Optoelectronics and Semiconductor Group

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Field of study: optoelectronic devices, optical communication networks, optical integrated circuits
Key words: Tunable laser, Optical network, Wavelength conversion
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1. The Subject and Aims of Research

Recent research aims at developing advanced optical switching technologies and key components for next generation optical networks. The ongoing projects include multiwavelength laser arrays, tunable lasers, wavelength converters, optical network switching, optical performance monitoring, and optical signal processing. We are also developing techniques for photonic integrated circuits, including quantum well intermixing and hybrid integration. Semiconductor optoelectronic devices for bio-sensing and image display are also under our research interests.

2. Related Recent Research Topics

(a) Multiwavelength laser arrays: we have demonstrated 32-wavelength DWDM laser arrays with accurate wavelength registration and minimal wavelength fluctuation. The wavelength selectable laser that integrates four novel tunable lasers with a MMI couples was successfully fabricated and can cover forty 50-GHz spaced channels. Currently, we are in collaboration with Prof. Yoshi Nakano of University of Tokyo to develop multiwavelength laser arrays for 100 gigabit Ethernet applications

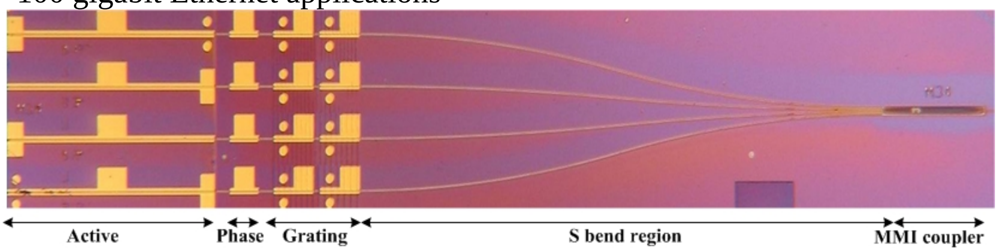

Fig.1 Wavelength-selectable lasers integrating 4 lasers and a MMI coupler（device is 3.5mm long）

(b) High-speed and high-yield DFB lasers: we have realized coolerless 10Gbps DFB lasers for metro and access networks. Novel two-section DFB lasers with asymmetric longitudinal structure were demonstrated to have high single-mode yield with simple fabrication. For their excellent wavelength and mode stability, the lasers are applied for wavelength conversion and optical clock recovery.

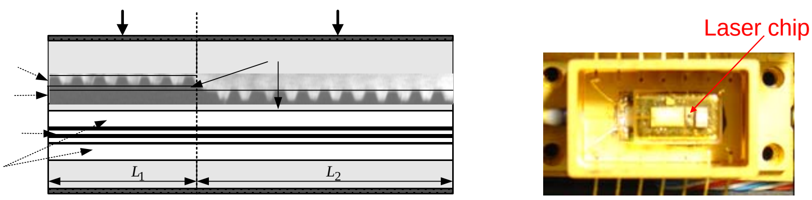

Fig. 2 Schematic of two-section DFB lasers and photo of packaged module

(c) Performance Enhancement on WDM-PONs: We have enhanced the performance by adding a FP etalon before the receiver of each optical network unit. The etalon performs spectral reshaping and then waveform reshaping to the downstream signals. This allows the use of low-ER downstream signals that reduce the intensity fluctuation of RSOA- remodulated upstream signals. This approach can also extend the transmission distance by reducing the transient chirp. Colorless operation can still be obtained since the same etalon can be used to enhance multiple wavelength channels.

(d) Optical performance monitoring for optical networks: we demonstrated several novel optical performance monitoring techniques for applications in OADM and optical switches to monitor the channel quality, including channel position, signal level, and OSNR. We are developing the photonic sampling schemes for monitoring the Q-factor and dispersion.

(e) Optoelectronic devices: we are developing dual-wavelength (1.5/1.57μm) DFB lasers and resonant-cavity enhanced photodiodes for gas sensing applications. Novel LED-based linear sources are under development for display and laser printing applications.

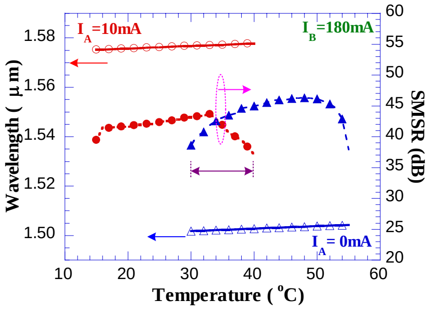

Fig. 3 Wavelength switching for dual-wavelength DFB laser

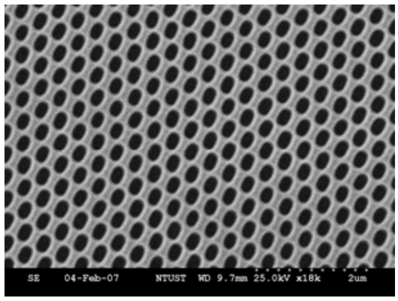

Fig. 4 SEM photo of 2D photonic crystal made by holographic exposure

(f) Quantum well intermixing (QWI): QWI provides selective modification of heterostructure bandgap profiles on the post-growth materials. We successfully fabricated high-performance laser diodes using the QWI with low-energy ion-implantation. Under the process, a blue shift of the wavelength in the intermixed QWs structure can be obtained. Thus, QWI process can be applied for the fabrication of monolithic photonic integrated circuits (PICs).

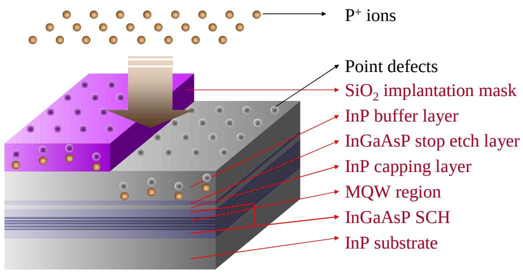

Fig. 4 Schematic diagrams of the ion implantation induced QWI process.

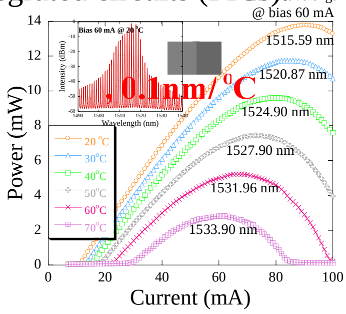

Fig. 6 CW L–I characteristics for QWI LD.

Fast Switching Operation Region

3. Selected Publications and Projects

Publications: Chiu-Lin Yao, **San-Liang Lee**, Ing-Fa Jang, and Wen-Jeng Ho, "Wavelength Selectable Lasers with Bragg-Wavelength-Detuned Sampled Grating Reflectors," J. Lightwave Technology, vol. 24, no. 9, pp. 2480-2489, Sept. 2006.

Patents: **San-Liang Lee** and Ing-Fa Jang, Adjustable Monolithic Multi-Wavelength Laser Arrays, U.S. patent 6,432,736. Aug., 2002

Projects: Enabling Technologies for WDM-PONs (NTPO)

Awards: Advisor for Best Master Thesis Award of National Science Council, 2003