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Classical and Quantum Light Generation with Nitride-based Semiconductor Nanostructures

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We present various types of group III-nitride micro- and nano-structures for novel classical and quantum photonic applications. We demonstrate phosphor-less white-color light generation, unidirectional light propagation, ultrafast single photon generation, and room temperature exciton-polariton generation using these group III-nitride based photonic structures. First, multi-color and broadband visible light emitting diodes based on GaN hexagonal truncated pyramid and columnar structures were demonstrated [1, 2]. Second, by using GaN/InGaN core–shell QW semiconductors grown on tapered GaN rods, which have a large gradient in their bandgap energy along their growth direction, highly asymmetric photonic diode behavior was observed [3]. Third, we utilized a novel approach of the self-aligned deterministic coupling of single quantum dots (QDs) to nanofocused plasmonic modes, which enhances spontaneous emission rate of QDs as high as ~ 22 over a wide spectral range [4]. We also discuss about effective method for enhancing collection efficiency of the QDs formed in these photonic structures [5]. Finally, we developed a novel exciton-polariton system working at room temperature resulting from strong coupling between a two-dimensional exciton and whispering gallery mode photon using a core–shell hexagonal wire with GaN/InGaN multiple quantum wells [6]. An overview and comparison of the characteristics of the above nanostructures will be given.

References

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