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A Novel Interrogation Technique for Simultaneous Measurement of Temperature and Strain Using Photonic Sensor

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Here we have proposed and demonstrated a cost-effective and simple novel interrogation technique for fiber Bragg grating (FBG) with customized in-line edge filtering single-multi- single mode fiber (SMS) component and optical time-domain reflectometer (OTDR). The performance of this proposed sensor head is analyzed in terms of performance metrics such as sensitivity, resolution and measurement range. The temperature and strain sensitivity values have been verified with theoretical analysis. A close agreement between the experimental and theoretical was observed. Furthermore, a controlled etching using hydrofluoric acid (HF) on FBG has achieved for enhancing the sensitivity. Using the etched FBG, an enhanced temperature and strain sensitivity of 6.7×10^{-2} dB/°C and 3.2×10^{-3} dB/ $\mu\epsilon$ covering the range of 20–200 °C and 100–2015 $\mu\epsilon$ respectively are also recorded and analysed by this integration method. The OTDR system itself has an intrinsic measuring accuracy of 0.05 dB. Therefore, it has about 0.75 °C resolution in temperature and 15 $\mu\epsilon$ accuracies for strain measurement. Further, 0.01 nm random variation of the central wavelength of the FBG will induce an intensity uncertainty of about 0.008 dB. Eventually, the efficiency and cost-effectiveness of the proposed method are compared with various reported techniques and presented here. From the comparison, it is clear that our proposed technique is well-positioned among different methods found in the past literature, yields high sensitivity with a higher measurement range and cost- effectiveness over the other reported methods. To take the maximum advantages of the method, the optimum parameters such as slope range of the steep edge in the SMS spectrum, peak reflectivity of the FBG at the central wavelength, the diameter of the cladding can be investigated for further studies. The designed sensor may find applications for simultaneous strain and temperature measurement in structural health monitoring, spatial analysis of engineering structures and fusion reactor relevant applications.

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