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열팽창 계수를 이용한 마이크로밴딩 장주기 광섬유격자 기반 온도센서의 구현

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

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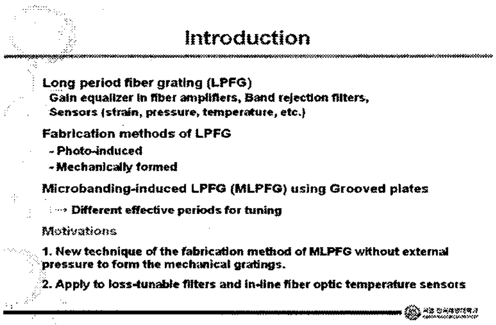
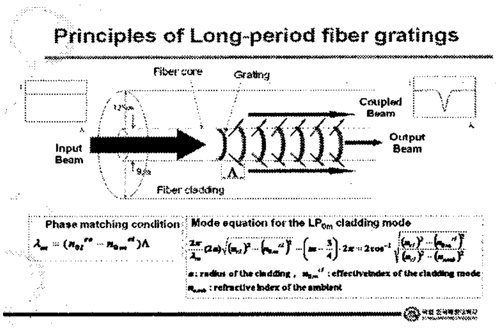
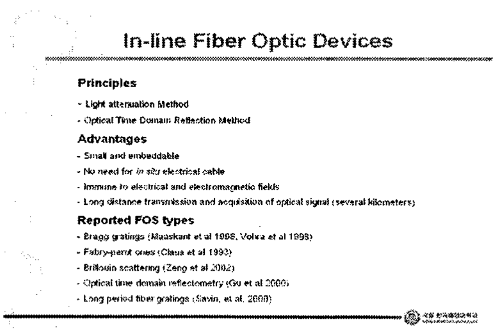
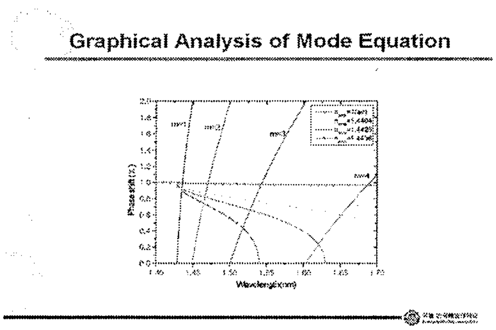
요 약 : 마이크로밴딩을 이용한 장주기 광섬유 격자를 금속선의 주기적인 배열로 구현하였으며 포토폴리머에 의한 자기 압력이 유지될 수 있게 하였다. 포토폴리머의 열팽창 계수가 소자제작에 사용된 다른 재질에 비해 상대적으로 큰 열팽창계수를 가지므로 온도 변화에 민감하게 반응하였다. 이러한 특징을 온도 변화를 감지하는 센서로 활용할 수 있음을 보여 주었다. 단일모드 광섬유의 플라스틱 코팅층이 있는 경우와 없는 경우에 대하여 각각 실험을 하였으며 그 결과를 비교 분석하였다.

핵심용어 : 열팽창계수, 장주기광섬유격자, 광섬유온도센서, 위상정합, 단일모드광섬유

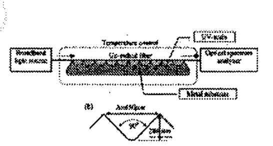


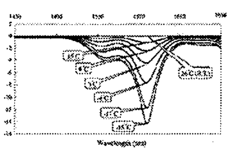




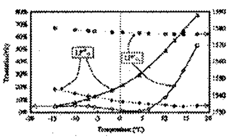


Thermally Controlled Loss-Tunable LPFG on Corrugated Metal Substrate



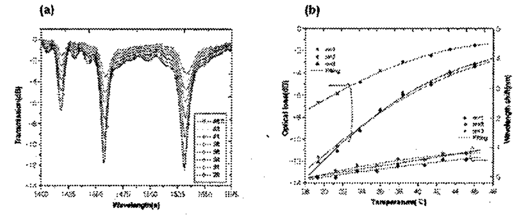


- 35 grating periods
- The strain caused by the difference in thermal expansion among the used materials
- Tuning range of -21dB



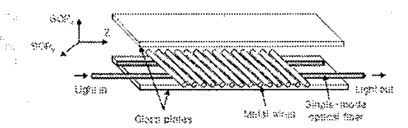
Source: E. Wu, et al. IEEE Photon. Technol. Lett., vol. 17, 2005

Measured Transmission Spectrum (1)



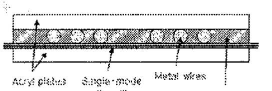
(a) Transmission spectra of MLPFG1 versus temperature. The SMF with jacket was installed.
(b) A plot for optical loss and loss-peak shift versus temperature.

Schematics of Proposed Loss-Tunable MLPFGs



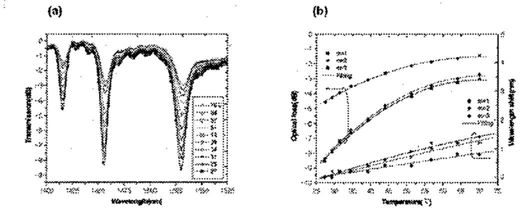
Coefficient of thermal expansion (CTE)

material	Optical fiber	Metal wire	UV-epoxy	Glass plate
CTE (ppm/°C)	0.5	12	225	8.5



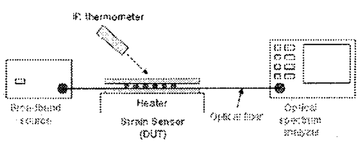
Bonging force between two glass plates

Measured Transmission Spectrum (2)

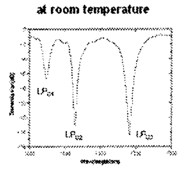


(a) Transmission spectra of MLPFG2 versus temperature. The jacket-removed SMF was installed.
(b) A plot for optical loss and loss-peak shift versus temperature

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 NOA65. 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 NOA65. 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