

Abstract

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Performance Evaluation of Fiber Bragg Grating Temperature Sensor: Apodized Fiber Bragg Grating Design and Simulation

In this work, different FBG temperature sensors are designed and evaluated with various apodization profiles. Evaluation is done under a wide range of controlling design parameters like sensor length and refractive index modulation amplitude, targeting a remarkable temperature sensing performance. New judgment techniques are introduced such as apodization window roll-off rate, asymptotic sidelobe decay level, number of sidelobes, and average sidelobe level. Evaluation techniques like reflectivity, Full Width at Half Maximum (FWHM), and Sidelobe Suppression Ratio (SLSR) are also used. For a single accurate temperature sensor measurement in extensive noisy environment, optimum results are obtained by the Nuttall apodization profile with a length of 19 mm and a refractive index modulation amplitude of 4×10^{-4} . The Nuttall apodization profile achieves a high reflectivity of 97.97%, a narrow FWHM of 0.2135 nm, a very low sidelobe strength of -89.71 dB, a very low sidelobe average of -90.79 dB, and finally a very high SLSR of 89.62 dB. For a quasi-distributed FBG temperature sensor in extensive noisy environment, optimum results are obtained by the Nuttall apodization profile with a length of 10 mm and refractive index modulation amplitude of 2.6×10^{-4} . It achieves an acceptable reflectivity of 51.43%, a narrow FWHM of 0.1985 nm (less than 25 GHz), a very low sidelobe strength of -100.94 dB, a very low sidelobe average of -121.74 dB, a very high SLSR of 98 dB and a high main lobe slope of about 73.5 dB/nm. These satisfactory results of both cases came on the expense of roll-off rate that is turned out to be low. Nuttall apodization is used to construct an optimum and reliable quasi-distributed temperature sensing system that has an adjacent channel isolation of more than 17 dB at 0.4 nm channel spacing, which is suitable for DWDM sensing systems.