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立方晶 GaN/AlN 量子ドットの単一量子ドット偏光特性

Polarization Properties of Single Zinc-Blende GaN/AlN 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 exhibit reduced spectral diffusion and much shorter radiative lifetimes [1], but the spectroscopy of single cubic GaN QDs has been so far very limited [1-3]. In this work, we study by microphotoluminescence (μPL) the polarization properties of zinc-blende GaN/AlN quantum dots (QDs) grown by plasma-assisted molecular beam epitaxy for two different growth processes: the droplet epitaxy (DE) technique and the Stranski-Krastanov (SK) growth mode [4].

We perform a statistical analysis of the polarization properties of single QDs and show that they can be tailored through their growth process. The polarization orientation of individual SK QDs is commanded by orthogonal antiphase domains (APD∥ and APD⊥) that are present in the SiC pseudo-substrate (Fig. 1(c)) and the degree of linear polarization (DLP) is always larger than 95% (Fig. 1(a)). On the opposite, single DE QDs are blind to such domains (Fig. 1(d)) and significantly smaller DLPs can be found, down to 28% (Fig. 1(b)). Additional 8-band *k.p* calculations performed for truncated-pyramid ZB GaN QDs show that QD elongation alone cannot explain the large DLP obtained in SK QDs and suggests that strain has a significant effect on their polarization properties.

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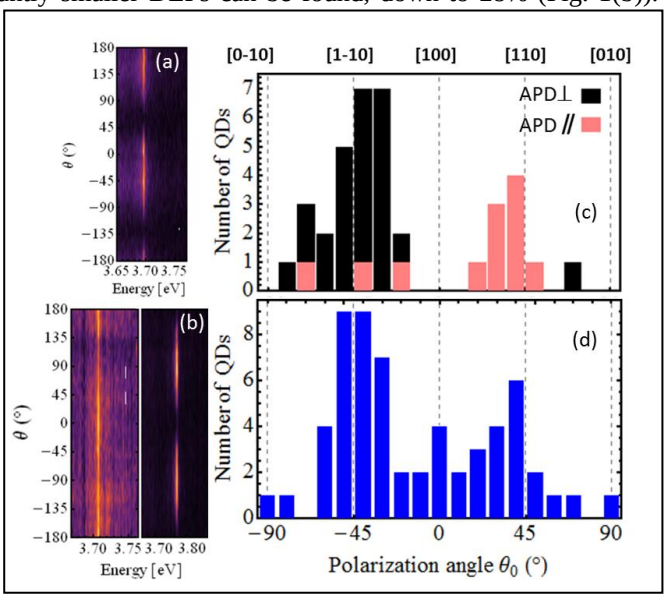

Fig. 1 Polarization-dependent μPL spectra of (a) a typical SK QD (DLP = 98%) and for (b) two typical DE QDs presenting DLP = 28% and DLP = 91%. Statistics of the polarization orientations of (a) single SK QDs and (b) single DE QDs.

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