Project 4.3 Optical and electronic properties of nitride nanowires with tweaked surfaces (experimental)

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Unit: ON4.4
www: https://www.ifpan.edu.pl/instytut-fizyki-pan/oddzialy-naukowe/oddzial-fizyki-i-technologii-nanostruktur-polprzewodnikow-szerokoprzerwowych/on4-4-zespol-mikroskopii-i-spektroskopii-elektronowej.html

Background:

When we consider large volume crystals, the influence of surfaces on their global properties is usually negligible. However, the smaller the element, the greater the surface-to-volume ratio, the greater the influence of the surface properties on the parameters of the entire system. So, for the objects of reduced dimensionality and nanometer size, surface properties became the priority research subject. Simultaneously, quasi one dimensional structures – nanowires – are considered as the basis of development useful devices. The influence of the surface can be, nevertheless, so strong that the part of the nanowire available for charge transport, charge carrier injection and light generation is markedly reduced. Therefore, the aim of the carried out project is to identify and comprehend the phenomena that occur at the surfaces of GaN/AlGaN nanowires and may be used to reduce surface-related suppression of carrier transport and luminescence in nanowires, acting as serious factor impairing characteristics of heterostructures or devices built into the nanowires.

Aim:

The aim of the project is to identify and comprehend the phenomena that occur at the surfaces of GaN/AlGaN nanowires (NWs) and may be used to reduce surface-related suppression of carrier transport and luminescence in NWs, acting as serious factors impairing characteristics of devices built into the NWs.

The surface properties will be modified by a chemical method or coating with oxides. The obtained systems will be studied with use of surface sensitive techniques – X-ray photoelectron spectroscopy (XPS) and polarization dependent X-ray absorption spectroscopy (XAS) (in a surface sensitive mode). Optical and electronic properties of individual nanowires would be investigated by spectroscopic and mapping techniques based on scanning electron microscopy – cathodoluminescence (CL) and electron beam induced current (EBIC). Global properties of the sets of NWs will be assessed by photoluminescence and X-ray diffraction. All the acquired data will be used to get insight into the links between the surface phenomena and opto-electronic properties of nitride NWs and NW-based nanostructures.

The successful candidate will participate in the preparation of the nanowires and modification of their surfaces. Main tasks of the candidate will consist in participation in extended studies of the nanowire surface properties by scanning electron microscopy, EDX, CL spectroscopy and mapping, electron beam induced current (EBIC) experiments and XPS measurements in the Institute of Physics as well as XAS experiments at the synchrotron radiation facility.

Requirements:

- Master's degree in physics, nanostructure engineering, materials science or equivalent,
- overall knowledge of semiconductor physics,

- proficiency in English suitable for reading scientific literature, writing scientific papers, and everyday communication (formal certification would be an asset),

The following skills would be advantageous:

- experience in scanning electron microscopy, EDX, cathodoluminescence experiments,
- experience in optical investigations of solids,
- experience in chemistry lab work

Funding:

Scholarship: grant funding of 5000 PLN per month, before subtracting obligatory employer and employee social security contributions (~15%), for 36 months. Afterwards, standard Polish PhD scholarship (about 2360 PLN/month net in years 1-2, 3640 PLN/month net in years 3-4).

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