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Simulations of Optical Properties of III-Nitride Quantum Dots and Nanowires

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Abstract. Nanostructures based on III-nitride semiconductors offer certain advantages for realization of single-photon sources and classical light emitters. Larger band offsets and effective masses lead to strong quantum-confinement effects which enable the operation of devices at higher temperatures. Wide band gap of III-nitrides leads to the emission in the blue and ultraviolet spectral range, which is not accessible with most of the other materials. In this work, simulation insights into the light emitting properties of III-nitride quantum dots and nanowires will be presented.

We performed the calculations of excitonic and biexcitonic states in self-assembled GaN/AlN quantum dots with special emphasis on the use of these dots for single-photon source applications [1]. Theoretical methodology for calculation of single-particle states was based on 8-band strain-dependent envelope function Hamiltonian, with the effects of spin-orbit interaction, crystal-field splitting, and piezoelectric and spontaneous polarizations taken into account. Exciton and biexciton states were found using the configuration-interaction method. Optimal dot heights for their use in single-photon emitters were determined for various diameter-to-height ratios.

Next, we investigated the electronic properties of InGaN quantum structures embedded in site controlled GaN nanowires [2]. The InGaN structures under consideration consist of two sections: the middle one, which is formed on the polar c-facet, and the side one, which is formed on the semi-polar r-facets. These structures exhibit two-color emission at 384 nm and 488 nm. We identified that the main origin of two-color emission is higher In incorporation on the nanowire polar c-facet, while the influences of internal electric field and strain are less significant.

REFERENCES

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