GaN/AlN 量子ドット・ブルズアイ紫外単一光子源の光学特性

Optical Properties of GaN/AlN Quantum-Dot-Bullseye UV Single Photon Emitters

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GaN/AlN quantum dots (QDs) are very promising solid-state single photon sources, which are required for applications such as on-chip optical transmission in quantum communication systems and optical quantum computing [1]. Much progress has been made toward the high-performance (in terms of single-photon purity and extraction efficiency) for the practical use of III-nitride QDs single photon sources [2]. In recent years, bullseye photonic structures [3] (composed of circular Bragg gratings) have been adapted for III-nitrides and fabricated by our team. Such structures in principle direct the emission into the vertical out-of-plane direction, so that the emission can be collected with an objective lens [3,4]. In this presentation, we discuss the optical properties of such devices, including simultaneous analysis of the second-order correlation function and the photon extraction efficiency. We demonstrate that the single photon purity of the device can be increased while maintaining an enhanced photon rate beyond the as-grown-QD limit, by optimizing the excitation and measurement bandwidth condition of the optical measurement. The dependence of the QD emission intensity and $g^{(2)}[0]$ value on the excitation power (see fig.1) shows that background contamination is the major cause of the non-zero $g^{(2)}[0]$ value in our QD-bullseye structure, which we expect can be further suppressed by reducing the density of dots during the sample growth.

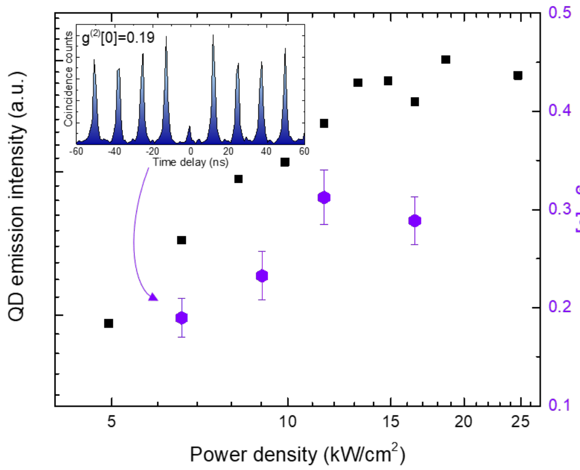

Figure 1. Characterization of power dependence of emission intensity and $g^{(2)}[0]$ value of a QD-bullseye structure. The inset shows an increased single photon purity, yielding a value of $g^{(2)}[0]=0.19$ under a lower excitation power density of 6.6 mW/cm^{-2} (top left).

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