The necessity to exchange classical lighting (tungsten bulbs, halogen lamps) for Light-Emitting Diodes (LEDs), due to economic and ecological reasons, has led to dynamic development of optoelectronic technologies, focusing on searching for more and more effective semiconductor light sources. In contrast to classical light bulbs, LEDs convert almost all electricity into light emission, which results in much lower energy consumption. With the use of electroluminescent diodes the power consumption can be reduced up to 70%. Lower energy consumption, in turn, translates into lower CO_2 emissions, which means that with the current threats resulting from the climate change, LEDs are the only lighting alternative for modern civilization. In addition, LEDs have a number of other properties that make them unrivaled compared to standard lighting: they are environmentally friendly (produced without the use of dangerous mercury), have a much longer lifetime (up to 15 years), and are characterized by a narrow spectrum of light (emit light with a specific wavelength).

Electroluminescent diodes have been known since the 1960s, but their widespread application has become possible only after the development of blue and ultraviolet (UV) LEDs. The light source in these diodes is the crystalline gallium nitride (GaN) layer. In order to achieve intensive light emission, the GaN layer must be free from defects, which impose the use of high vacuum and expensive techniques, such as Metal Organic Chemical Vapor Deposition (MOCVD). A potential substitute for the GaN in these LEDs is zinc oxide (ZnO). This is due to a number of reasons, the key of which are the wide and direct energy band-gap and high exciton binding energy (~ 60 meV), almost 2.5 times higher than in GaN, enabling their efficient recombination at room or higher temperature (radiative recombination). In addition, the refractive index of ZnO is significantly lower than that of GaN, which facilitates the extraction of photons from the surface of the material. Both of these processes (efficient recombination of excitons and better photon extraction) contribute to the potentially excellent emission properties of ZnO in the UV light range. In addition, ZnO is non-toxic, chemically resistant and can be manufactured by simple and economical methods. Unfortunately, the efficiency of UV light emission is hampered by the presence of structural defects that disturb the dynamics of excitons in this material. Defects introduce additional energy states located within the semiconductor energy band-gap, which act as traps for energy carriers (electrons, holes), redirecting radiative recombination from the short-wavelength (UV) to the long-wavelength (visible) range. As a result, ZnO emits green, orange or red light. This problem is trying to be solved by using a variety of modulators (e.g. materials with a larger energy band-gap than that in ZnO), which covers the surface of ZnO (coating material, CM), or by using metallic nanoparticles (plasmonic metal, PM) that generate surface plasmon resonance in the selected spectral region. These modulators introduce additional channels into the optical system for charge or energy flow that can contribute to both amplification and suppression of UV emission in ZnO. Methods based on the introduction of the modulators require constant improvement and a better understanding of their basics and operative mechanisms. **The aim of the project is to master the charge and/or energy transfer processes in ZnO-based optical systems in the presence of various CM and PM in order to obtain a strong and stable enhancement of exciton recombination in ZnO (UV light emission).**

The aim of the project will be implemented by fabrication of repeatable optical systems based on hexagonally ordered ZnO nanostructures, produced always under the same conditions using anodic aluminum oxide (AAO) assisted atomic layer growth (ALD) technique. First step to increase the UV emission will rely on arrangement of ZnO nanostructures into a self-resonant luminescent antennas (collective amplifying mode). Next, controlled external variables (known electron properties of the introduced materials, such as bandgap energy, energy of Fermi level and its position relative to the ZnO conductivity band, etc., and controlled geometric parameters, such as the thickness of the modulator layer, the size of metallic nanoparticles, etc.) will be sequentially introduced to the hexagonally ordered ZnO nanostructures, and then the luminescence properties of the ZnO-based optical systems will be analyzed as a function of the introduced variables (individual amplifying modes). Upon analysis of the reaction of the ZnO-based optical systems on the introduced modifications, it will be possible to observe indirectly the energy and charge transfer at the ZnO-CM-PM interfaces. **The approach merging both the collective and individual amplifying modes into one optical system will be a completely novel approach to enhance UV light emission from defective broad bandgap semiconductors.** Realization of the project assumptions will, therefore, contribute to the production of efficient, ecological and inexpensive semiconductor light sources.