Our research interest is to understand optical and quantum properties of nanostructures and nanomaterials and to develop opto-nanoscience for creation of innovative functional materials. Optical properties of semiconductor quantum nanostructures and strongly-correlated electron systems in low-dimensional materials are studied by means of space- and time-resolved laser spectroscopy. The main subjects are as follows: (1) Investigation of optical properties of single nanostructures through the development of high-resolution scanning near-field optical microscope, (2) Development of nanoparticle assembly with new optical functionalities, and (3) Ultrafast optical spectroscopy of excited states of semiconductor nanostructures.

**Presentations**


**Grants**


Inouye H, Luminescence Dynamics of Self-Assemble Nanocrystal Composite Film and Study for Realizing High Luminescence Efficiency, Grant-in-Aid for Young Scientists (B), 1 April 2005 - 31 March 2007.

**Award**

An Individual Single-Walled Carbon Nanotube Spectroscopy

Single-walled carbon nanotubes have attracted a great deal of attention because of their potential use in electronic devices and their unique physical properties. We investigated photoluminescence properties of individual micelle-encapsulated single-walled carbon nanotubes. Figure 1 shows 3-dimensional plot of a single-walled carbon nanotube photoluminescence image, detected at a range of 1.18 - 1.37 eV at room temperature. Each sharp peak corresponds to the photoluminescence signal from an individual single-walled carbon nanotube. We observed that single photoluminescence peak from isolated individual single-walled carbon nanotube showed a linear increase and saturation behavior of the photoluminescence intensity with an increase of excitation power. We also found unusual photoluminescence intensity fluctuation in the temporal evolutions of the photoluminescence intensity, referred to as photoluminescence intermittency. The photoluminescence intermittency is attributed to the fluctuation of induced local electric field by trapped charges around single-walled carbon nanotubes.

Femtosecond Laser Spectroscopy of Wide Band-Gap Semiconductors

Over the past decade, there have been many experimental and theoretical studies on the optical properties of nitride semiconductors such as GaN, In$_x$Ga$_{1-x}$N, and Al$_y$Ga$_{1-y}$N crystals. In In$_x$Ga$_{1-x}$N ternary alloys, efficient photoluminescence (PL) is due to the exciton localization at potential minima. We have clarified the exciton localization processes in In$_x$Ga$_{1-x}$N ternary alloys by means of optical Kerr-gate time-resolved PL measurements. Figure 2 shows the temporal change of the PL spectra after the femtosecond laser excitation. It is clearly shown that the photogenerated carriers relax to the lower energy state within the 15 ps. Time-resolved PL spectral measurements are one of the most useful methods for understanding the exciton localization dynamics and the radiative recombination processes in semiconductor mixed crystals.

![Figure 1](image1.png)

Figure 1. 3-dimensional plot of a single-walled carbon nanotube photoluminescence image by scanning confocal microscopy.

![Figure 2](image2.png)

Figure 2. Time-resolved PL spectra of the In$_x$Ga$_{1-x}$N thin film.