Abstract

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Performance Analysis and Comparative Study of Uniform, Apodized and Pi-phase Shifted FBGs for Array of High Performance Temperature Sensors

The main target of this paper is to obtain an optimum performance for fiber Bragg Grating (FBG)-based temperature sensors which can be multiplexed to form an array. Accordingly, theoretical analysis and numerical comparisons are carried out to evaluate the performance of different FBG types including uniform, pi-phase shifted FBG (?FBG) and apodized FBG with various apodization profiles. The evaluation is done under a number of controlling parameters including grating length and refractive index modulation amplitude. Various evaluation characteristics are used as peak reflectivity, number of observed side lobes, side lobes strength, side lobe suppression ratio (SLSR), full width at half maximum (FWHM), roll-off rate and ripple factor. Analysis and comparison reveal that, the ?FBG shows an outstanding performance, with high two peak reflectivities and ripple factor, but unfortunately it shows a remarkable failure when talking about the side lobes and FWHM. Meanwhile, the Nuttall and cos8 apodized FBGs solve this problem but at the expense of reducing reflectivity and ripple factor. Accordingly, combining the three profiles introducing a new “hybrid FBG” consisting of one Nuttall and one cos8 apodized FBGs separated by pi-phase shift is the way to get the optimum performance. This hybrid FBG has recorded the best performance in terms of side lobes analysis (two with maximum amplitude of - 60.93 dB and SLSR of 95.22%), a ripple factor of 0.97432 and a FHWM of 1.046 nm with a fair reflectivity of 77.63%. A simple simulation setup of temperature sensor is also introduced. Finally, a study of the temperature variation is performed on the proposed hybrid FBG indicating its stable operation over increased temperature.