

Photoluminescence of GaN quantum dots in AlN matrix.

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Group III nitrides based quantum dots (QDs) received a lot of interest lately due to their potential application as efficient light emitters in the visible and ultraviolet (UV) spectral region. In GaN/AlN QD systems the huge band gap difference (2.7 eV) between GaN and AlN. Other peculiarity of wurzite GaN/AlN systems is the electric field along the (0001) growth axis. This electric field is caused by the difference of polarizations between the barrier and dot materials [1]. In the present work we studied the photoluminescence (PL) of self-organized GaN/AlN QD structures. For revealing the nature of radiation, the spectrum of temperature dependence and time-resolved PL have been measured. The structures with GaN/AlN QDs are grown by molecular beam epitaxy (MBE) on (0001) sapphire substrate, where a AlN buffer layer (100nm) was grown. Then GaN 3D islands were formed on the AlN surface. It has been observed reflection high energy electron diffraction (RHEED) that 3D islands form even for extremely low (2ML) GaN coverage without 2D → 3D transition. The GaN islands layer was covered by 10 nm thick AlN layer. This procedure was repeated 10 times. The aspect ratio (heights diameters) of islands in our experiments was about 10/100 nm. A low-temperature PL spectrum excited by light with $E_1 = 3.81$ eV from GaN QDs sample have maximum near 2.55 eV that is about 0.9 eV below the band gap of bulk GaN (3.47 eV). Such spectrum was not observed from layers GaN and AlN. We found that the PL intensity decrease slightly with temperature from 5 – 300K, in the same way the PL spectrum shifts to the same region with delay time after laser impulse. In conclusion, the PL properties of the GaN QDs structures have been studied. The PL below GaN energy gap can be attributed to the strong electric field.

[1] F. Bernardini, V. Fiorentini and D. Vanderbilt, Phys. Rev. B 56, R10024 (1997).

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