Light emission in nitride based devices under hydrostatic pressure

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One of the issues of light emitters with InGaN/GaN QWs grown along the polar c-direction of the wurtzite crystal is the strong polarization-induced electric field (F_{Tot}). Its influence on the band structure and the emitted light wavelength/energy is determined by so called Quantum Confined Stark Effects (QCSE). It consists of built-in macroscopic polarization and p-n junction related contributions causing bending of the potential profile. During device operation, applied driving current (I_D) introduces carriers to the active region, which causes electroluminescence but at the same time a screening of F_{Tot} takes place. Resulting magnitude of the QCSE is not well understood, e.g., we observed that with increasing I_D the emission energy (E_{EL}) increases non-monotonically. We distinguish two regions in the emission energy on driving current dependence: low I_D region where emission energy rises significantly and region of high I_D where saturation of E_{EL} occurs.

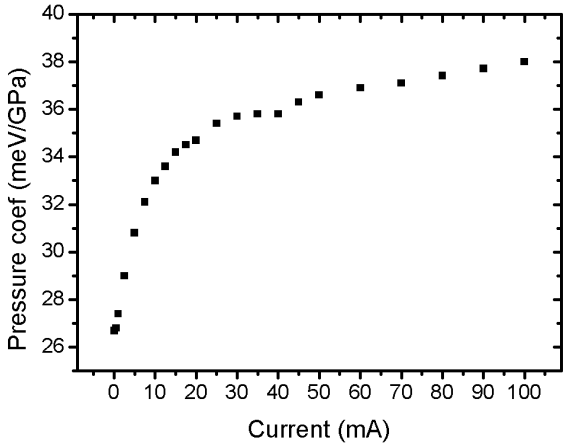

Fig. 1. Pressure shift of the electroluminescence energy as a function of driving current in LD, T=300K.

In this work we performed measurements of hydrostatic pressure dependence of E_{EL} at different driving currents to examine the microscopic mechanisms responsible for the above described behavior in light emitting diodes (LEDs), superluminescent diodes (SLEDs), and laser diodes (LDs). We found similar dependences of emission energy E_{EL} and pressure coefficient (dE_{EL}/dp) on driving current. In particular, we observed strong increase of E_{EL} and dE_{EL}/dp at low driving currents, I_D, and a saturation at high I_D towards the bandgap value of dE_G/dp.

Results obtained for nitride light emitters are in contrast to literature reports on similar experiments performed on GaAs-based devices. For arsenide LEDs and LDs, dE_{EL}/dp and dE_L/dp always show evolution corresponding to pressure variation of their QW band gap. We discuss the above described phenomena in terms of the QCSE screening and the band-tail filling effects.

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