MBE Growth and Optical Properties of GaN, InN and A^3B^5 Nanowires on SiC/Si(111) Hybrid Substrate

R. R. Reznik [1,2,4,5], I. V. Ilkiv [1], K. P. Kotlyar [1], I. P. Soshnikov [1,3,4], I. V. Shtrom [1,3,4], E. V. Nikitina [1], S. A. Kukushkin [6], A. V. Osipov [6] and G. E. Cirlin [1,4,5]

[1] *St-Petersburg Academic University – Nanotechnology Research and Education Centre RAS, Khlopina 8/3, St-Petersburg, Russia*
[2] *Peter the Great St.Petersburg Polytechnic University, Polytechnicheskaya 29, St-Petersburg, Russia*
[3] *Ioffe Physical Technical Institute RAS, Politekhnicheskaya 26, St-Petersburg, Russia*
[4] *Institute for Analytical Instrumentation RAS, Rizhsky 26, St-Petersburg, Russia*
[5] *ITMO University, Kronverkskiy pr. 49, St-Petersburg, Russia*
[6] *Institute of Problems of Mechanical Engineering Russian Academy of Science, Bolshoj 6, St-Petersburg, Russia*

The wide-gap nanoheterostructures based on GaN are of great interest for creating electronic and optoelectronic devices [1]. Works in growing GaN layers on silicon [2] have been very promising recently. However, the lattice misfit of such materials is 17%, which leads to the formation of defects of different nature It is known that the optoelectronic GaN based devices can operate for a long time without degrading despite the high density linear defects. Nevertheless, to extend the lifetime of optoelectronic devices is necessary to increase the perfection of GaN structures.

In this work, in order to reduce the number of misfit dislocations a nanometer (about 50 nm) buffer layer of SiC was used. It is grown on Si by solid-phase epitaxy, which provides extremely low val-ues of the density of misfit dislocations, since the difference in the lattice parameters is only 3%, and also, instead of a planar layer, growth GaN nanowires (NWs), which can radically reduce the density of structural defects.

Growth experiments are carried out using Riber Compact12 MBE setup equipped with the effusion Ga cell and the nitrogen source. Growth time of GaN NWs was 16 hours.

After the growth, the samples are studied by applying the scanning electron microscopy (SEM) and low-temperature photoluminescence (PL) techniques.

Comparison of photoluminescence spectra of grown GaN/SiC/Si and the most successful GaN NWs structures on silicon. The figure shows that the intensity of radiation grown on SiC buffer layer GaN NWs is more than two times higher than the intensity of the best grown on silicon structures of GaN. This fact leads to the conclusion that grown in this work structures have fewer defects compared with GaN NWs on silicon substrate, which, in its turn, have few defects. This is caused by a smaller lattice constant mismatch between GaN and SiC as compared with GaN and Si.

Moreover, a possibility of A^3B^5 GaAs, AlGaAs and InAs nanowires growth on a silicon substrate with a nanoscale buffer layer of silicon carbide has been demonstrated for the first time. The diameter of these NWs is smaller than diameter of similar NWs which were grown on a silicon substrate, because of significant lattice mismatch. In particular, InAs NWs diameter was less than 10 nm. In addition, based on photoluminescence measurements, it was found that, in case of AlGaAs NWs growth on such substrates, complex structure forms due to the self-organized AlGaAs quantum dot with lower composition of aluminum embedded in NWs body.

[1] S. J. Pearton, F. Ren, *Adv. Mater*. **11**, 1571 (2000).
[2] I. G. Aksyanov, V. N. Bessolov, S.A. Kukushkin, *Techn. Phys. Lett*. **34**, 479 (2008).