Luminescence spectra from InGaN/GaN multi quantum disks on GaN nanorods

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Recent interests in the semiconductor research field come from the quantum dots due to the zero-dimensionality. The quantum disks with the nano-meter size also have the zero-dimensionality. The control of the form and size of the quantum dots in solids are hard, while the manufacture and the control of the form of the quantum disks are not so difficult. We have successfully produced the InGaN/GaN multi-quantum disks with different InN mole fraction of 20-30% which are grown on the GaN nanorods over the Si (001) substrates by a radio-frequency plasma-assisted molecular beam epitaxy technique. The quantum disks having 20 cycles of InGaN well layer (2 nm width) and GaN barrier (6nm width) have been grown over 100 nm GaN nanorods. The average diameter of the QDisks is 50 nm or less than that. The luminescence shown in figure is observed at various temperatures, originating from the recombination of the exciton captured at a neutral donor. The fractionation of In contents makes the half width of the luminescence wider. The confinement of the exciton in the disk compels the luminescence to shift to the higher energy side. The peak shifts to longer wavelength with temperature. In the present report, we will address the temperature dependence of the luminescence peak in the two-dimensional environment in comparison with that in the three-dimensional (bulk) environment, and discuss phonon mode interacting with the electronic band in the two-dimensional environment because the band shrinkage with temperature is caused by electron – phonon interaction.

Luminescence spectra from InGaN/GaN MQD with In content of 0.23.