Temporal and spatial recombination dynamics in nitride-based nanostructures

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Recent progress in the nitride-based light emitting devices has been contributed from the development of the growth technology of InGaN/GaN/AlGaN hetero interfaces. Although the emission wavelength can be tuned from infrared to ultraviolet by controlling In mole fraction in InGaN active layers, good device performance is only in the limited range from about 365 nm to 480 nm for operating light emitting diodes and laser diodes. Two major factors, degree of potential fluctuation [1,2] and piezoelectric fields, have to be taken into account to interpret the emission mechanism [3-6] in these layers because the former leads to the exciton/carrier localization, and the latter to the quantum confined Stark effect [7, 9]. Degenerated pump and probe spectroscopy has been employed to assess which factor plays an important role. Moreover, photoluminescence mapping with scanning near-field optical microscopy [8, 10] has revealed the clear correlation between micro/nano structures in InGaN and diffusion, localization, radiative and nonradiative recombination processes. Furthermore, blinking phenomena as well as photo-memory effects were observed in samples emitting at blue-green to green spectral range. The former is the simultaneous switching of PL intensity between bright state and dark state at local points with time scale of sub-second, and the latter is gradual increase or decrease of PL background intensity in accordance with continuous wave (CW) photo-excitation, both of which suggests the importance of trapped carriers on the oscillator strength of localized carriers/excitons.

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