

# **Modification of luminescence of the nitride nanowires by chemical treatment of their surface**

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Although the influence of surface conditions on transport and optical properties of semiconductor nanowires (NWs) has been identified, the methods of controlling it and inhibiting its detrimental impact on the NW characteristics still remain an important subject of research. As the depth of the depletion or accumulation layer induced by surface band bending may become comparable with the diameter of the NW, its part available for transport, charge carrier injection and light generation can be markedly reduced. This applies also to NWs made of the group III nitrides. Therefore, we carry out complementary studies of luminescence of GaN NWs vs. chemical and electronic conditions on their surfaces.

The NWs are grown catalyst-free on in-situ nitradated Si (111) substrates by plasma-assisted molecular beam epitaxy (MBE). The morphology of the samples is assessed by scanning electron microscopy (SEM). The luminescence of individual NWs is investigated by SEM-based cathodoluminescence spectroscopy and mapping. X-ray photoelectron spectroscopy (XPS) enables us to measure the shifts of the valence band maximum with respect to the Fermi level (i.e. to deduce changes in surface band bending) as well as assess changes in the chemical composition of the surface.

We report the results of CL and XPS experiments on the GaN NWs modified by etching their surfaces in KOH and HCl solutions. Both substances are used as media that etch, deoxidize or passivate nitride surfaces [1-3]. Therefore we applied them to modify surface chemical composition and charge accumulation in view to optimize luminescence of the GaN NWs.

The CL technique enabled us to reveal changes induced in luminescence of individual NWs as well as of the ensemble of them. Cathodoluminescence line-scans helped us to follow changes in the intensity and spectrum of luminescence along the NW. The XPS experiments, carried out in an oblique configuration to probe a substantial part of the side NW surface, allowed us to follow the changes in the emission from the GaN atoms, surface contaminants (oxygen and carbon) and residues of the etching solutions. So, changes in the surface chemical composition could be assessed. Shifts of the valence band edge vs. the Fermi level showed the changes in the surface band bending. The correlation of the results acquired by both techniques evidenced the possibility to control GaN NW luminescence by surface etching.

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