Charaterization of suitable excitation parameters for quantum defects in GaN

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Semiconductors hosting defect-based single photon emitters are promising for realizing integrated photonic platforms. Such devices provide attractive possibilities for realizing on-chip quantum computations. A combination of highly efficient emitter with a host material that has mature technology of microfabrication is highly desired. Recent study shows that nonradiative processes dominate at smaller transition energies [1], which could explain the difficulty in obtaining emitters in the infrared region. GaN has been reported to host bright emitters in the visible range [2,3], which maintain strong emission in the zero-phonon-lines even at room temperatures. In combination with mature techniques of growing and etching high-quality GaN into the desired nanophotonic structures this sets an excellent perpsective for establishing a novel nanophotonic platform.

Despite many advantages, the origin of the single photon emitters states in GaN is not fully known to the scientific community. Also, the dephasing mechanism and energy level structures of the emitters are debated in the literature. To fully take advantage of quantum applications of such states, more information about their energy structure and excitation dynamics is required. Here, we present our results on relevant excitation parameters of defect states in GaN.The sample consists of two GaN layers grown on a sapphire substrate. The carbon concentration in top GaN layer was intentionally varied to control the number of emitters in visible spectral range. We analyzed how different carbon concentrations impact the emitter density and intensity of emission. Later we performed photo luminescence excitation measurements at low temperatures to find that most of them can be optimally excited by around 540 nm excitation. Some emitters were found to follow sharp resonances in the emission with the change in excitation wavelength. We attribute the resonances to multi-phonon assisted excitation. We also performed time scans at resonance excitations to find that the emitters are stable in terms of linewidths and intensity. The results open new pathways for future studies and applications of the defects.

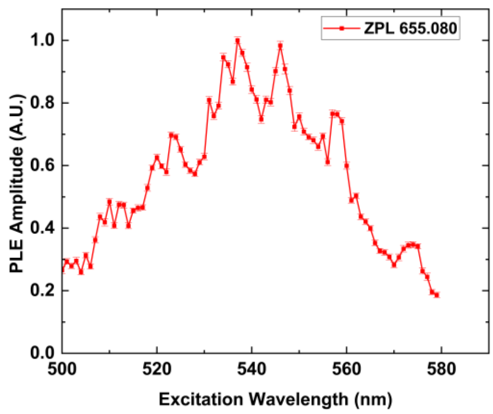

Figure 1. PLE signal of an emitter, gaussian fit amplitude vs excitation wavelength, with zero phonon line at 655 nm .

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