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

Title of Project : Highly functional semiconductor nanophotonic devices and their applications for photonic RAM

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Research Area : Engineering
Keyword : Optical devices and circuits, Light control, Laser, Spintronics

【Purpose and Background of the Research】

Dramatic increase in communication traffic to support various future services will cause a serious problem, namely the gigantic power consumption of network systems. One of the power consuming devices in the present network systems is the electrical router for the packet signals. Optical packet switching is therefore emerging as an important technology to overcome this critical problem. To handle the contention of the output ports at an optical packet-switching node, a high-speed low-power-consumption optical memory for buffering data is required. Optical flip-flop memories, in which one bistable device acts as a one-bit memory, are the promising candidates for this scenario.

The aim of this research project is to create novel highly functional semiconductor nanophotonic devices and to develop a low-power-consumption photonic RAM using these devices.

【Research Methods】

(1) Subwavelength semiconductor laser sources are expected to be key components in future nanophotonics circuits. The lasing characteristics will be studied to achieve optical bistable switching with low power consumption. Spintronics deals with the control of the electron spin as an information carrier. Injection of aligned spins into VCSELs using ferromagnetic electrodes will be studied as well as perpendicularly magnetized electrodes in this project.

(2) To improve performances of optical memory, lasing threshold of the polarization bistable VCSELs will be reduced by the strong carrier confinement using oxidation. The faster memory operation will be demonstrated by using low-Q cavity.

(3) An optical buffer memory using a 2D array of polarization-bistable VCSELs will be constructed.

【Expected Research Achievements and Scientific Significance】

Development of all-optical buffer memory is the most important challenge to realize the transparent optical packet-switching networks. Our group demonstrated a multi-bit optical memory for the first time. There is no other optical buffering device than the present proposed device which gives the realistic solution to the challenge and thus takes an initiative to make the breakthrough in networking technology near future.

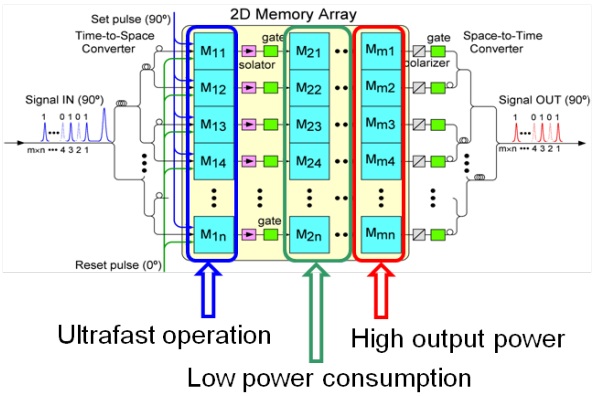

Figure 1 Optical buffer memory with shift-register function

【Publications Relevant to the Project】

- H. Kawaguchi, T. Mori, Y. Sato and Y. Yamayoshi, "Optical buffer memory using polarization-bistable vertical-cavity surface-emitting lasers," Japanese J. Appl. Phys., Vol. 45, pp. L894-L897 (2006).
- H. Kawaguchi, "Polarization-bistable vertical-cavity surface-emitting lasers: application for optical bit memory," Opto-electronics Review, Vol. 17, pp. 265-274 (2009).

【Term of Project】 FY2012-2014

【Budget Allocation】 99,100 Thousand Yen

【Homepage Address and Other Contact Information】

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