三重層構造を有する InAs/GaAs 量子ドットからの 1.42μm帯発光

Emission at 1.42 μm from InAs/GaAs Trilayer Quantum Dots

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InAs/GaAs bilayer quantum dots (QDs) have attracted much attention because of its potential in extending emission wavelength of GaAs-based QDs from well-developed O-band to C-band. [1-3] InAs/GaAs QD lasers based on bilayer structure have been reported lasing at 1.34 μm without InGaAs strain-reducing layer (SRL). [2] InAs/GaAs bilayer QDs without InGaAs SRL have been reported emitting at 1.4 μm at room temperature (RT). [3] In order to further extend the emission wavelength, we previously proposed a new structure named InAs/GaAs trilayer QDs. [4] In this report, we demonstrated emission at 1.42 μm from InAs/GaAs trilayer QDs without InGaAs SRL which was longer than the longest reported wavelength of the bilayer QDs.

The basic structure of InAs/GaAs trilayer QDs consists of three QD layers and two spacer layers. These QD layers are named as seed layer 1 (SL1), SL2 and active layer (AL). The strain field generates after growing the SLs and contributes to reducing the strain in the AL. It leads to the extension of emission wavelength of QDs in the AL which is optically active in the trilayer structure. Comparing to the bilayer QDs, the strain in the AL is further reduced due to the increased SLs.

Samples were grown on Si-doped GaAs (001) substrates by using a solid source molecular beam epitaxy system. As shown in Fig. 1, after thermal cleaning and growth of a GaAs buffer, the trilayer QDs were embedded in two AlGaAs barriers which were designed to enhance the carrier collection for the photoluminescence (PL) measurement. Four samples with different InAs coverages from 3.7 to 5.9 ML for the AL were prepared. Fig. 2 shows the PL results. Although the PL intensity decreased rapidly as the InAs coverage increasing, the emission wavelength was extended from 1393 to 1418 nm. The RT PL spectrum of one with InAs coverage of 5.9 ML was plotted in Fig. 3. The ground state peak located at 1418 nm with a narrow linewidth of 19.7meV. Narrow linewidth is also a kind of features of the trilayer QDs, because of the good QD size distribution which is attributed to the template effect of the SLs.

In summary, emission at 1.42 μm from InAs/GaAs trilayer QDs was achieved, which was longer than those of the bilayer QDs reported. The results experimentally proved the great potential of the trilayer QDs in the wavelength extension. Further extension of the emission wavelength using InGaAs SRL will be also discussed at this presentation.

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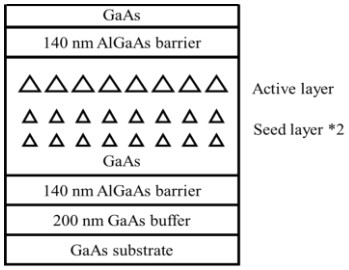

Fig. 1 Basic structure of InAs/GaAs trilayer QDs

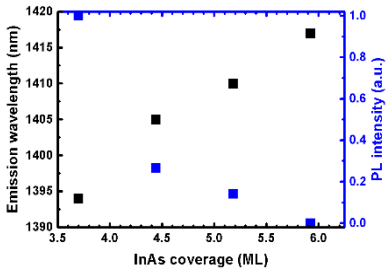

Fig. 2 InAs coverage dependence of the active layer

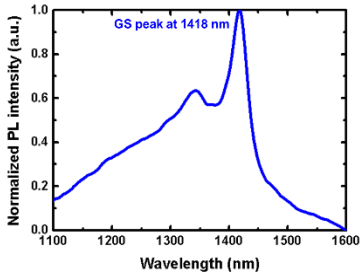

Fig. 3 RT PL spectrum of InAs/GaAs trilayer QDs with 5.9 ML InAs in the active layer

References

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