation, intrinsically safe
- Water and corrosion resistant
- Rugged, small size and light weight
- Multiplexed in parallel or in series

Despite the many obvious advantages fiber optic sensing struggle with the reputation of being expensive and difficult to handle due to the fibers being very fragile. This limits or delays deployment of new fiber sensing applications.

The Fiber Bragg Grating (FBG) sensor is a short piece of optical fiber with a periodic modulation of the refractive index in the optical fiber. The periodic modulation of refractive index is generated by an interference pattern, and it creates a narrow filter response with peak reflectivity at a wavelength determined by the period of the FBG.

## mPOF

Our drawing facility allows us to design and draw fibers that are more suited for different applications.

**But why to chose polymer fibers?**

Because they are:

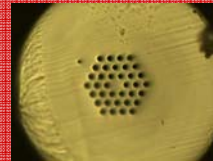
- Cheap
- Easy to draw, because of their low melting temperature
- Well suited for sensors e.g.:
  - Good response to strain (low Young modulus)
  - Biocompatible



**And why to chose a microstructured fiber?**

Because they are:

- Endlessly single-moded
- Well suited for evanescent field applications: can be easily infiltrated and



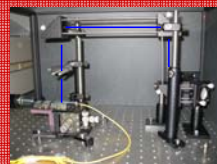
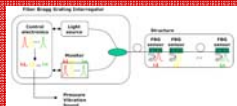
**It is possible to design the structure with any pattern of holes!**

## The sensing idea: Fiber Bragg gratings

**A Bragg grating consists of a modulation in the refractive index that causes constructive interference of the reflected light only for a limited number of wavelengths, related to the period of the grating.**

The idea in a Bragg grating sensor is to measure the variations in the reflected (transmitted) peak (dip) due to the interaction with the phenomena that have to be measured, e.g., strain, temperature (they introduce a variation of the period of the grating) and different samples, introduced in the holes (they change the refractive index of the fiber, and consequently change the guiding properties of the fiber and than change the Bragg peak wavelength).

Multiple sensing is also possible, because different gratings with different reflection peaks and with different properties can sense a various range of phenomena.



UV writing set-up

A Bragg grating in a polymer fiber can be written by:

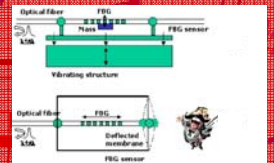
- UV writing with a phase mask
- Femtosecond direct writing

## Sensing applications

### Optical microphone

A fiber Bragg grating can be use as an optical sound detector, i.e. as a microphone.

With a mPOF Bragg grating it is possible to measure small deformations in a fiber with high accuracy. If the deformations are due to sound vibrations, then it is possible to convert sound into light information.

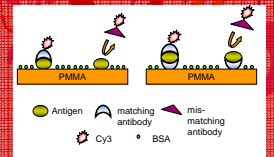


### Labeled biomolecules detection

In the holes of a mPOF is possible to attach antigens for detecting specific biomolecules.

In a second stage a solution that has to be analyzed is infiltrated in the holes.

If the matching molecule is in the solution it attaches to the antigen. When the molecule is attached the light in the fiber experiences a different refractive index, which leads to a variation of the Bragg peak.



In this way it is possible to detect the presence of a certain molecule in the solution.