Fabrication of Temperature Sensors Based on Microbanding-induced Long-period Fiber gratings using Coefficient of Thermal Expansion

Kyung Rak Sohn* · June Huan Shim*

*Dept. of Electronic Communication Engineering, Korea Maritime University, Pusan 606-791, Republic of Korea

Introduction

Long period fiber grating (LPFG)
- Gain equalizer in fiber amplifiers, Band rejection filters,
  Sensors (strain, pressure, temperature, etc.)
- Fabrication methods of LPFG
  - Photoinduced
  - Mechanically formed
- Microbanding-induced LPFG (MLPFG) using Grooved plates
- Different effective periods for sensing

Modifications:
1. New technique of the fabrication method of MLPFG without external pressure to form the mechanical gratings.
2. Apply to low-birefringent fibers and in-line fiber optic temperature sensors

Principles of Long-period fiber gratings

Mode equation for the LPFG:

\[ \Delta n_{eff} = \frac{1}{2} \int \left( \frac{d n}{d x} \right)^2 \left( 1 - \frac{1}{2} n_{eff}^2 \right) dx \]

Graphical Analysis of Mode Equation

In-line Fiber Optic Devices

Principles
- Light attenuation limited
- Optical Phase-Shifting Fabry-Perot
Advantages
- Small size and insulable
- Non-slippery, no electrical failure
- Less susceptible to electromagnetic fields
- Long-distance transmission and compatibility of optical source and detectors

Repeatability
- Long period fiber grating (Duan et al. 2006)
- Small size and insulable (Duan et al. 2006)
- Non-slippery, no electrical failure (Duan et al. 2006)
- Long-period fiber grating (Duan et al. 2006)
Thermally Controlled Loss-Tunable LPFG on Corrugated Metal Substrate

Schematics of Proposed Loss-Tunable MLPFGs

Measured Transmission Spectrum (1)

(a) Transmission spectra of MLPFG1 versus temperature. The SMF with jacket was installed.
(b) A plot for optical loss and loss peak shift versus temperature.

Measured Transmission Spectrum (2)

(a) Transmission spectra of MLPFG2 versus temperature. The jacket-removed SMF was installed.
(b) A plot for optical loss and loss peak shift versus temperature.

Experimental Setup

Typical transmission spectrum at room temperature

Conclusion

- We have presented a new type of loss-tunable MLPFGs formed by bonding a SMF and arrayed metal wires between two flat glass plates.
- The mechanical force to induce the periodic index variation on the fiber is realized by the adhesion force of NOA56. So an initial built-in compressive strain in the fiber of MLPFG was sustained by itself without external pressure.
- Loss tuning was achieved by the CTE of NOA56. By change the ambient temperature, the peak loss was easily controlled without appreciable shift of the center wavelength.
- The jacket of the fiber has influence to the temperature sensitivity and the measurable temperature range.
- The model of proposed MLPFGs may be useful to realize compact, robust, and efficient loss-tunable filters and temperature sensors.