Cathodoluminescence studies of individual GaN based nanowires

A. Reszka [1], A. Pieniążek[1], K. P. Korona[2], M. Sobanska[1], K. Klosek[1], G. Tchutchulashvili[1], Z. R. Zytkiewicz[1] and B. J. Kowalski [1]

[1] Institute of Physics, Polish Academy of Sciences, Al. Lotnikow 32/46, 02-668 Warsaw, Poland

[2] Institute of Experimental Physics, Warsaw University, Hoża 69, 00-681 Warsaw, Poland

III-N family nanowires (NWs) grown on Si substrates have attracted a lot of attention due to their promising applications in optoelectronic nano-devices. Their main advantage over planar layers is high surface-to-volume ratio. Small contact area of GaN with Si substrate allows easy elastic accommodation of misfit strain and reduction of related extended defects.

In this work we studied morphological and local optical properties of GaN based nanowires with the use of scanning electron microscopy (SEM) and cathodoluminescence spectroscopy (CL). These two techniques combined together enabled us direct nano-scale correlation of morphology, structural and optical properties of nanowires.

Undoped GaN, GaN-AlN and GaN:Mg-GaN:Si nanowires were grown on in-situ nitridized Si(111) substrates without catalyst by plasma-assisted molecular-beam epitaxy (see [1] for details). CL measurements were performed at room and liquid helium temperatures. CL spectra and spatially resolved panchromatic and monochromatic maps were recorded on NW ensembles as well on the individual NWs.

The CL linescans along individual NW with p-n junction (Fig. 1) enabled us to record spectra of subsequent parts of the nanowires, identify their characteristic spectral features and correlate their chemical composition, expected band structure and observed optical properties. In particular, the intensity and energy position of wide donor-acceptor recombination (DA) band and excitonic luminescence (DX) line were analysed.

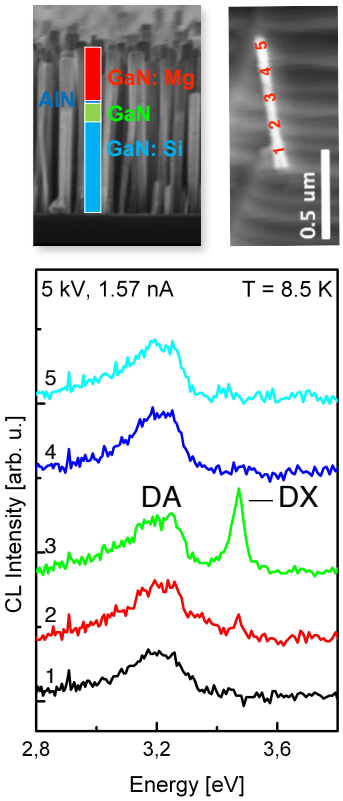

Fig 1. Schematic illustration of the structure of p-n nanowire and CL spectra taken at subsequent positions on the individual nanowire with wide donor-acceptor recombination (DA) band dominating on doped GaN and sharp donor-bound exciton (DX) 3.47 eV on the undoped part of the nanowire.

This work was partly supported by the Polish National Science Centre (NCN) Grant No. DEC-2012/07/B/ST5/02484 and by the European Union within European Regional Development Fund, through grant Innovative Economy (POIG.01.01.02-00-008/08 NanoBiom).

[1] A. Wierzbicka, Z. R. Zytkiewicz, S. Kret, J. Borysiuk, P. Dluzewski, M. Sobanska, K. Klosek, A. Reszka, G. Tchutchulashvili, A. Cabaj, and E. Lusakowska, *Nanotechnology* **24**, 035703 (2013)