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Comparison of photoluminescence thermal stability of high quality AlGaAs/GaAs quantum wires and quantum wells

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Recently, quantum wire (QWR) structures have attracted much attention. However, to achieve high quality QWR structures, particularly QWRs with true one-dimensional (1D) features, is still a challenge for crystal growth technology. Because of the increase in surface to volume ratio in QWR compared with QWL structures, elimination of nonradiative recombination centers at interfaces is more important for QWR. Recently, very high quality V-grooved QWR structures were achieved by using improved growth techniques,[1, 2] which showed clear one-dimensional (1D) features extended over mesoscopic distances,[3] and extremely low defects and impurity density.[4] Based on the former progress in the fabrication of high quality QWR, it is very interesting to compare optical properties of high quality V-grooved QWRs with the QWL structures.

Three $Al_{0.39}Ga_{0.61}As/GaAs/Al_{0.39}Ga_{0.61}As$ single QWR structures with wire thicknesses of 2, 5, and 9 nm were grown on 4 μm pitch V-grooved GaAs (001) substrates by means of flow modulated epitaxy (FME) technique using tertiarybutylarsine as the arsenic source. The layer structures consisted of a 200 nm thick GaAs buffer layer, a 900 nm thick $Al_{0.39}Ga_{0.61}As$ barrier layer, a single FME-grown GaAs QWR layer, a 0.2 μm thick $Al_{0.39}Ga_{0.61}As$ upper barrier layer, and a 10 nm thick GaAs cap layer. By using the same system, three single QWL structures were also grown with well thicknesses of 2, 5, and 9 nm. Figure 1 shows the temperature-dependent integrated PL intensities of the QWRs and QWLs with different thicknesses. One striking feature in the figure is the integrated PL intensities of QWRs are constant within temperatures T_c of 90, 140, and 170 K for the 2, 5, and 9 nm thick QWRs respectively, while, those of the QWLs are constant within about 40 K for all the samples, and then decreases continuously.

[1]X. -L. Wang, V. Voliotis, R. Grousson, M. Ogura, J. Crystal Growth, **213**, 19 (2000). [2]X. -L. Wang and M. Ogura, J. Crystal Growth, **221**, 556 (2000). [3]A. Crottini, J.-L. Stachli, D. Deveaud, X.-L. Wang, and M. Ogura, Phys. Rev. B **63**, 121313 (R) (2001). [4]X.-Q. Liu, X.-L. Wang, and M. Ogura, Appl. Phys. Lett., 79, 1622 (2001).

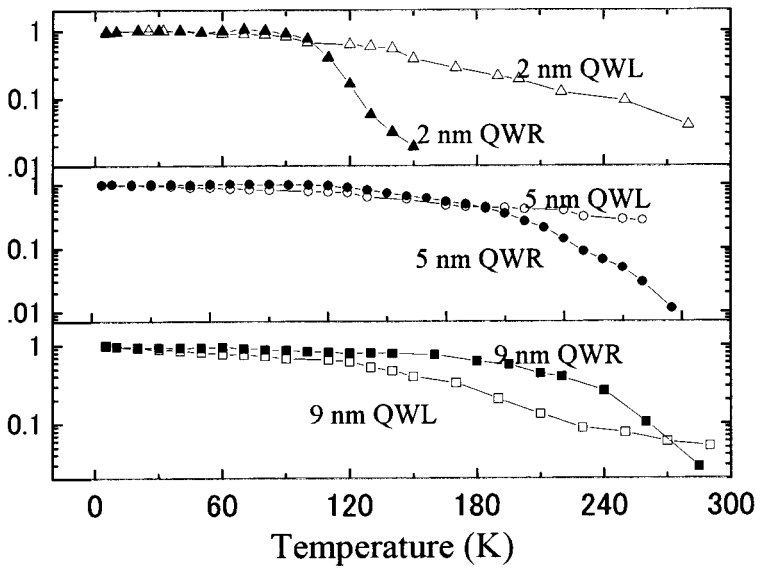

Fig.1. Comparison of temperature-dependent integrated PL intensities of QWRs and QWLs with different thicknesses.