【Grant-in-Aid for Scientific Research (S)】

Science and Engineering (Engineering)

Title of Project : Creation of Ultra-low Power-consumption Semiconductor Membrane Photonic Integrated Circuits toward On-chip Optical Interconnections

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Research Project Number : 15H05763 Researcher Number : 30151137
Research Area : Engineering, Electrical and Electronic Engineering
Keyword : Photonic devices, Photonic circuits

【Purpose and Background of the Research】

Recently, optical communication technology has been implemented in board-to-board and rack-to-rack communications in most of high-performance super-computers as can be seen in the TOP500 (www.top500.org). This trend will be extended to chip-to-chip communication in LSIs with many core architecture, and on-chip optical interconnections will be very important in next generation LSIs.

In such optical interconnects, not only compactness of each element but also ultra-low energy-cost for signal transmission such as 10-100 fJ/bit will be required. We proposed "semiconductor membrane laser," which consists of a thin core layer sandwiched by low refractive-index dielectric materials or air so as to enhance an optical confinement into the active region by a factor of around 3 compared with that of conventional semiconductor lasers, and demonstrated record-low threshold current operation of distributed-feedback (DFB) lasers, wire waveguides, and photodiodes based on GaInAsP/InP membrane structure prepared on a Si substrate.

The purpose of this research is to create a photonic integrated circuit (PIC) based on the semiconductor membrane structure, as shown in Fig. 1, toward on-chip optical interconnects in next generation LSIs.

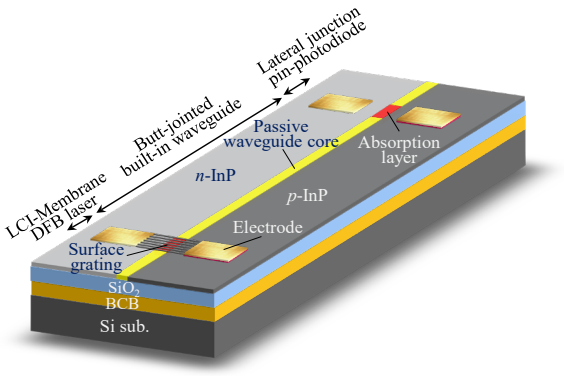

Figure 1 Fundamental structure of semiconductor membrane photonic integrated circuit.

【Research Methods】

We promote the research concerning the following 4 targets.

(1) **Elemental technology:** Design and fabrication of the light source, the waveguide, and the photodetector.
(2) **Monolithic/hybrid integration technology:** Monolithic integration of elements above and heterogeneous integration by surface activated bonding (SAB) technology.
(3) **Integration on Si-substrate:** High efficiency operation for high-speed with low energy-cost.
(4) **Integration on CMOS platform**

【Expected Research Achievements and Scientific Significance】

This research will contribute for realization of ultra-low energy consumption photonic devices toward next generation LSIs as well as their heterogeneous integration on various combinations of substrates by wafer bonding technologies.

【Publications Relevant to the Project】

・D. Inoue et al., Appl. Phys. Express, vol. 7, no. 7, pp. 072701-1-4, July 2014.
・S. Matsuo, et al., IEEE J. Sel. Top. Quantum Electron., vol. 19, no. 4, p 4900311, July/Aug. 2013.
・K. Takeda et al., Nature Photonics, vol. 7, no. 7, pp. 569 – 575, May 2013.
・S. Arai et al., IEEE J. Sel. Top. Quantum Electron., vol. 17, no. 5, pp. 1381-1389, Sep. 2011.

【Term of Project】 FY2015-2018

【Budget Allocation】 153,200 Thousand Yen

【Homepage Address and Other Contact Information】

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