Optoelectronics and Semiconductor Group

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Field of study: Fiber sensor, Optical Communication
Key words: Optical amplifier, fiber Bragg grating, WDM
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1.The Subject and Aims of Research

Subject: Fiber optics subsystems and components, fiber sensor, IP for LED and LCD
Aims: Build up a new & practical research environment for students.

2.Related Recent Research Topics

(1). Investigation and application of WADM in a passive optical ring networks.

Optical add/drop and optical cross-connect and are crucial functions in a metropolitan area network. The possible solutions for WADM are thin film based WADM, array waveguide grating (AWG) based WADM and fiber Bragg grating (FBG) based WADM. This project will study and compare various WADM architectures from the view of point of material, merits and reliability in optical networks. Most likely, we will investigate WADM using high reflectivity FBGs in this project. In additional to single-wavelength WADM, low-loss multi-wavelength WADMs are also investigated. The goal is to reduce the insertion loss of each WADM to less than 2.5 dB. For the time being, some processes are undergoing. Based on the plan mentioned in our main project, the optical networks are passive and no optical amplifier inside. The POR test bed has two unidirectional sub-rings in cascade with ring-by-ring protection. There are 16 wavelengths and 8 WADM nodes in each ring, for a total number of 16 WADMs. This project will deliver these WADMs with qualified specifications and support other subprojects such WADMs. Each WDM channel transmits 10-Gb/s WAN-PHY based Ethernet signal, for an overall capacity of 160 Gb/s. The POR test bed will be finished in three phases of (1) a four-node four-WADM unidirectional ring, (2) an eight-wavelength eight-WADM unidirectional ring, and (3) the complete dual-ring POR with ring-by-ring-protection. Finally, we may also conduct a field trial at the campus of National Taiwan University using the existing campus-wide fiber plant.

(2). Investigation of fiber based variable optical attenuator

Today, variable optical attenuator (VOA) is extensively used in optical communication and fiber sensor such as to balance the power levels among WDM channels, to reduce the launched power into photo detector, for power measurement and so forth. However, the commercial products are somewhat expensive due to the intelligent property (i.e., paten) cost when one has to buy the authority for mass production. In this proposal, we hope to develop a novel VOA based on photonic crystal fiber (PCF). And we also plan to apply a VOA related paten in this project.

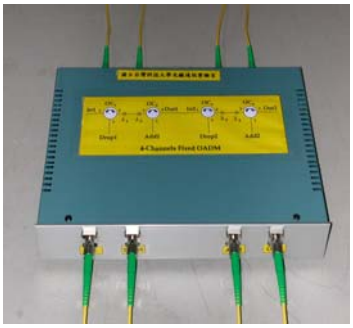
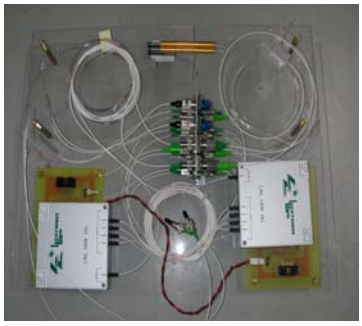
PCF will induce loss because the effects of bending or stress. In such conditions, light will scatter out from fiber core and then attenuated itself. Unlike a single mode fiber (SMF), PCF have some advantages over a SMF such as dynamic controlled dispersion, novel attenuation characteristic and small bending loss, etc. It is possible to develop an all-optical variable optical attenuator using simple fabrication process but has a novel structure. The predicted specifications of our proposed product are 1510 to 1570 nm, 2 dB to 30dB, 0.2 dB, -40 dB, -20°C to 70°C for the operation wavelength, variable range, adjustment resolution, return loss and operation temperature, respectively.

(3) Parameters Optimization of Raman Fiber Amplifier and its Application in Lightwave Communication

Optical amplifiers are one of the key parts in new generation fiber communication systems. They are used to compensate the fiber loss in a lightwave system. Optical amplifiers with wavelength division multiplexing (WDM) technologies can provide high speed and secure optical links that are immune to EM interference and that can transmit information to long distance without using electronic repeaters. Among them, erbium-doped fiber amplifier (EDFA) is the most commercial product to date. However, it can only cover the 1530~1560 nm range. On the other hand, Raman fiber amplifier (RFA) in fiber transmission system attracts a great attention because of its several advantages such as low noise, simplicity, flexible use of signal wavelengths and a broad gain-bandwith product. The

RFA can operates in the band other than the conventional optical amplifiers, depends on the selection of pumping wavelengths. So, the RFA will play a more and more important role in the future optical communication system. In the project, we propose a rule to select pump-power and pump-wavelengths to realize optimal gain spectrum. We propose and numerically study the broadband RFAs with several pump channels, gain flatness can be preserved at different gain levels by means of changing optical parameters. The energy transfer between pumps and signals, pump and pump are considered. And the gain-spectrum-dependent optical parameters are also discussed.

We concentrated on the investigation of (1) Simulation of Raman amplifier and parameters optimization, (2) Investigation and power equalized RFA, (3) Verification of RFA applications in lightwave communication. We will also study the nonlinear effects of Stimulated Raman scattering (SRS), and hybrid amplifier (RFA+EDFA). We believe that RFA may find vast applications in WDM lightwave transmission.

Figs. Temperature compensated fiber Bragg grating (left). Four-channel fixed WADM (mid.), and four-channel reconfigurable WADM.

3.Selected Publications and Projects

Publications:

1 S.-K. Liaw, H.-Y. Tseng and S. Chi, "Parallel pump-shared linear-cavity lasers array using 980 nm pump reflectors or N pieces of gain fibers as self-equalizers," *IEEE Photon. Technol. Lett.*, vol. 12, no.1, pp.19-21, 2000.

2 S.-K. Liaw and K.-P. Ho, "Reduction of power penalty in bi-directional wavelength reused lightwave system using polarization-control, *IEICE Transactions on Communications*, pp. 1589-1590, Vol. E86B. No.5, 2003.

3 K.P. Ho and S.-K. Liaw "Impacts of nonlinear phase noise to DPSK signals: experimental verification of a simplified theoretical model", *IEEE Photonics Technology Letters*. vol.17, no.10, pp.2236-2238, 2005.

Patents:

1. S.-K Liaw, Y.-C Tseng, T.-F Wu, WB Yang and YF Chiang, "Variable optical attenuator", ROC paten No. 158406. *2004.04.01-2022.11.24*
2. S.-K Liaw, H.-Z Song, "Novel methods for power equalized fiber components", ROC paten No. 158406, *2002.06.11-2021.04.15*

Projects:

1. Investigation and application of WADM in a passive optical ring networks.
2. Investigation of fiber based variable optical attenuator
3 Parameters Optimization and applications of Raman Fiber Amplifier

Awards:

1. Outstanding Young researcher award, the Chinese Optical Engineering Society 1999
2. Outstanding Young Engineer award, the Chinese Electrical Engineer Society 2004
3. Marquis Who's Who in the World, 2006