R1-P-035802

LUMINESCENCE CONTROL OF LED HETEROSTRUCTURES GROWN BY METHOD METALORGANIC VAPOR PHASE EPITAXY ON SAPPHIRE

ZIXUAN LI, VLADIMIR I. OLESHKO, LYUDMILA V. VOROBJEVA

The National Research Tomsk Polytechnic University，Tomsk，Russia

Recently, GaN-based semiconductor heterostructures are one of the most promising optoelectronic materials [1, 2]. However, obtaining high-quality structures is accompanied by a series of difficulties. Uncontrollable impurities, intrinsic defects and dislocations formed in the crystal lattice during the growth process have a significant impact on the properties of layers and heterostructures. Therefore, the successful development of modern optoelectronics is realized by creating technologies, which can cultivate highly advanced semiconductor heterostructures. As we all know, luminescence diagnosis can control the degree of stoichiometry, the existence of impurities and defects, and determine whether the structure is suitable for manufacturing light sources [3 - 8].

Objective to study the luminescence characteristics of GaN / InGaN epitaxial layer grown by metalorganic vapor phase epitaxy on sapphire. These structures were formed in different laboratories. The excitation of luminescence inspection is realized by two methods: high current electron beam (HCEB) and nitrogen laser (λ = 337.1 nm, τ = 10 ns). The effective energy of electrons in HCEB ~ 250 keV spectrum, and the pulse duration is 15 ns. The energy density of the electron beam ranges from 0.002 J / cm^2 to 0.2 J / cm^2. The pulsed cathodoluminescence (PCL) and pulsed photoluminescence (PPL) spectra of the samples were measured at 300 K. The time resolution (~ 15 ns) spectra were recorded by the measurement system based on diffraction monochromator (MDR) - 23, photoelectric electronic multiplier PMT-84 and computer related oscilloscope Tektronix DPO 3034. The integral (pulse time) spectra of PCL and PPL stimulated spontaneously were measured by optical fiber spectrometer AvaSpec-ULS2048CL-EVO-RS.

The spectral dynamics of spontaneous PCL and PPL GaN / InGaN quantum wells are explained in the donor receptor recombination model.

It was found that the stimulus PCL spectra measured in the same sample but in different local areas were different. The change of the maximum position of the forced radiation band of GaN / InGaN quantum wells is observed in the range of 2.81 – 2.83 eV, which may be due to the change of the composition of quantum pits in different heterostructure regions.

REFERENCES

[1] Туркин.А, “Обзор развития технологии полупроводниковых гетероструктур на основе нитрида галлия (GaN),” Полупроводниковая светотехника, № 6, С.6-9, 2011.

[2] В.В.Лундин, А.Е. Николаев, А.В. Сахаров, Е.Е. Заварин,С.О. Усов, В.С. Сизов, А.Л. З акгейм, А.Е. Черняков, А.Ф. Цацульников, “Высокоэффективные InGaN/GaN/AlGaN светодиоды с короткопериодной InGaN/GaN сверхрешеткой для диапазона 530−560 nm,” Письма в ЖТФ, Т. 36, № 22, С, 89–95, 2010.

[3] С.Г.Горина, Ли Цзысюань, А.В.Сычева, “Время-разрешенная люминесцентная спектроскопия эпитаксиальных слоев GaN, выращенных на подложках Al_2O_3,” Современные техника и технологии : сборник докладов XX Международной научно-практической конференции студентов, аспирантов и молодых ученых, Томск, Россия, С.103-104, 2014.

[4] Andrianov, V.Yu. Nekrasov, N.M. Shmidt, E.E. Zavarin, A.S. Usikov, N.N. Zinov’ev, M.N. Tkachuk, “Low-temperature time-resolved photoluminescence in InGaN/GaN quantum wells,” Физика и техника полупроводников, Т, 36, № 22, С,679-684, 2002.

[5] Домрачева, Я. В. и др, “Исследование многослойных светодиодных гетероструктур на основе InGaN/GaN методами рентгеноспектрального микроанализа и катодолюминесценции,” Поверхность. Рентгеновские, синхротронные и нейтронные исследования. № 8. С. 10-15, 2009.

[6] V. I. Oleshko, S. G. Gorina, S. V. Lazarev, V. V. Lopatin, “Effect of dislocation density on exciton luminescence intensity of GaN epitaxial layers,” Изв. вузов. Физика, Т. 57, № 12/3, С. 62-65, 2014.

[7] В. И. Олешко, С. Г. Горина, В. И. Корепанов, В. М. Лисицын, И. А. Прудаев, О. П. Толбанов, “Люминесценция тонкопленочных светодиодных структур при возбуждении сильноточным электронным пучком,” Изв. вузов. Физика. Т. 56, № 1, С. 55-58, 2013.

[8] В. И. Олешко, С. Г. Горина, В. И. Корепанов, В. М. Лисицын, И. А. Прудаев, О. П. Толбанов, “Суперлюминесценция светодиодных гетероструктур при возбуждении сильноточным электронным пучком,” Изв. вузов. Физика. Т. 56, № ½, С. 175-177,2013.