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Commentary

Bragg Fibers for the Detection of Brain Cancer

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ABOUT THE STUDY

The detection performance of bragg fibers with defective layers in the cladding region has been optimized for brain cancer detection using the refractive index of brain lesion fluids. Optimization is achieved by comparing the confinement loss of a low-contrast bragg fiber and a defective high-contrast bragg fiber with a similar standard bragg fiber. Using the transfer matrix method and fitting the fields at different interfaces yields an equation for inclusion loss in the presence of defect layers. We observe that the detection performance of the low-contrast wave guide is better than that of the high-contrast waveguide in the absence of the defect layer, whereas the situation is reversed in the presence of the defect layer. Wavelength interrogation exhibits high detection performance in defect layer refractive index changes, while intensity interrogation exhibits high detection performance in core refractive index changes. Here, high-contrast bragg fiber wavelength interrogation is shown to detect normal and abnormal brain tissue due to its feasibility.

The human body has a strong immune response to any disease, but some lesions can cause serious illness. Brain tumors are one of them, and early detection helps in treatment. There are a number of newly invented micro and macro level diagnostic techniques to detect cancer cells. Since the Refractive Index (RI) of cells is also a measure of the physical state of cells, normal or abnormal cells and optical fiber based sensors are promising tools for detecting cancer cells. Detection of brain tumour tissue has been successfully demonstrated by several study groups using the transmission spectra of 1D photonic crystal. Therefore, due to the complex structure of the brain, in-line sensors that are compatible and easily attached to fiber optic waveguides are advantageous for targeted detection of brain tumour cells. Originally designed for communication purposes, optical fibers are now widely accepted in the biosensor and biomarker fields. In particular, optical fibers based on the band gap mechanism, such as Photonic fibers, hollow-core fibers, etc., have attracted much attention in sensor applications with better sensor performance and feasibility than standard fiber waveguides. Photonic fiber offers exclusive properties of light guiding that do not require total internal reflection for light propagation. There are two types of Photonic fibers: 1D Photonic fibers and 2D Photonic fibers. 2D photonic fibers have air holes in the cladding region, forming a light-guiding band gap, while 1D photonic fiber have light-guiding multilayer cladding, also known as bragg fibers.

Bragg fibers consist of a hollow or low RI core surrounded by periodic cladding layers of high and low index materials. This hollow core bragg fiber can be used as a compact in-line sensor where functional materials can be integrated into the hollow core region. A target analytic is loaded into the core of this fiber and its sensitivity can be estimated by monitoring variations in transmittance or power spectrum. Hollow core fibers serve as excellent platforms for light-matter interaction due to their unique signaling mechanism in the core medium. In contrast to evanescent wave-based sensor applications, in these sensors light directly interacts with the aqueous medium in the hollow core region. Many types of hollow core multilayer and hollow defective photonic structures have been proposed and experimentally demonstrated for sensing applications. They have great potential for RI detection. A small change in the RI of the detection medium can cause a large change in the detected signal. This mechanism is more effective than evanescent wave-based detection mechanisms where the evanescent wave penetration depth limits the detection applications. In Bragg fibers, any type of change that occurs in the fibers cladding region alters the optical path of the light, thus altering the response of the sensor. Therefore, by disrupting the structure of bragg fibers, their sensitivity can be manipulated. Breaking can be accomplished by structural deformation.

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