GaN 界面揺らぎ量子ドットを用いた高純粋度単一光子発生
High Purity Single Photon Emission from a GaN Interface Fluctuation Quantum Dot

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Single Photon Sources (SPSs) are now an extensive research subject thanks to their possible applications in secure communication and quantum information processing. Quantum Dots (QDs) have shown promising results for the realization of SPSs thanks to their remarkable physical properties. III-Nitride QDs, with their large band offsets and wide range of bandgaps, allow operation up to high temperature at wavelengths ranging from the UV all the way to the IR [1]. In recent years, GaN interface fluctuation QDs [2-4] have been developed and show exciting emission properties such as narrow emission linewidths (down to 87 μeV) and single photon emission. In this study, we present measurements of high purity single photon emission from an interface fluctuation quantum dot, and furthermore show that the dots themselves can operate at temperatures up to 77K.

Micro photoluminescence experiments were conducted using a 266 nm continuous wave laser. Thanks to the low QD density, emissions from individual dots were distinguishable without any processing. Photon autocorrelation measurements were performed on an isolated dot using a Hanbury-Brown & Twiss Setup, and the data, which reveals clear single photon emission via strong antibunching, is shown in figure 1. In figure 1a we plot a $g^{(2)}(\tau)$ autocorrelation measurement performed on a QD using a low excitation power of 25μW. The low power was used to remove any spectral background, and results in a measured raw $g^{(2)}(0)$ value of 0.085. This value is the lowest ever reported for a III-nitride QD, and is actually limited by the detector response function. A fitting which takes this into account (green and red lines in figure 1a) reveals a deconvolved $g^{(2)}(0)$ value as low as 0.02±0.05, showing the remarkable nature of these dots. Next we measured the temperature dependence of the autocorrelation using larger excitation powers (see figure 1b). As the temperature is increased, the signal-to-background ratio of the emission progressively worsens, resulting in an increase in the measured value of $g^{(2)}(0)$. However, we find that after correction for the uncorrelated background emission, all measured values of $g^{(2)}(0)$ become almost zero to within the experimental error, revealing that the QD itself is acting as a good SPS. Although the lateral confinement in these fluctuation dots is expected to be weaker than traditional SK QDs, it is expected that this 77K value is not a fundamental limit to the operational temperature of the devices. Further increase in operational temperature is expected after removal of the GaN layer which is the source of the spectral contamination.

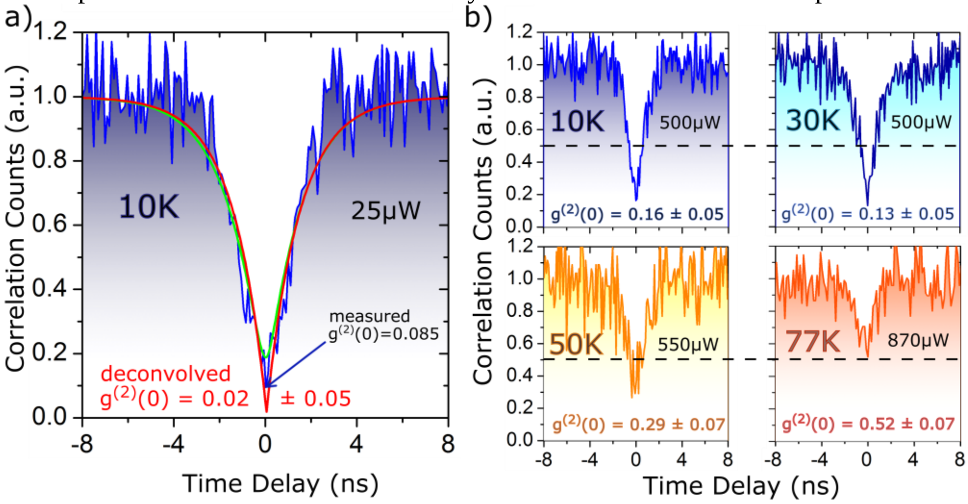

Figure 1: Autocorrelation measurements on a single GaN fluctuation QD. a) Single photon emission with high purity at 10K. b) Single photon emission at higher temperatures, after correction all measured values of $g^{(2)}(0)$ become almost zero to within the experimental error.

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