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立方晶 GaN/AlN 自己形成量子ドットの単一量子ドット分光
Single Dot Spectroscopy of Cubic GaN/AlN Self-Assembled Quantum Dots

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Because of their strong exciton binding energy and their large band offsets, GaN quantum dots (QDs) are promising solid state emitters for novel devices operating at high temperature such as nanolasers or single photon sources. However the potential of polar GaN QDs is hindered by the presence of a giant built-in electric field that extends their radiative lifetime and broadens their spectral linewidth via an enhanced spectral diffusion. Because of the absence of polarization in the zinc-blende phase of group-III nitrides, cubic GaN QDs are a good alternative to their wurtzite counterpart and should exhibit reduced spectral diffusion and much shorter radiative lifetimes [1], but the spectroscopy of single cubic GaN QDs have been so far very limited [2]. In this work, we study by microphotoluminescence (μPL) the optical properties of single cubic GaN QDs confirming their fast radiative recombination, their limited spectral diffusion and their high-temperature operation.

Stranski-Krastanov cubic GaN/AlN QDs are grown by plasma-assisted molecular beam epitaxy on a 3C-SiC/Si(100) substrate [3]. Single lines originating from exciton recombinations can be found on the higher energy side of the QD ensemble PL. Time-resolved measurements show that the radiative lifetime of such excitons is shorter than 520 ps, evidencing the absence of a giant built-in electric field. As a result, the spectral diffusion is much smaller than in polar GaN QDs so that resolution-limited linewidths as narrow as 500 ± 50 μeV can be observed, the narrowest reported so far in GaN QDs. Despite a significant phonon broadening, the excitons can be observed at temperatures as high as 205 K (Fig. 1 (a)), confirming good prospects for their use in devices operating at high temperature.

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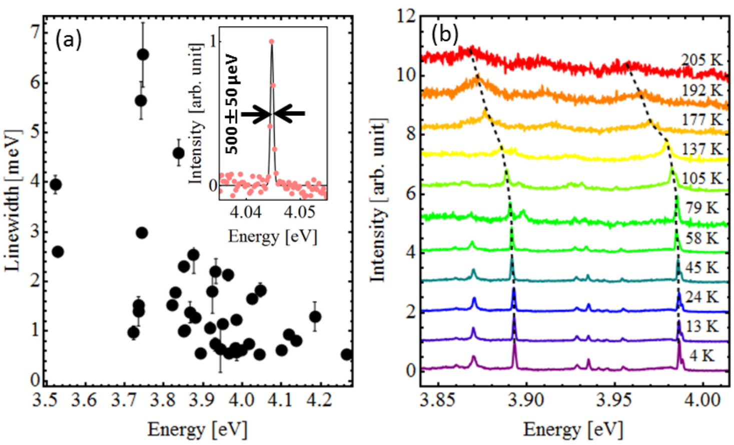

Fig. 1 (a) Linewidths of all the observed single QDs. The vertical bars correspond to the error on a Gaussian fit to the μPL spectra. Inset is the spectrum of the narrowest line. The black line is a Gaussian fitting to the data. (b) Temperature dependent μPL spectra of single QDs between 4 K and 205 K. The dashed lines are guides for the eyes.

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