III-NITRIDE BASED HETEROSTRUCTURES ON SILICON FOR OPTICS AND ELECTORINCS APLICATIONS

(приглашенный доклад)

G. P. Yablonskii[1], E. V. Lutsenko[1], H. Kalisch[2], R. H. Jansen[2], B. Schineller[3], M. Heuken[2,3]

[1] Institute of Physics of NAS Belarus, Minsk, Belarus;
[2] Institut für Theoretische Elektrotechnik, RWTH Aachen, Germany;
[3] AIXTRON AG, Kackertstr. 15-17, 52072 Aachen, Germany.

Modern level of electronics requires larger carrying capacity of the communication optoelectronic channels between separate elements of the silicon chips, interaction and self-organization of the silicon chips by means of ultra-high frequency channels, integration of various sensor devices into the silicon chips. In this work, optical, laser and electrical properties of InGaN/GaN multiple quantum well (MQW) and electroluminescent test (ELT) heterostructures as well as AlGaN/GaN heterostructures with 2D electron gas for high electron mobility transistors (HEMT) grown on silicon substrate are considered. Principal possibility of integration into silicon electronics of such elements as GaN-based LEDs, LDs and HEMTs is shown.

High-quality InGaN/GaN MQWs and InGaN/GaN MQW electroluminescent test (ELT) heterostructures on silicon substrates were fabricated and investigated. In InGaN/GaN MQW laser action was obtained up to 360°C with threshold ~25 kW/cm^2 at room temperature. Maximal wavelength of MQW lasers was 480 nm. It was shown that it is possible to create InGaN/GaN MQW laser on Si emitting in the green spectral region that is important for optoelectronic communications and sensors on plastic waveguides. Green CdSe quantum dot lasers pumped by emission of both InGaN/GaN MQW laser grown on Si and commercial InGaN LD were created. InGaN/GaN ELT heterostructures with cutoff voltage of about 3 V were fabricated. The active region of these ELTs has excellent quality that is demonstrated by the low laser threshold I_{thr} = 77 kW/cm^2 (λ=432.5 nm) at optical excitation into GaN:Mg layer. In such a way principal possibility of fabrication of InGaN/GaN laser diodes grown on Si was demonstrated.

AlGaN/GaN HEMT heterostructures with piezoelectric fields ~500 kV/cm (from photoreflection) and positive gain up to 18.9 GHz were created with 2D electron gas sheet density Ns = $1.5\cdot10^{13}$ cm^{-2}, charge carrier mobility μ = 1500 cm^2/Vs, transconductance G_{ext}=268 mSm/mm (gate length is 0.5 μm), and maximal drain current 600 mA/mm (gate length is 1 μm).

Thus the basic opportunity of creation of the microwave and optoelectronic devices compatible with silicon electronics is shown.