論文内容の要旨

論文題目：NOVEL FUNCTIONAL PHOTONIC DEVICES FOR DWDM SYSTEMS BASED ON FIBER BRAGG GRATINGS INCORPORATING NONLINEAR STRUCTURES/MATERIALS

非線形構造・材料を組込んだファイバブラッググレーティングを利用したDWDMシステムのための機能フォトニックデバイス

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This thesis is a study of sampled fiber Bragg gratings for the device applications in dense WDM communication systems. Multi-channel devices with dense channel spacing, broad bandwidth, in-channel dispersion compensation function, as well as the tunability are proposed and realized using sampled fiber Bragg gratings incorporating nonlinear materials/structures.

The rapid growth of the Internet has raised the demands for more transmission bandwidth and speed, WDM systems continue to grow in complexity and sophistication with increasing numbers of channels, longer transmission distances and higher bit rates. Thus WDM devices with novel functions are required to meet the demands: dispersion compensation ability for higher bit rates and longer distances; broad bandwidth, dense channel spacing for more numbers of channels; tunability for managements and reconstructions of more and more complicated systems in changing environments.

On the other hand, the fiber Bragg grating is one of many technologies that greatly enhance the performances of high density WDM systems. The filtering capabilities of Bragg grating combined with its all-fiber configuration make it an ideal candidate for high channel count density components such as multiplexers/demultiplexers, optical interleavers and add/drop filters. Moreover, due to its great flexibility, Bragg gratings can also performed other functions such as spectrally-designed complex filter and dispersion compensator. In today networks, fiber Bragg gratings have found applications in which they stand out from all other technologies, in both performance and cost.

However, realization of sampled fiber Bragg gratings to meet the requirements of new specifications is difficult. Conventionally, gratings with broader bandwidth, denser channel spacing requires longer length and higher maximum refractive index changes, which both are physically limited. Gratings for multi-channel dispersion compensators are difficult to realize due to the unbalanced parameters or complicated experimental setups. Besides, grating design is in lack of flexibility due to the device restraints and high cost, conventional tuning methods are also in lack of quality.

This thesis addresses these problems. From the theoretical study, we propose novel fabrication methods and realize sampled fiber Bragg gratings with broad bandwidth, dense channel spacing and in-channel dispersion compensation ability using the optimum parameters. We also propose low cost, highly effective methods to enable the tunability and flexible design of channel spacing and in-channel dispersion compensation of sampled fiber Bragg gratings for tunable applications. Finally, we design and demonstrate the potentials of novel switching devices based on fiber Bragg gratings incorporating nonlinear materials/structures such as carbon nanotubes and tapered structure.