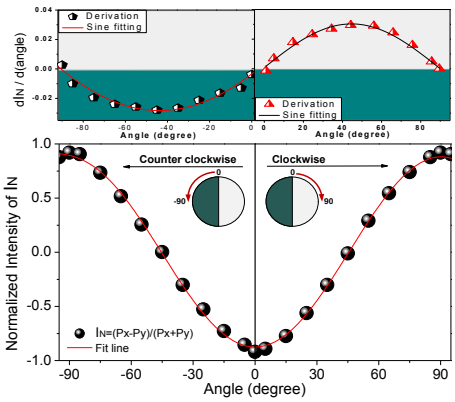

Fig. 7. Normalized intensity of the orthogonal-polarimetric PM-FBG for direction-recognized rotation measurement. The top two figures (colored in green & gray) present the rotation directions and sensitivities.

Figure 7 shows actual response of the VCSEL-driven system using the normalized intensity ratio $I_N=(P_x-P_y)/(P_x+P_y)$ of the orthogonal-polarimetric modes extracted from the real time oscilloscope data. The top part of Fig. 7 also shows the first order derivative of the normalized intensity plots and the corresponding fit lines. By using both normalized intensity and the first derivative data (set the origination of x- or y-polar as zero twist degree, as shown in Fig. 5), the rotation direction and the sensitivity are identified unambiguously (hence the name "vector rotation sensor"), with the green shaded regions corresponding to counter clockwise twist (minus value) and the gray regions to clockwise (plus value).The average sensitivity of the torsion is 0.09 dB/deg.

Finally, apart from the temperature sensitivity associated with the spectral shift of the FBG there might be a temperature-dependent polarization rotation in the SMF section of the twisted fiber, but based on the results shown in Ref. 15 this effect should be negligible (i.e. less than 1 degree of rotation) for temperature variations of a few tens of degrees Celsius, and twist angles up to 90 degrees.

5. Conclusion

A compact VCSEL-based PM-FBG fiber-optic polarimetric torsion sensor is proposed and experimentally demonstrated. The high-speed continuous wavelength tunable VCSEL and single photodetector coupled to a real-time data acquisition system enable the high SNR measurement of a closely spaced pair of reflections that correspond orthogonal modes of the PM fiber. We have shown that both the twist angle and direction of the rotation over a range of −90 to + 90 degrees can be accurately detected by comparing the normalized reflected powers of the two modes. This interrogation system effectively eliminates the potential light source power fluctuations while maintaining very low intrinsic sensitivity to temperature and axial strain as long as the two reflected peaks remain within the VCSEL spectral window. Compact size, low cost, good reproducibility, high sensitivity and SNR make the proposed PM-FBG sensor a good candidate for in-field torsion measurement.

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