The LED light bulbs routinely purchased for lighting our homes or offices contain sets of small semiconductor systems, “sandwiches” composed of layers of semiconductors with properly selected electric characteristics converting electric energy into blue light which, in turn, is converted in a phosphorescent material into light covering the visible spectrum so, that we accept it as a ”warm” white light suitable for domestic use. The invention of this energy-efficient, environmentally friendly and long-living light source gave its authors – Akasaki, Amano, and Nakamura, the Nobel Prize in Physics in 2014. But definitely this was not the end of the story. This achievement paved the way for ideas of further development of even more energy and cost effective semiconductor light sources. There are still important physical phenomena and technological obstacles which limit the efficiency of energy conversion, from electric energy to visible light, below the theoretically achievable limit in the devices manufactured up to now. For example, fabrication of perfect thin layers of nitride semiconductor on a cheap substrate which has different parameters of crystal lattice is quite a challenge. One of the seriously considered solutions is to replace in light emitting devices some continuous layers of semiconductors with a “brush” of narrow sticks grown on the substrate. As they usually have diameter of the order of 100 nm or less – they are called “nanowires”. In such narrow structures, strains due to crystal lattice mismatch with the substrate can easily be accommodated and defect formation avoided. Moreover, new phenomena can be utilized, like resonances in cavities or light guiding, in order to improve light generation or extraction from the structure. However, new challenges also appear. If we want to control and improve properties of the whole devices we have to know and understand the properties of nanowires, in particular optical and electronic, with submicron or nanometer resolution which allows us in turn revealing properties of such sub-structures of nanowires, as quantum wells, barriers, *p*- o *n*-type layers in the heterojunctions etc. Therefore we plan to study phenomena causing irregularities in the growth of nanowires, leading to disadvantageous modifications of their structure acting as main obstacles for efficient energy conversion in nanowire-based systems and also to consider some phenomena appearing by nature during the growth, like strain induced at the junctions with the lattice constant misfit, as a tool for controlling the important properties of the structure, like energy of the emitted light.

In our studies, we are going to use molecular beam epitaxy as a method of well controlled growth of nanowire ensembles composed of gallium and aluminum nitrides and spectroscopic and imaging methods based on scanning electron microscopy as the tools for local probing the properties of electronic system of nitride semiconductor nanowires. The latter will be cathodoluminescence (luminescence excited by the electron beam) and electron beam induced current spectroscopies, also used in imaging mode. The combination of the nanometer or submicron lateral resolution (due to strong focusing of the electron beam in the microscope) with high spectral resolution allow conclusive studying of abovementioned parameters of individual nanowires.

The primary result of the project implementation will consist in the conclusions concerning fundamental physical properties of the complex one-dimensional semiconductor systems, like mechanisms of light generation processes in such systems or accommodation and role of strains in nanowires with radial and axial heterostructures. Apart from those conclusions important for basic research, the project should deliver information necessary for optimization of one-dimensional nitride system technology and potential improvement of energy and cost effective sources of light. As a considerable part of human energy consumption is related to artificial lighting, saving any part of it contributes to environmental protection, limiting the green-house effect and supports the sustainable development of the civilization.