

ABSTRACT (200-300 words)

Photonics WEST – Optical comb interrogation of structured FBGs for physiological pressure sensing

Monitoring physiological pressure indices is crucial in the biomedical field, essentially for diagnosing and monitoring critical health conditions. Key parameters such as Intracranial pressure (ICP), instantaneous wave-free ratio (iFR), gastrointestinal pressure, intracolonic and bladder pressure offer vital metrics for clinicians to assess the severity of various diseases, including but not limited to, traumatic brain injury, coronary artery diseases, gastrointestinal motility disorders, diverticular diseases, and urinary tract disorders.

Optical fiber sensors have distinct advantages over traditional electrical sensors due to their biocompatibility, immunity to electromagnetic interference, and ability to integrate with standard catheters and pressure guidewires. Despite their potential, conventional Fiber Bragg Gratings (FBGs) face limitations in pressure sensitivity (3.14 pm/MPa) and spatial resolution (~10mm), restricting their efficacy in precise biomedical applications.

This study explores the use of specially structured Fiber Bragg Gratings (sFBGs) interrogated with Dual Optical Frequency Comb (DOFC) as a pressure sensor unit for potential physiological pressure monitoring. The structured FBGs enhance spatial and strain resolution along with strain sensitivity, which significantly improves pressure sensitivity. DOFC interrogation method substantially increases the limit of detection and signal-to-noise ratio of strain and, thereby, pressure compared to standard FBG interrogation systems. Integrating sFBGs into catheters and monitoring Bragg wavelength shifts using DOFC can potentially provide a minimally invasive solution with enhanced resolution (~10-20mmHg) for in-vivo pressure sensing applications.

Summary (50-130 words)

Monitoring physiological pressure indices is crucial for diagnosing and monitoring critical health conditions. Key metrics such as intracranial pressure (ICP), instantaneous wave-free ratio (iFR), gastrointestinal pressure, intracolonic pressure, and bladder pressure provide essential information for assessing diseases like traumatic brain injury, coronary artery diseases, and gastrointestinal motility disorders. Optical fiber sensors, particularly structured Fiber Bragg Gratings (sFBGs) interrogated with Dual Optical Frequency Comb (DOFC), offer advantages over electrical sensors due to their biocompatibility and immunity to electromagnetic interference. This study demonstrates that sFBGs significantly enhance spatial and strain resolution, leading to improved pressure sensitivity. The DOFC method increases the limit of detection and signal-to-noise ratio. DOFC-interrogated sFBGs can potentially provide a minimally invasive solution with enhanced resolution (~10-20mmHg) for in-vivo pressure sensing applications.