【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)

Title of Project : Advances of integrated photonics for ultra-low power consumption optical interconnects

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Research Area : Electrical and electronic engineering, Electron device/Electronic equipment

Keyword : Optical devices/Optical circuits, Semiconductor lasers, Optical interconnects

【Purpose and Background of the Research】

Ultrahigh speed data transmission beyond 20Gbps will be needed for carrying future super-high definition images and so on. The development of low power consumption devices is important toward "Green ICT". While Tera-bits/s data transmissions are already realized for long-haul optical communications, the innovation of optical link technologies with scalability and low power consumption should be needed for short reach applications. The purpose of this project is to develop "athermal" vertical-cavity surface emitting semiconductor lasers (VCSELs), densely- packed multi-wavelength VCSEL arrays and miniature optical detectors/modulators with slowing light. Their array integrations, multi-wavelength arrays, ultrahigh speed operations and ultralow power consumptions will be realized. Key innovative photonic integrated devices will be developed toward ultra-high capacity optical link technologies/interconnects.

【Research Methods】

We proposed an athermal VCSEL with a fixed wavelength even under temperature changes using the self-compensation based on a thermally actuated cantilever structure as shown in Fig. 1. The structure is based on micromachined tunable VCSELs. We have demonstrated small temperature dependence in micromachined vertical cavity optical filters and VCSELs. It is a challenge to realize an athermal and tunable VCSEL based on the proposed concept. Also, we will establish the precise multi-wavelength integration of VCSELs using sub-wavelength high-contrast grating for making chip-scale 100 multi-wavelength integrated sources. The basis of VCSEL photonics enabling high-density photonic integration will be established.

In addition, slow light can be obtained in Bragg reflector waveguides with their large waveguide dispersion. We demonstrated a slow light modulator with a Bragg waveguide, which shows a possibility of low modulation voltage even for ultra-compact waveguide modulators. We will develop ultra-compact modulators, detectors and optical switches based on slow light photonics.

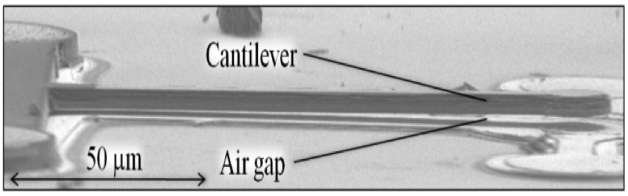

Fig. 1 Athermal VCSEL with MEMS structure.

【Expected Research Achievements and Scientific Significance】

By making temperature controllers unnecessary, our athermal and tunable VCSEL may enable low power consumption and size reduction of transceivers for WDM applications. The wavelength engineering in VCSEL technologies enables us ultra-high capacity of optical local area networks as well as optical interconnects.

【Publications Relevant to the Project】

・ H. Sano, A. Matsutani and F. Koyama, "Athermal 850nm Vertical Cavity Surface Emitting Lasers with Thermally Actuated Cantilever Structure," Appl. Phys. Exp, vol. 2, 07210, pp. 1-3, 2009.
・ P. Babu Dayal, T. Sakaguchi, A. Matsutani, and F. Koyama, "Multiple-Wavelength Vertical-Cavity Surface-Emitting Lasers by Grading a Spacer Layer for Short-Reach Wavelength Division Multiplexing Applications," Appl. Phys. Exp., vol. 2, no. 9, 2009.
・ F. Koyama, "VCSEL Photonics -advances and new challenges, " IEICE ELEX, vol. 6, no. 11, pp. 651-672, 2009.

【Term of Project】 FY2010-2014

【Budget Allocation】 161,700 Thousand Yen

【Homepage Address and Other Contact Information】
http://vcsel-www.pi.titech.ac.jp/index-j.html