Department of Electrical and Computer Engineering

Development of micromachined optical fiber devices

Hironori KUMAZAKI
Professor, Dr. Eng.
Email : kumazaki@gifu-nct.ac.jp

Research Fields Sensors, High value-added ultimate technology

Keywords Optical fiber, Fiber Bragg Grating, Micro-machine, Etching

Research Outline

Mechanical stress sensors using micromachined grating fibers

We present the design and fabrication of a novel fiber optic bend sensor capable of measuring bending direction and degree of curvature simultaneously. The sensor has a serial arrangement of two FBGs with two different center reflection wavelengths and similar asymmetrical cross sections with different etching faces on an independent single-mode fiber. These cross sections were fabricated by anisotropic reactive ion etching (RIE) using CF_4 plasma. Figure 1 shows a serial arrangement of two FBGs with two different center reflection wavelengths and similar asymmetrical cross sections with $\pi/2$ different etching faces for bend sensor. Figure 2 shows the experimental setup used for the curvature sensor based on a grating fiber with an asymmetrical cross section. Broadband light from the ASE light source was incident on the input port and it passed through an optical circulator before reaching the grating fiber. Light at the Bragg wavelength was reflected and extracted at the optical circulator. Spectra of the reflected light were measured for various curvature radii on a flat in-plane bend using an optical spectrum analyzer. After controlling the bending direction using a rotation stage, the FBG sensor was curved downward by displacing a bend feeder that applied forces to two points on the micromachined FBG separated by 80 mm. The bending direction was defined relative to the original orientation when the fiber was bent in the opposite direction to the etched surface. The FBG was then fixed halfway between the two clamps of the fiber holder without twisting the fiber during the experiment.

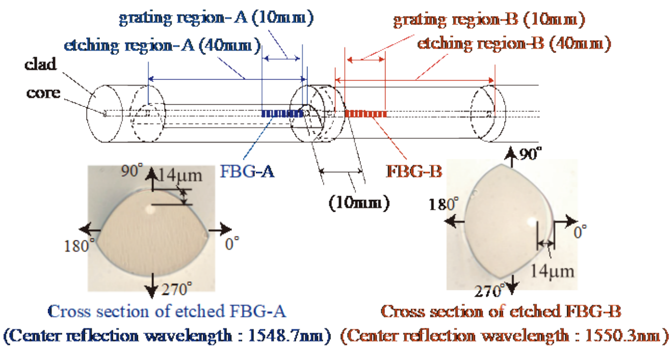

Figure 1. A serial arrangement of two FBGs with an asymmetrical cross section for bend sensors.

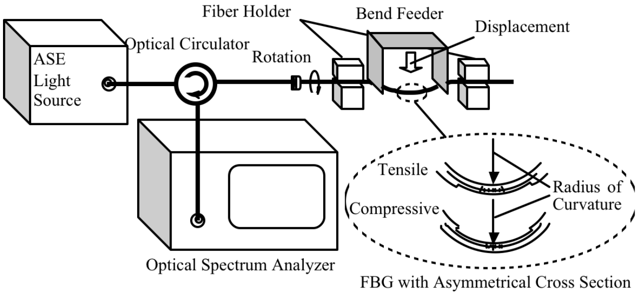

Figure 2. Experimental setup for a bend sensor using a FBG with an asymmetrical cross section.

Figure 3 shows the measured spectra for FBG-A and FBG-B under various bending direction and the degree of curvature. When the bending direction was 0˚, 180˚, only the center reflection wavelength for FBG-B was shifted by ±0.25nm on bending that imparted a curvature of ±7 m^{-1}. On the other hand, when the bending direction was 90˚, 270˚, only the center reflection wavelength for FBG-A was shifted by ±0.25nm on bending that imparted a curvature of ±7 m^{-1}.

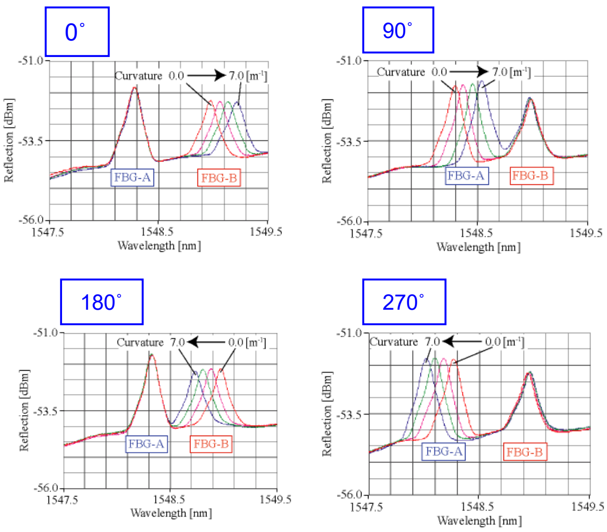

Figure 3. Measured spectra for FBG-A and FBG-B under various bending direction and the degree of curvature.