Department of Electrical and Computer Engineering

Studies on Optical Functional Devices and Electric Microstructured Devices

Isao TOMITA
Associate Professor, Ph.D.
Email : itomita@gifu-nct.ac.jp

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Research Outline

Studies on Optical Functional Devices

Because of wide prevalence of the Internet, optical fiber communication comes closer to us. A laser beam with a fixed wavelength that has 1/0 signals is generated from a semiconductor laser and travels through optical fibers nearly at the speed of light. In my laboratory, such semiconductor lasers for high-power output are designed, and their detailed characteristics are analyzed.

In addition to the above, developing optical devices that have such a function as wavelength conversion, or a function that can shift from one wavelength to another, is very important to prevent line-crossing caused by the collision of optical signals at the same wavelength. One of the effective ways to achieve the wavelength conversion is to use a nonlinear optical effect. In my laboratory, nonlinear-optical wavelength converters for highly-efficient output are studied by designing optically-strong confining structures in the converters. Examining their output characteristics in detail takes much time, but gives us interesting results and knowledge.

Studies on Electric Microstructured Devices

The large-scale integration of electronic circuits has made it possible for us to use highly functional electronic tools, such as laptop computers, automobile navigation systems and smart-phones. In addition, if the current situation of downsizing electronic tools continues, electronic circuits will be much more highly integrated, and electric wires used in integrated circuits will be much narrower. If the narrow wires come into the microscopic scale, or the wire width is comparable to de Broglie wavelength of electrons (typically ~10 nm at room temperature), the wave nature of the electrons in the wires will strongly affect electrical conduction and isolation in the integrated circuits.

In my laboratory, electrical transport and confinement properties of ultra-small wires, dots and rings embedded in semiconductor or metal microstructured devices are analyzed in terms of quantum mechanics. Some of their magnetic and temperature dependences show interesting tendencies that cannot be explained from classical mechanical and statistical point of view.