Magnetoluminescence of excitonic emission in gallium nitride nanowires

P.S. Perkowska[1], M.R. Molas[2], A. Reszka[3], K.P. Korona[1], M. Sobanska[3], K. Klosek[3], M. Potemski[2], A. Wysmołek[1], Z.R. Zytkiewicz[3]

[1] *Faculty of Physics, University of Warsaw, Hoza 69, 00-681 Warsaw, Poland*
[2] *Laboratoire National des Champs Magnétiques Intenses, CNRS-UJF-UPS-INSA, 25, avenue des Martyrs, 38042 Grenoble, France*
[3] *Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, 02-668 Warsaw, Poland*

Due to excellent physical and optical properties gallium nitride (GaN) is an important semiconductor for current optoelectronic technology. Nowadays mainstream experiments on GaN are focused on low dimensional structures, like quantum well, quantum dots, microcavities and nanowires (NWs). In the case of nanowires, the role of surface effects, electric field fluctuations and defects in optical processes is still not well understood.

In this communication low temperature micro-photoluminescence (micro-PL) at magnetic field up to 14 T, time-resolved photoluminescence (TRPL) and electron microscopy (SEM) experiments performed on ensemble of GaN NWs as well as on single GaN NWs deposited on various substrates are presented. The GaN NWs (with a length of about 1-2 μm and a diameter of 30-50 nm) were grown catalyst-free by MBE on Si(111). Then they were cut off from the Si substrate using methanol ultrasonic bath and deposited on a desired substrate. SEM studies showed that main part of NWs formed self-arranged groups on the substrate.

Micro-PL spectra are dominated by recombination of different bound exciton emissions. Interestingly, very sharp transitions were observed for nanowires deposited on a copper plate in the energy range from 3,3 eV to 3,5 eV, where narrow emission lines with a width of 0,4 meV were found. However, very narrow emission lines were also observed, on ensemble on GaN NWs. An example of the magnetic field evolution of two lines in energy 3,4201 eV and 3,4114 eV (with a width of 1,5 meV and 0,46 meV, respectively) are presented in Fig. 1. The most apparent result is strong telegraph behavior (both energy position and intensity) caused by electric field fluctuations originating at the NW surface and/or impurities and defects in placed in the vicinity of recombining excitonic complex. It is observed that some emission lines do not react on the magnetic field (such as line 1 in Fig. 1), there are lines which move towards higher or lower energies with magnetic field without noticeable splitting as well as some lines which split into 2 (as line 2 in Fig. 1) or more components.

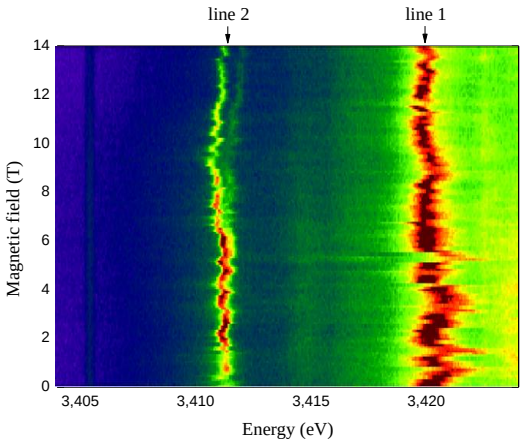

Fig. 1: Photoluminescence spectrum at magnetic field (from 0 T to 14 T) at low temperaturę (4 K) GaN nanowires.

The observed magnetic field behavior is discussed in terms of different excitonic recobination within stacking faults (which serve in NWs as a kind of quantum wells of varying widths), as well as due to emission of exctions bound to single donors, acceptors or defects located at different distances from the surface of the nanowire.

This work was supported by the Foundation for Polish Science International PhD Projects Programme co-financed by the EU European Regional Development Fund.

[1] K. P. Korona et al., *J. Luminescence* **155**, 293–297 (2014)