Temperature-dependent near-field imaging of delocalized and localized excitons in single quantum wires

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Published in:

DOI:
10.1109/QELS.2001.961797

Published: 01/01/2001

Citation for published version (APA):

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Download date: 02. Jan. 2019
Temperaturdependent near-field imaging

In this paper, we present the first experimental evidence for such delocalized excitons in a novel QWR nanostructure. We observe that the one-dimensional confinement of excitons give rise to a strong enhancement of the exciton-acoustic-phonon coupling.

Resonant Stokes and anti-Stokes luminescence of GaAs/AlGaAs quantum dots on a (411)A GaAs surface

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Recent studies of semiconductor quantum dots (QDs) using optical micro-probing techniques have revealed many unique and interesting properties of an individual QD, such as sharp homogeneous linewidth, luminescence intermittency, optical nonlinearity and nonclassical light emission. We have investigated the µ-photon luminescence (µ-PL) and excitation (µ-PLE) spectra of GaAs/AlGaAs QDs grown on a (411)A GaAs surface. Under resonant excitation of the dot, we have observed several PL lines corresponding to discrete energy levels of the dot. Surprisingly, we found that the PL lines appear not only on the Stokes side but also on the anti-Stokes side even at low temperature.

The GaAs QDs used in this study are based on a GaAs/AlAs/GaAs quantum well (QW) grown on a (411)A GaAs surface. A small number of QDs are included in a triangular-pyramidal structure formed on the GaAs surface. We performed µ-PL and µ-PLE measurements of the single pyramidal structure at 3.8K.

The µ-PL spectrum observed from the single pyramidal structure is shown in Fig. 1(c). The µ-PL spectra detected at four luminescence lines (#1 to #4) in Fig. 1(c) are shown in Figs. 1(a) and (b). The PL spectra have several sharp peaks reflecting the discrete energy levels of the QD. Close similarity between the PLE spectra for #1 and #4, and for #2 and #3, suggests that the luminescence #1 and #4 originate from an identical dot, and #2 and #3 from another dot in a pyramid. Furthermore, it is noteworthy that the lines #4 and #3 have sharp anti-Stokes resonance at the lines #1 and #2, respectively.

Figure 2 shows the PL spectra for various excitation power under resonant excitation at the downward arrow, which corresponds to the line #4 in Fig. 1(c). One can clearly see that the PL lines appear on both the Stokes and anti-Stokes sides. The energy separation of the anti-Stokes PL ranges over more than 6 meV. Because the spectra were taken at low temperature (3.8K), the anti-Stokes PL cannot originate from thermal excitation. To discuss the origin of the PL lines, we have analyzed the excitation power dependence of the PL line intensities. From the analysis, we found that the anti-Stokes PL lines indicated by a filled circle in Fig. 2 arises when at least two excitons are created in the QD. Thus, the anti-Stokes PL line is supposed to be caused by Auger excitation of the dots, which often results in the luminescence intermittency and photo darkening effects.

We have performed µ-PL and µ-PLE measurements of the single pyramidal structure at 3.8K. Under resonant excitation of the dot, we have observed several PL lines corresponding to discrete energy levels of the dot. Surprisingly, we found that the PL lines appear not only on the Stokes side but also on the anti-Stokes side even at low temperature. The GaAs QDs used in this study are based on a GaAs/AlAs/GaAs quantum well (QW) grown on a (411)A GaAs surface. A small number of QDs are included in a triangular-pyramidal structure formed on the GaAs surface. We performed µ-PL and µ-PLE measurements of the single pyramidal structure at 3.8K.