GaN 界面揺らぎ量子ドットにおける発光ピーク線幅の低下
Reduction of the linewidth of the emission lines from a GaN interface fluctuation quantum dot

°高 亢 [1], 有田 宗貴 [1], M. Holmes[1, 2], 荒川 泰彦 [1]
1. 東大ナノ量子機構, 2. 東大生研
°K. Gao[1], M. Arita[1], M. Holmes[1, 2] and Y. Arakawa[1]
1. NanoQuine, 2. IIS, Univ. of Tokyo
E-mail: pandagk@iis.u-tokyo.ac.jp

III-Nitride semiconductor materials have enjoyed great success in many practical fields such as light emitting diode (LED) and laser structures. III-Nitride quantum dots (QDs) are also useful for achieving single photon emission with many advantages, such as a wide emission wavelength range, the possibility of high temperature operation, and very recently, single photon emission with high purity[1]. However, spectral diffusion broadened linewidths of III-Nitride QDs are generally over an order of magnitude larger compared with other materials such as Arsenide QDs. Recently, however, MOCVD grown GaN interface fluctuation QDs have been shown to exhibit much improved, narrower, linewidths [1].

In this work, we investigate the emission linewidths of a GaN interface fluctuation QD under various excitation conditions. The sample was held in a continuous-flow helium cryostat, cooled to 5K, and excited by a tunable ultrafast UV pulsed laser (200fs pulses at 80MHz). Micro-photoluminescence was directed to a 75cm-length spectrometer with a 2400mm^{-1} diffraction grating, and emission spectra were detected using an attached nitrogen cooled CCD array. Second order diffraction was used to enhance the resolution of emission spectrum to a limit of ~35μeV. Figure 1 shows the full width at half maximum (FWHM) of our studied single QD as a function of the excitation laser wavelength, from 270nm to 310nm (4.59eV→3.88eV) at the same power. Figure 2 reveals the FWHM while changing the excitation laser power under 310nm pulse laser excitation. We can observe that both the reduction of the excitation photon energy and laser power are helpful to suppress linewidth broadening from ~120μeV to ~80μeV. This resulting spectral diffusion suppression is likely due to a reduction in the number of itinerant carriers excited in the vicinity of the QD. The linewidths measured here are comparable with the lowest emission linewidths obtained under CW excitation in of the same structures [1]. This information provides hope that we may be able to control the emission linewidth, and will be important for the future quantum applications such as the generation of the indistinguishable photons by using this material system.

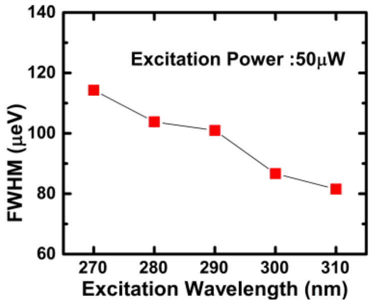

Figure 1: Excitation laser wavelength dependent emission linewidth.

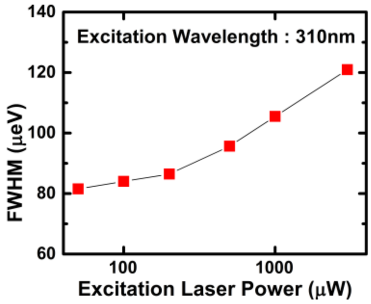

Figure 2: Excitation power dependent emission linewidth.

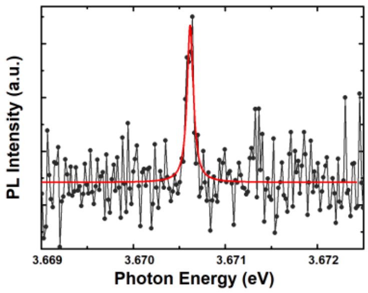

Figure 3: Suppressed emission linewidth of ~80 μeV.

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References: [1] M. Arita, *et al.*, Nano Letters, 17(5) 2902 (2017).